B&L Woodwaste Site
Pierce County, Washington

Engineering Design Report (EDR) Addendum 3

Phase 2 Part 1 Remediation Design Report

Groundwater Recovery and Treatment System

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1.0 Introduction

This Addendum to the Engineering Design Report (EDR; Floyd|Snider/AMEC 2009a) for the B&L Woodwaste Site (Site) describes the remedial design for a portion of the remedy specified in the 2008 Cleanup Action Plan (CAP) for the Site issued by the Washington Department of Ecology (Ecology 2008). The Site remedy specified in the CAP includes the following components:

- A slurry wall constructed around the perimeter of the B&L Woodwaste Landfill (Landfill) enclosing contaminated groundwater directly beneath the Landfill.
- An interceptor trench located on the upgradient portions of the slurry wall to facilitate groundwater flow around the barrier wall.
- In-situ treatment of groundwater along the leading edges of the groundwater plume extending downgradient from the Landfill.
- Recovery and treatment of groundwater enclosed by the slurry wall to establish and maintain an inward hydraulic gradient across the barrier wall.
- Recovery and treatment of contaminated groundwater in areas outside the Landfill.
- In-situ treatment of contaminated groundwater remaining outside the Landfill following the conclusion of recovery and treatment
- Removal of contaminated sediment in ditches that have been affected by releases from the Site.

The elements of the remedy described in the first three bullets above have been implemented under EDR Addenda 1 and 2 (Floyd|Snider/AMEC 2009b and 2009c, respectively). This Addendum addresses the fourth and fifth bullets. Future Addenda will address the sixth bullet, concerning area in-situ treatment, and the final bullet concerning ditch sediment removal. Implementation of the remedy specified in the CAP will be complete when ditch sediments have been removed and remediation of the groundwater arsenic contamination outside the Landfill has been completed.

The fifth and sixth bullets reflect a decision by Ecology in 2010 to remediate the areas outside the Landfill using a hybrid approach. The goal of this approach, which is based on the results of an Engineering Alternatives Evaluation (EAE; Floyd|Snider/AMEC 2010), is to use groundwater recovery to reduce the mass of arsenic in the groundwater plume by recovering groundwater from the highest concentration areas, followed by in-situ treatment to achieve cleanup levels. This approach was developed and approved based on a number of factors; refer to the EAE for additional details. First, groundwater recovery is better suited to mass removal than to aquifer restoration, particularly in the more permeable portions of the aquifer where the highest concentrations of arsenic in groundwater (greater than approximately 500 µg/L), and approximately 80 percent of the arsenic mass, are located. While groundwater recovery is generally not effective at aquifer restoration, in-situ treatment has been demonstrated to be effective at remediating arsenic in Site groundwater. Secondly, focusing groundwater recovery on the highest concentration areas provides for an optimum treatment plant capacity; one that is large enough to allow substantial flexibility for future operations but small enough to be operated efficiently for the reduced groundwater recovery flow rates that will occur from the Landfill for long-term future operations.

The groundwater recovery system design will target the areas where arsenic is estimated to be greater than 500 µg/L. Numerical modeling results used to evaluate the capture zone for the recovery wells indicate that the wells will also capture impacted groundwater from areas beyond the projected 500 µg/L contours. The results indicate that groundwater from much of the area in which arsenic is greater than the cleanup level of 5 µg/L in the vicinity of the pumping wells will flow toward recovery wells and be recovered. This large cone of depression will help to reduce the footprint of the plume in these areas. This is particularly relevant in the areas along the eastern (i.e., upgradient) side of the plume, where capture is projected to include nearly all of the Eastern Boundary Mini-Plume, including the small portion that extends onto the adjacent property northeast of the B&L Property. Groundwater recovery will also capture much of the Agricultural Field Plume and the Wetlands Plume. The estimated extent of the groundwater plume in these areas is shown on Figure 2.1.

A pilot study for in-situ treatment of arsenic in groundwater will be completed in 2011. The pilot study area will be located west of the estimated 500 µg/L arsenic contour in the Wetlands area north of the Landfill; refer to Drawing C-02. The primary goals of the pilot study are to establish the effectiveness of in-situ treatment technologies previously used at the Site as permeable reactive barriers for area treatment of arsenic, and to support optimization of in-situ treatment for areas of contamination remaining following mass removal by groundwater recovery.

Specifically, this Addendum addresses the design and construction of the groundwater recovery system and a groundwater treatment system needed to remove contaminants and discharge the treated water. The groundwater recovery system will address groundwater contained within the existing barrier wall, two small plumes of contaminated groundwater located to the east and west of the Landfill, and a large groundwater plume to the north of the Landfill. Collected groundwater will be treated in an above-grade system to remove contaminants, achieve discharge criteria, and release the treated water to the existing surface water drainage system. The groundwater recovery and treatment system will include instruments and controls as appropriate to ensure it achieves protectiveness standards specified in the CAP. These remedy components will be the initial construction element for the Phase 2 CAP implementation to be performed under Consent Decree No. 08-2-10610-7 (Consent Decree). The Phase 2 implementation has subsequently been divided into two parts: Part 1 addresses the components included in this Addendum, as described above, and Part 2 will address removal of contaminated ditch sediments. Addendum 4, to be prepared next year, will address Part 2 of the Phase 2 implementation program.

The Site is located within unincorporated Pierce County (Drawing G-01). The Landfill property, property ownership, and general land use for area properties are described in the EDR; the descriptions are not repeated here. The definitions for abbreviations and acronyms used in this Addendum are those described in the EDR.

The work described in this Addendum will be performed primarily within the B&L Property (refer to EDR, Figure 1.1), but will extend onto adjacent properties, specifically the property located west of the B&L Property that is owned by the Washington State Department of Transportation (WSDOT; property was previously owned by City of Fife), the Interurban Trail owned by the City of Milton, and the Redford property to the north of the Interurban Trail. The purpose of the groundwater recovery and treatment systems is to ensure that contaminated groundwater beneath the Landfill will not be released to groundwater outside the barrier wall and to remove contamination in groundwater outside the barrier wall with the ultimate goal of achieving the cleanup levels specified in the CAP.

This Addendum is organized as follows:

- Section 2.0 presents the design criteria and design basis.
- Section 3.0 presents an overview of the design of the groundwater recovery and treatment systems.
- Section 4.0 presents an overview of the construction plan for the remedy components described in Section 3.0.
- Section 5.0 describes performance monitoring and plans for operation, monitoring, inspection, and maintenance.
- Section 6.0 presents the construction schedule and anticipated reports.
- Section 7.0 lists references.

1.1 REGULATORY REQUIREMENTS

The EDR and this Addendum fully address the requirements specified in the Model Toxics Control Act (MTCA) regulations specified at WAC 173-340-400(4)(a). Table 1.1 provides a summary of the MTCA requirements (first column) and references the appropriate sections of the EDR and Addendum 3 (second and third columns, respectively) which address each of the requirements.

2.0 Design Scope, Criteria, and Basis

This section presents the scope, criteria and basis for design of the groundwater recovery and treatment systems. A design basis memorandum was approved by Ecology on December 10, 2010. Key components of the design basis are described below. Appendix 3A includes a copy of the approved Design Basis Memorandum. The primary design objectives for this portion of the CAP implementation project are:

1. to recover groundwater from the contained area beneath the Landfill to prevent outward migration of contaminants and
2. to recover groundwater from the plume outside the Landfill with the long-term objective of achieving groundwater cleanup levels outside the Landfill.

Recovered groundwater must be treated and discharged in a manner that is protective of human health and the environment.

The scope of the design addressed by this Addendum includes groundwater recovery within the barrier wall surrounding the Landfill, groundwater recovery from the Eastern Boundary Mini-Plume, groundwater recovery from the Agricultural Field Mini-Plume, and groundwater recovery from the Wetlands Area (refer to Figure 2.1). The scope includes treatment and discharge of recovered groundwater.

2.1 DESIGN CRITERIA

Design criteria were developed for design of the groundwater recovery and treatment systems. These criteria are summarized below for each component of the design addressed by this Addendum.

The design criteria for the groundwater recovery system are as follows:

- The recovery wells will be distributed to achieve recovery of groundwater within the designated recovery area and to provide operational flexibility during future operations.
- Piping and manifolds for collection of groundwater will support flexible operations so that individual wells can be removed or returned to operation without significantly affecting operation of other wells.
- The recovery wells will be designed and constructed in accordance with the current standard practice.
- Collection piping, power lines, and control wiring for the collection system will be constructed below grade to the extent practicable.
- Trenching for collection piping, power, and controls will be designed for minimal impact to wetlands.

Design criteria for the groundwater treatment system include the following:

- Provide sufficient treatment capacity and operating flexibility to support operation of the groundwater recovery system to achieve CAP objectives.
- Remove site contaminants from groundwater and achieve discharge criteria that are protective of human health and the environment.
- Discharge treated water to the existing surface water drainage system.
- Size process equipment for the current design flow and for expected future flow reductions.
- Include standby redundancy for critical process equipment to minimize process downtime.
- Automate the main treatment processes to allow un-manned operation during weekends, evenings, and weekdays when an operator is not present.
- Include a centralized control system that can be remotely monitored via an internet connection.
- Provide sufficient storage for chemical feed solutions for at least 1 week of run time under average flow conditions.
- Comply with applicable, relevant, or appropriate regulations and standards (federal, state, and local).

General design criteria that address all remedy components included in this Addendum are as follows:

- Conduct remediation work within wetland areas located on or adjacent to the B&L Property in accordance with applicable laws and regulations and in accordance with permits, as appropriate.
- Do not adversely impact neighboring properties, including the Interurban Trail, during and after construction of the remedy components.
- Comply with applicable, relevant, or appropriate regulations and standards (federal, state, and local) for the remedy components included in this Addendum.
- Comply with appropriate industry, professional engineering, and technical standards for the remedy components included in this Addendum.

The preliminary design for the groundwater recovery and treatment systems and the monitoring well network presented in this Addendum addresses the above criteria.

2.2 DESIGN BASIS

The design criteria and basis provide a foundation for completing the design and engineering of the remedy components addressed in this Addendum. This section summarizes the engineering and design basis used to complete the preliminary design and to be used in preparation of the plans and specifications. The design and construction approach presented in Sections 3.0 and

4.0 of this Addendum are based on the above criteria and the design basis summarized below. A copy of the Design Basis Memorandum that was used in preparation of this design is included as Appendix 3A.

2.2.1 General Design Basis

The general design basis for the groundwater recovery system and treatment plant is as follows:

- Groundwater recovery within the contained area beneath the Landfill will be capable of achieving a minimum head differential across the barrier wall of 0.5 feet (ft).
- Groundwater recovery capability will be provided for the areas outside the barrier wall that has been estimated to exceed 500 µg/L arsenic, as depicted in Appendix 3A, Figure 1.[1]
- The total pumping capacity for the groundwater recovery systems will be at least 150 percent of the recovery rates estimated to achieve the design objectives identified in Items 1 and 2 above.
- The groundwater treatment system will be designed for a continuous, average flow capacity of 40 gallons per minute (gpm).
- The groundwater treatment system will be designed to operate at a minimum continuous flow rate of 15 gpm and a maximum, short-term flow rate of 60 gpm to accommodate a range of potential operations.
- The groundwater treatment system will be designed to receive the groundwater quality presented in Appendix 3A, Table 1, which is considered as a reasonable, worst-case groundwater quality that will be recovered from either inside and outside the barrier wall.
- The groundwater treatment system will be designed to achieve the anticipated water quality criteria listed in Appendix 3A, Table 2 in the treated effluent.
- The groundwater treatment process design will be based on the results of a pilot treatability study conducted in 2010; the treatability study report is included as Appendix 3B. The process will consist of a primary treatment process using chemical oxidation with potassium permanganate ($KMnO_4$), pH adjustment/precipitation with lime, and settling, which will then be followed by a secondary treatment consisting of pH adjustment, filtration, and adsorption.
- The groundwater treatment system will include an automated control and data acquisition system, and will be designed to operate under automatic control, with minimal direct operator attention during normal operations. The control and data acquisition system will monitor groundwater level in selected observation wells/piezometers, and will allow remote monitoring of operations and groundwater

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[1] This area is estimated to provide optimum use of groundwater recovery capacity for arsenic mass removal. Groundwater outside the 500 µg/L contour is also expected to be recovered and remediated. Arsenic contamination remaining after mass removal by groundwater recovery will be addressed by in-situ treatment.

levels. The control and data acquisition system will include the following, at a minimum:

  - Automatic control of the groundwater recovery pumps for the contained area and the areas outside the Landfill.
  - Automatic control of the groundwater treatment plant.
  - Monitoring of transducers in selected groundwater wells and piezometers.
  - Monitoring and supervisory control for the existing interceptor trench pump control system.
  - Remote autodialing and alarm capability.
  - Data logging/recording capability.
  - Remote monitoring capability for the groundwater recovery pumps, treatment system operations, and level monitoring instruments.
- The design shall be for a permanent facility suited for reliable, long-term operations.
- The design shall not adversely affect the Landfill, barrier wall, or interceptor trench.
- The design shall be consistent with current and anticipated future land uses near the B&L Property.
- The design shall support compliance monitoring and monitoring of facility operations.

2.2.2 Environmental Protection Basis

The design basis includes the following measures and precautions for environmental protection:

- Construction will be performed in accordance with a General Stormwater Permit.
- Construction of the remediation components included in this Addendum that require disturbance of soils will occur during the dry season, which is assumed to end at the beginning of October (assumed to be October 1).
- Work conducted within wetland areas will be performed in accordance with the terms and conditions of a wetlands permit obtained from the U.S. Army Corps of Engineers (USACE).

3.0 Remedial Measures Design

This section presents the design for the groundwater recovery and treatment systems. The designs are based on the project criteria and design basis described in the previous section, and on the remediation approach specified in the 2008 CAP. This design addresses the groundwater recovery and treatment portion of the Phase 2 implementation program described in the Consent Decree. Preliminary drawings supporting the system design are included in this document. Final drawings will be prepared for the Plans and Specifications; final drawings will be included in Appendix 3F (Reserved).

3.1 LANDFILL GROUNDWATER RECOVERY SYSTEM DESIGN

The groundwater recovery system for the Landfill is designed to withdraw groundwater from the Upper Sand Aquifer (USAq), within the area enclosed by the existing slurry wall. The primary purpose of the recovery system is to maintain the groundwater elevation within the enclosed area at a lower head than the USAq outside the barrier wall and below the lower silt aquitard, so that contaminated groundwater will not flow from the contained area. The Landfill groundwater recovery, in conjunction with the barrier wall, will provide hydraulic containment of the contaminated groundwater beneath the Landfill.

3.1.1 Landfill Groundwater Recovery Wells

The groundwater recovery wells for the Landfill will consist of a network of new and existing wells distributed over the surface of the Landfill (Drawing C-02). Groundwater modeling results indicate that the optimal pumping pattern to achieve the design cross-wall gradient of 0.5 ft for hydraulic control can be attained by pumping primarily from wells distributed over the northwestern (i.e., downgradient) portion of the Landfill. Minimal pumping requirements were projected by the model for the southeastern (upgradient) portion of the Landfill. Groundwater modeling also predicted that the highest pumping rates for individual wells would be those located near the known aquitard gaps (i.e., the central portion of the east side and in the southwest corner of the Landfill). Groundwater modeling results for waste dewatering indicated that an optimal pumping pattern would withdraw groundwater predominantly in the central and southeastern portions of the Landfill, and would include several wells that would not be used in the optimal pattern for hydraulic control. The groundwater recovery rates for individual wells that were predicted to support waste dewatering may exceed the capacity of individual wells to produce water, depending on the nature of the USAq formation in the vicinity of the well. The hydraulic conductivity is generally low in the USAq beneath the center and southeastern portion of the Landfill, and the USAq is known to be fairly heterogeneous. For this reason, it is possible that the recovery well network prepared for this design may require future modifications to achieve waste dewatering. The individual wells in the Landfill network will be evaluated to assess the maximum well production capacity, based on data collected during startup and initial operations.

Based on these considerations, the recovery well distribution shown on Drawing C-02 has been incorporated into the design. Groundwater modeling results indicate that this distribution will support attainment of the design hydraulic control objective (i.e., a minimum cross-wall gradient of 0.5 ft). Groundwater modeling results also indicate that this well network would enable waste dewatering, provided that wells in these locations have the specific capacity to pump at the modeled rates; as noted above, it may be necessary to supplement this network, depending on actual well capacities. Additionally, this well distribution will support groundwater recovery from an area distributed over most of the contained area, which will allow flexibility in pumping patterns and allow groundwater recovery operations flexibility. It should be noted that existing Well PD-109 will not be incorporated into the recovery well network, as this well is apparently screened in a low permeability zone and the yield is not sufficient for effective groundwater recovery.

The pumping rates for individual wells predicted by the groundwater model to establish hydraulic control varied from 0.25 to 4 gpm. The highest pumping rate was predicted for Well R-2, on the east side of the Landfill. The predicted pumping rates for the three wells located in the southwest portion of the Landfill were 2.5 to 3 gpm. The total predicted optimal pumping rate for hydraulic control was approximately 20 gpm. The maximum pumping rate predicted for waste dewatering was approximately 15 gpm from Well R-2, with a total predicted pumping rate of approximately 38 gpm.

The Landfill extraction wells will be designed as shown on Drawing P&ID-05. Each newly installed well will be 6-inch diameter Schedule 80 PVC with a minimum screen length of 10 ft. Boreholes will be logged during installation to ensure that the well screen is placed in a transmissive zone within the USAq. Well screens will be 6-inch diameter PVC vee-wire wells screens. Sand pack, grouting and surface completion will be as shown on Drawing C-09. The wells will be completed in a below-grade vault, with collection piping, power, and controls entering the vault from the utility trench. The surface of the vault will be flush with the surface of the landfill cap so that the wells do not interfere with maintenance of the cap. The well heads will be equipped with a manual shutoff valve, check valve, totalizing flow meter, and a pressure gauge. The location and top-of-casing elevation of each well will be surveyed after completion. Excess soil from installation of the wellhead vaults will be spread over the landfill cap and will be hydroseeded.

3.1.2 Groundwater Collection Manifold

The groundwater from the landfill wells will be collected in a buried high-density polyethylene (HDPE) piping network. The piping will be run underground to provide freeze protection, to eliminate potential UV damage from the sun, protect the pipe from physical damage and vandalism, and to support maintenance of the landfill cap. The piping will be buried in a common trench with the power and control cables to minimize installation cost.

In order to avoid damage to the landfill cap, the piping will be buried in a 1.5 foot deep trench, with the last 6 inches being excavated by hand. Four inches of pea gravel will be placed as pipe bedding and haunching. Sufficient backfilled pea gravel will be used to provide a minimum of 6 inches of cover over the installed pipe. The remainder of the trench will be backfilled with existing material (provided there are no large lumps of clay, organic material, stones, or construction debris) and mechanically compacted. The trench width at the pipe grade will be equal to the pipe outer diameter plus 12 inches. Electrical and control wiring conduit will be placed adjacent to the piping, in the same trench, as described below. Excess soil from the trenches will be spread over the landfill cap and covered with topsoil and hydroseed.

The piping layout is shown in Drawing C-04. The piping network has a branched structure with small-diameter piping connecting each well to a main trunk of larger diameter. Pipe diameters were selected to provide suitably low pressure drop at the maximum flow condition of 6 gpm for any one well within a single pipe branch with the remaining wells on that branch pumping at their average expected flow rate. The layout was developed to provide reliable flow conditions with minimal piping lengths. There will be a swing check valve for each well connection to the pipe network to ensure the pumps are not working against each other.

3.1.3 Pumps, Electrical, and Controls

Each extraction well will be equipped with a submersible, multistage centrifugal well pump. The well pumps will be selected to provide sufficient head to overcome the static head of the well depth as well as dynamic head losses due to pipe friction from piping and fittings. The dynamic head loss calculations will consider flow contributions from all other pumps connected to the shared lines under maximum flow conditions. The pumps will have integral dry-run protection, to prevent damage to the pumps in the event that the well is completely exhausted of groundwater.

Each well pump will be variable speed to allow fine control of pumping rates from each well. The pumps will be controlled by the treatment system centralized programmable logic controller (PLC) that will utilize the transducer readings of the perimeter piezometers to monitor the cross-wall groundwater gradient and adjust the pumping rates accordingly. The run time of each pump will be totalized by the PLC to provide appropriate maintenance intervals.

Power and control cables will be buried in a common trench with the groundwater collection piping. The power and control cables will be selected to prevent moisture damage, and will be installed in HDPE conduit adjacent to the groundwater piping.

Piezometers installed around the perimeter of the Landfill will have buried power and control cables. The buried cables will be tied into the trench network for the groundwater piping. The level signals from the piezometers will be recorded by the PLC and will be used to control the speed of the well pumps in that region. Transducers will be placed in the existing piezometer pairs around the Landfill that monitor groundwater level on each side of the barrier wall; the piezometers completed in the Lower Sand Aquifer (i.e., PZ-8c and PZ-4c) will also be equipped with a transducer that will be monitored and recorded by the control system.

3.2 OUTSIDE AREA GROUNDWATER RECOVERY SYSTEM DESIGN

Groundwater will be recovered from three areas located outside the Landfill, including the Wetlands Plume area, Eastern Boundary Mini-Plume, and Agricultural Field Plume. The groundwater recovery network for these areas will include six wells for the Wetlands Plume, two wells for the Eastern Boundary Mini-Plume, and two wells for the Agricultural Field Plume.

Groundwater produced from these areas will be collected and directed to the groundwater treatment system located on the B&L Property via underground piping manifolds. The design for the outside area groundwater recovery system is described below.

3.2.1 Outside Area Groundwater Recovery Wells

The groundwater recovery wells for the three outside area plumes will consist of a network of new wells distributed as shown on Drawing C-04. Groundwater modeling results indicate that these wells will capture groundwater within the estimated extent of the plume exceeding 500 µg/L arsenic in each of these areas. Optimal pumping rates predicted by groundwater modeling are as follows:

- Wetlands Plume: 1 gpm per well, 6 gpm total
- Eastern Boundary Mini-Plume: 1.6 to 2.1 gpm per well, 3.6 gpm total
- Agricultural Field Plume: 1.6 gpm per well, 3.2 gpm total

The total predicted pumping rate for the outside areas is 12.8 gpm. These pumping rates are generally less than those anticipated for the landfill recovery wells.

The well distribution shown in Drawing C-04 is expected to effectively contain and recover groundwater exceeding 500 µg/L within the areas outside the Landfill based on groundwater modeling using the model calibrated to the Site. The well distribution is also designed to recover the most highly contaminated groundwater and to minimize, to the extent practicable, drawing the plume downgradient and away from the Landfill. Given the capture zone for the well distribution at the low pumping rates predicted from the modeling, it is expected that the capture zones for individual wells could be readily increased by pumping the well at a greater rate, enabling the operator to adapt the capture zone to address actual subsurface conditions. This well distribution is expected to meet the design basis described above and included in Appendix 3A.

The design for the outside area groundwater extraction wells is shown on Drawing P&ID-05. Each well will be 6-inch diameter Schedule 80 PVC with a minimum screen length of 10 ft. Boreholes will be logged during installation to ensure the well screen is placed in a transmissive zone within the USAq. Well screens will be 6-inch diameter PVC vee-wire wells screens. Sand pack, grouting, and surface completion will be as shown on Drawing C-08A. The outside area recovery wells will be completed above grade, with steel-protective surface casing. The well and protective casings will extend about 1 foot above the 100-year flood plain. The well will be connected to power, control wiring, and groundwater collection piping inside the protective casing. The protective casing will include a locking cover to reduce the potential for vandalism. Groundwater collection piping, power, and controls will enter the protective casing below grade from the utility trench. The piping and controls will be directed to the top of the well casing for connection to the well at an elevation above the flood plain, allowing access for operations and maintenance. The well heads will be equipped with a manual shutoff valve, check valve, back pressure regulator, totalizing flow meter, and a pressure gauge. The location and top-of-casing elevation of each well will be surveyed after completion.

3.2.2 Groundwater Collection Manifold

The groundwater from the outside area wells will be collected in a buried HDPE piping network. The piping will be run underground to provide freeze protection, eliminate potential long-term UV damage, and protect the piping from physical damage and potential vandalism. The piping will be buried in a common trench with the power and control cables to minimize installation cost and reduce the trenching requirements, especially in wetland areas.

The trench design for the outside area wells will minimize the potential for encountering contaminated groundwater, thereby avoiding safety issues and avoiding costs for management and disposal. The obvert of the pipe will be a minimum of 18 inches below grade. The trench will be over-excavated by a minimum of 6 inches; the over-excavated depth will be filled with pea gravel for pipe bedding. The minimum trench width at the pipe grade will be equal to the pipe outer diameter plus 12 inches. Sufficient backfilled pea gravel will be used to provide a minimum of 6 inches of cover over the installed pipe. Electrical and control wiring conduit will be placed adjacent to the piping, in the same trench, as described below. The remainder of the trench will be backfilled with native soil (provided there are no large lumps of clay, organic material, stones, or construction debris) and mechanically compacted in 8-inch lifts. Excess soil from the trenches will be spread over the landfill cap as topsoil and will be hydroseeded.

The preliminary piping layout is shown in Drawing C-04. The piping network has a branched structure with small-diameter piping connecting each well to a main trunk of larger diameter. Pipe diameters will be selected to provide suitably low pressure drop at the maximum flow expected flow condition for each well. For most wells the maximum expected flow is 2 gpm. For wells R-12 and R-21 the maximum expected flow will be 4 and 2.1 gpm, respectively. The layout was developed to provide reliable reasonable headloss, with minimal piping lengths and to minimize disturbance of wetland areas. Where possible, the piping manifolds located on the B&L Property will be run along the existing access road surrounding the Landfill. A single, perpendicular crossing of the Interurban Trail will be made to avoid excessive disturbance of the trail; it is expected that a trench will be placed through the trail, followed by repair of the asphalt surface according to City of Milton street work standards. There will be a swing check valve for each well connection to the pipe network to ensure flow is only toward the treatment building.

3.2.3 Pumps, Electrical, and Controls

Each extraction well in the outside area will be equipped with a submersible, multistage centrifugal well pump. The well pumps will be selected to provide sufficient head to overcome the static head of the well depth as well as dynamic head losses due to pipe friction from piping and fittings. The dynamic head loss calculations consider flow contributions from all other pumps connected to the shared lines. The pumps will have integral dry-run protection, to prevent damage to the pumps in the event that the well is completely exhausted of groundwater.

Each well pump will be a fixed-speed pump operated under on/off control. Flow from individual wells will be manually set using the back pressure regulators. The pumps will be controlled by the treatment system centralized PLC. The run time of each pump will be totalized by the PLC to provide appropriate maintenance intervals. Total flow from each well will be recorded by the well head flow meters.

Power and control cables will be buried in a common trench with the groundwater collection piping. The power and control cables will be selected to prevent moisture damage and will be installed in HDPE conduit adjacent to the groundwater piping.

3.3 GROUNDWATER TREATMENT SYSTEM DESIGN

Groundwater recovered from beneath the Landfill and from the recovery areas outside the Landfill must be treated so that it can be discharged to surface waters. The treatment process will be based on the results of on-site pilot testing that was conducted on groundwater at the Site in 2010. The pilot testing report is included as Appendix 3B. Testing results indicated that groundwater at the Site can be treated to achieve the cleanup criteria specified in the 2008 CAP. The treatment plant will be operated under a National Pollutant Discharge Elimination System (NPDES) permit issued by Ecology. Treated water will be discharged to the stormwater pond located immediately north of the Landfill; this pond overflows to the adjacent agricultural ditch.

3.3.1 Process Design

The groundwater treatment system has been designed with the primary goal of removing arsenic from the contaminated groundwater recovered from the Site, to achieve effluent concentrations that meet the discharge criteria summarized in Section 2.2. The treatment system consists of oxidation, pH adjustment and co-precipitation, clarification, pH adjustment, filtration, and adsorption. A flow diagram is presented in Drawing PFD-01. The treated groundwater will be pumped along a buried pipeline to the north pond (Drawing C-04). The solids stream from the clarification process will be stored in a sludge tank before being dewatered with a filter press; dewatering of sludge will be done periodically on a batch basis. The filter cake will be picked up and transported to an appropriate waste receiver for disposal. Treatment chemicals will be stored in tanks or transportable totes. All treatment equipment will be located within a treatment building. The following sections describe the treatment processes in more detail.

3.3.1.1 Chemical Oxidation

Groundwater from the recovery wells will be collected in a small groundwater collection tank located in the treatment building and flow by gravity to the oxidation tank. The collection tank will provide a small amount of flow equalization and provide a suitable location to collect a composite sample of the influent groundwater. The total groundwater flow will be measured by an influent flow meter before it enters the oxidation tank. The oxidation tank and co-precipitation tank will each be completely mixed, so that they will provide load equalization and help to dampen changes in influent concentration of the various constituents.

The purpose of the oxidation tank is to provide mixing for the addition of $KMnO_4$ and sufficient reaction time to oxidize iron, manganese, and arsenic. Based on the 2010 treatability testing,

$KMnO_4$ was selected as the preferred chemical for oxidation; the treatability study report is included as Appendix 3B. The addition of $KMnO_4$ will cause both arsenic (III) and iron (II) to be oxidized to arsenic (V) and iron (III), respectively. The higher oxidation states of arsenic and iron precipitate more readily and arsenic (V) is amenable to adsorption on the iron floc.

The oxidation tank will have a working volume of 1,200 United States gallons (gal) which provides 30 minutes of residence time at the average treatment flow rate. Mixing will be provided by a top-mounted 1.0 horsepower (HP) mixer. The tank will be completely mixed to ensure sufficient distribution of the $KMnO_4$, and reduce the likelihood of short-circuiting.

During the treatability testing, the dosage for $KMnO_4$ was determined to be 145 milligrams per liter (mg/L) of groundwater. This dosage has been utilized as the appropriate dosage for design of the full scale treatment system. The dosage depends upon the influent concentration of permanganate-consuming constituents (i.e., iron, arsenic, manganese, and oxidizable organics). The $KMnO_4$ handling system will be designed to provide a range of dosages to support the required flexibility to accommodate changes in the groundwater quality and to service the full range of groundwater flow as set in the design basis. The actual dosage will require adjustment to avoid over- or under-dosing.

Based on the average flow, the expected consumption of dry $KMnO_4$ will be 70 pounds (lb) per day, or approximately 500 lb per week. Due to this level of consumption, a bulk handling system has been included in the design. Drums of granular, crystalline $KMnO_4$ will be purchased from a local chemical supplier and delivered to the treatment building as needed. The drums will be loaded into a drum dumper which will lift and tip the drum to empty the contents into a hopper. The top of the drum and the hopper will be sealed to minimize the escape of dust or fines. From the hopper the $KMnO_4$ will be transported to the top of the $KMnO_4$ storage tank via a flexible conveyor. $KMnO_4$ solution will be made up on a batch basis as needed. The operator will add the correct amount of water to the tank based on the volume of solution to be prepared (determined by the tank level). The run time of the conveyor will be utilized to ensure the correct amount of $KMnO_4$ is added to the storage tank. The operator will add sufficient $KMnO_4$ powder and add the correct volume of water to produce the target concentration, depending on the volume available in the make-up tank. The make-up tank will have a volume of 1,800 gal, which will allow approximately 7 days of operation. For operations at the design flow, it is planned that partial batches of $KMnO_4$ feed solution be made up twice per week to prevent running the tank completely empty, causing an interruption in treatment operations.

The target $KMnO_4$ solution concentration will be 35 grams (g) of powdered $KMnO_4$ per liter (L) of solution (350 lb of $KMnO_4$ per 1,800-gal tank). This is below the published solubility of about 43 g/L water at 10^oC (Lange 1999).

The $KMnO_4$ feed solution will be fed to the oxidation tank via a chemical dosing skid via redundant diaphragm metering pumps to ensure accurate and continuous dosing. The solution will be fed to the system at a rate that is proportional to the influent groundwater flow. Based on the results of the 2010 pilot testing (observed arsenic and iron concentration in untreated water and the optimal dose), a volumetric feed ratio of 1:241 ($KMnO_4$ feed solution flow to groundwater flow) would be used. The feed ratio will be adjusted by operations personnel as necessary to achieve proper treatment and avoid overdosing. At the average design groundwater flow rate (40 gpm), the $KMnO_4$ feed solution flow rate would be 627 mL/min for this volumetric feed ratio. Concentrations of the permanganate-consuming constituents in the untreated groundwater will be monitored to establish and control the proper $KMnO_4$ feed rate.

An oxidation-reduction potential (ORP) sensor and transmitter will be installed in the oxidation tank to monitor ORP and ensure appropriate oxidative conditions are maintained. The ORP sensor will be monitored by the PLC. A warning alarm will be initiated if the ORP is outside of the expected range to alert the operator that there is a potential problem with the $KMnO_4$ dosing system so that corrective action can be taken.

3.3.1.2 Co-precipitation

The groundwater will flow by gravity from the overflow of the oxidation tank to the co-precipitation tank. Lime will be added to the groundwater in the co-precipitation tank to raise the pH to a target value of 8.8 in order to induce the co-precipitation of arsenic with the iron that is present in the groundwater; this is a recognized method for the removal of arsenic and was successfully tested during the 2010 treatability testing. The ferric iron (Fe^{+3}) formed in the oxidation tank will form hydroxides at the elevated pH and precipitate. Arsenic (V) will adsorb to the floc and be entrapped by the precipitated iron hydroxides. These precipitates will settle in the inclined plate clarifier and be removed from the treated groundwater stream. The co-precipitation tank will have a working volume of 1,200 gal, which will provide a 30-minute retention time. The tank will be completely mixed by a 1 HP, top-mounted mixer.

In order to induce the pH change, a lime dose of 5.95 g of dry hydrated lime [$Ca(OH)_2$] per gallon of groundwater was required in the treatability testing. This dosage has been used for full scale system design. Hydrated lime will be delivered to the Site in the form of a slurry, at a concentration of 3.5 lb $Ca(OH)_2$ per gallon of water. Delivery and feed of the lime in this manner eliminates the need for a complex and high maintenance slaking or dry chemical feeding process on site. Lime slurry will be delivered in 2,500-gal bulk loads and stored in a 4,580-gal lime storage tank. The storage tank will be continuously and completely mixed by a 1.5-HP mixer to prevent sedimentation. The lime will be constantly recirculated in a loop via a large peristaltic pump to prevent deposition and scale formation in the lime piping. An automated three-way control valve will be utilized to feed the required volume of lime slurry to the co-precipitation tank from the recirculation loop. An automatic periodic water flush will be utilized to ensure the stagnant portion of piping at the dosing point remains free of any blockage. The lime slurry feed rate will be automatically adjusted with a pH control loop in the PLC to achieve the target pH in the co-precipitation tank.

At the design average groundwater flow rate, the estimated consumption of lime slurry is 216 gallons per day (gal/d). Each load of slurry (2,500 gal) would last approximately 12 days under this flow condition and the dosage determined from pilot testing.

3.3.1.3 Settling

The groundwater will flow by gravity from the co-precipitation tank to an inclined plate clarifier unit. The clarifier unit will be provided with integral flash mix and flocculation tanks. A polymer flocculant will be added directly to the flash mix tank at a rate proportional to the influent groundwater flow rate; for design, a volumetric ratio of 1:358 (flow of polymer to flow of groundwater) has been used.

The polymer will be purchased as neat liquid in 5-gal pails, and will be diluted to a concentration of 0.1 percent (wt/wt) in batches with a vendor-supplied, automated make down system designed especially for effective wetting of the polymer to prevent “fish-eyes” and improper dilution. The expected consumption rate of dilute polymer solution will be 161 gal/d and 0.9 gallons of neat polymer per week. The polymer feed solution will be stored in a 60-gal feed tank that will also be used to prepare new feed solution. The small feed tank has been selected to ensure short storage times for dilute polymer, which will minimize degradation and ensure that freshly prepared polymer is provided to the treatment process. The feed tank is equipped with slow mixing while batches are being prepared. New batches of feed polymer will be automatically prepared when the level in the polymer day tank reaches the low-level set point. Initially, the low-level point will initiate preparation of fresh feed polymer solution when 20 gallons have been used, which should occur approximately every 3.0 hours.

The clarifier unit will be a skid-mounted unit with an integrated rapid-mix tank, flocculation tank, and inclined-plate settler. The rapid-mix tank will provide complete mixing of the groundwater and the dilute polymer solution. The flocculation tank will provide a period of slow mixing to allow proper floc formation. The flocculated groundwater will then flow into the inclined plate settler, allowing the solids to settle to the sludge hopper, and the clarified groundwater to overflow the effluent weir. The clarifier will provide an effective settling area of 160 square feet (ft^2), which provides an overflow rate of 360 gallons per day/ft^2 (gpd/ft^2) at average flow conditions, and 540 gpd/ft^2 at maximum flow conditions. Sludge from the sludge hopper will be pumped to the sludge management process, which is described below.

3.3.1.4 pH adjustment

The clarifier overflow will flow by gravity to the pH adjustment tank. Pilot testing results indicate that in order to achieve effective adsorption of the remaining arsenic in the adsorption columns, the pH should be lowered to a target value of 6.6. The pH will be reduced by the addition of 93 weight percent sulfuric acid (H_2SO_4). The pH adjustment tank will have a working volume of 1,200 gal, providing a residence time of 30 minutes at the average design flow rate. The pH tank will be completely mixed with a 1.0-HP, top-mounted mixer.

Acid will be added to the pH adjustment tank via a vendor-supplied dosing skid, utilizing a duplex diaphragm metering pump system. The wetted parts of the pumps and the acid tubing will be Teflon® or other material selected to ensure compatibility with concentrated sulfuric acid. The rate of acid addition will be controlled by a pH control loop in the PLC and a pH sensor in the pH tank. The expected dosing rate is 1 gallon per hour (gal/hr).

Concentrated acid will be delivered in 265-gal chemical totes. The totes will be placed on containment sump upon delivery to provide secondary containment in the event of a leak. Two totes will be on-site at any given time, to allow one to be in use while the second is being replaced. At the expected dosing rate and the design average flow rate, a single tote should last approximately 11 days.

3.3.1.5 Filtration and Adsorption

The final unit operation to achieve the low-level arsenic concentration targets is adsorption on activated alumina. Based on the performance during treatability testing and cost, activated alumina was selected as the preferred media.

The groundwater will be pumped from the pH tank to a duplex-cartridge filter system. The pumps will provide sufficient pressure to pass through the filters, the adsorption columns, and the discharge pipeline to the north pond. The cartridge filters will remove any remaining particulate to prevent clogging and fouling of the adsorption columns. The cartridges will be periodically removed and replaced, based on pressure readings across the filter housings. Each filter is sized to handle the maximum design flow rate of 60 gpm.

After passing through the filters, the groundwater will flow to the adsorption columns. The activated alumina requires an empty bed contact time of 5 minutes, which equates to a 200-gal (media volume, not including freeboard) adsorption column. The empty bed contact time was recommended by the media manufacturer and verified during the 2010 pilot treatability testing. The media is expected to function for 40,000 bed volumes before significant breakthrough. In order to ensure consistent compliance with the discharge targets, the groundwater will be fed through two 200-gal columns in series. Once 40,000 bed volumes of groundwater have been treated or breakthrough of arsenic is detected in samples collected after the first column, the media in the first column will be replaced and the second column will become the primary column. The spent media will either be returned to the vendor to be recycled or will be transported to an appropriate waste facility. Treated effluent from the second column will be directed to the north pond via an underground pipe.

3.3.1.6 Sludge Management

Underflow from the clarifier will be pumped to the mixed, cone-bottom, sludge storage tank with a pneumatic diaphragm pump operated on a timer control system. The sludge storage tank will have a working volume of 5,264 gal. It is estimated that the sludge will leave the clarifier at a solids concentration of about 1.5 to 2 percent (wt/wt). The sludge will be accumulated in the storage tank for treatment in batches by a filter press. Filter press operation requires continuous operator attention, so the sludge dewatering process will be manually initiated when an operator is on-site.

When a sludge dewatering batch is initiated, sludge will be pumped from the sludge storage tank to the filter press by a second pneumatic diaphragm pump. The filtrate will flow by gravity to a collection sump, where it will be pumped to the influent collection tank for treatment with untreated groundwater. At the end of each filter press cycle, as determined by pressure at the filter press feed, the press will be opened and the sludge cake will fall out of the plates and into a roll-off container below. The roll off container will be stored indoors. The roll-off containers will be removed and replaced as necessary by a waste handling company and taken to an appropriate waste facility. The filter press will produce dewatered sludge that meets the paint filter test and is suitable for landfill disposal.

The solids loading to the clarifier is estimated to be 144 lb dry solids per day, based on the average design flow rate. This estimate includes a 15 percent safety factor over the theoretical calculated value, which is based on the influent metal concentrations and the expected hydroxides that will form. The design solids loading also includes the solids recirculated back to the clarifier from the filter press filtrate, assuming a 95 percent solids capture by the filter press.

It is estimated that under average design flow conditions, two filter press cycles would be needed each week. This could be done in 8 hours of operation spread out over two separate site visits by the operator. The sludge storage tank will have enough capacity for 5 days of storage under average design groundwater flow rates and the groundwater quality observed during the 2010 pilot treatability testing. If the filter press achieves greater percent solids, the mass of dewatered sludge generated each week would be less.

Approximately 960 lb of dry solids in the dewatered filter cake would be produced each week under average design flow conditions. Assuming a conservative (i.e., low) cake solids concentration of 25 percent (wt/wt), the expected total cake weight per week is 3,830 lb (wet). Based on these quantities, the roll-off container of filter cake would require removal from the system for off-site disposal once approximately every 8 weeks.

3.3.1.7 Instrumentation and Controls

The instrumentation for the treatment system is depicted in the process and instrumentation diagrams (P&IDs, Drawings PID-00 through PID-05). The system has been designed to be automated to the extent practical. It is estimated that the system will require two visits to the site per week by a qualified operator to ensure continuous and effective operation. The frequency for operator attention may be greater during periods of high groundwater flow, but is not expected to be less at flow rates below the design average.

The treatment system will include significant instrumentation for control and monitoring purposes. The treatment equipment and instrumentation will be automated with a single, centralized PLC. The system operations can be monitored via a human machine interface (HMI) located in the treatment building. The system will also have remote monitoring and data collection capabilities through an internet interface, to allow the operator to view the status of the system at any time from an alternate location. The control system will also have dial-out functionality so that critical alarms can trigger an automated call to the operator’s mobile phone. The control system will include data logging and tracking of all process inputs.

Flow meters at well heads will provide information about groundwater recovery rates from individual wells; the well head flow meters will not be tied to the PLC. The PLC will monitor and record influent and effluent flow rates, as shown on the P&IDs. The PLC will control pumping rates from the landfill recovery wells, based on a control strategy to be developed and presented in the final design documents. Pumping rates from the outside area wells will be manually controlled using the back pressure regulators included in the well heads. The PLC will exercise on/off control for outside area recovery wells.

3.3.2 Treatment System Pad and Building

3.3.2.1 Building Pad

Due to the historical occurrences of surface water flooding during periods of high rainfall in the area of the B&L Property, a building pad will be constructed for the treatment system at an elevation of approximately 20 ft to match the elevation of the existing access road around the Landfill. This elevation has been consistently above recent flood elevations and is above the elevation of the 100-year flood (MGS Engineering Consultants et al. 2004). The extent of this building pad is shown on Drawing C-03. It will encompass the area around the building, the property access ramp down from Fife Way, and the truck/vehicle parking and turning area.

Based on the results of a geotechnical investigation (refer to Appendix 3K), subsurface soils beneath the building pad will be reinforced with compacted aggregate piers and structural fill. Refer to Drawings C-3.01 through C-3.05 in Appendix 3F. Structural fill will be placed over compacted aggregate piers designed to mitigate excessive settling due to soft to medium stiff silt and peat at depth. The foundation has been specifically designed, and footings specifically located, based on ground improvement using aggregate piers as shown in the drawings. Aggregate piers are also expected to improve the seismic liquefaction stability of the soils underlying the building.

The surface of the building pad will be predominantly ¾-inch crushed rock; however, a sloped concrete pad will be constructed in the area where the lime slurry truck will be parked during chemical unloading. The concrete pad will be sloped to a sump. This will provide spill containment in the event of an unplanned release from the lime slurry truck during unloading, preventing lime from entering the surrounding wetland areas. An environmental containment enclosure will be installed on the outside of the building beneath the lime connection point to collect any drips and spills during lime truck unloading.

The sump will include a sluice gate, which when open will allow stormwater collected on the concrete pad to flow north-east, following the existing drainage pattern which is toward the wetlands area north of the building pad location. A written procedure will be in place to instruct the operator that the sluice gate must be closed before a lime truck is brought on to the Site and parked on the concrete pad. If a spill occurs, the lime would be held in the sump and on the concrete pad where it can be collected and disposed of properly. As part of site preparation, drainage from the building pad and building will be directed to a newly constructed, vegetated swale that will reduce the velocity of runoff from the building pad and direct it to the north, following the existing drainage pattern, which eventually empties to the secondary stormwater pond (constructed by Hydrometrics) and to the agricultural ditch along the south side of the Interurban Trail.

3.3.2.2 Treatment Building

The preliminary elevations of the treatment building are shown in Drawing AS-04. The treatment building will be a metal-clad, pre-engineered building. It will house the treatment equipment, chemical storage tanks, a washroom, an electrical room, an office and laboratory area for bench scale testing, process monitoring, and instrument maintenance. A pre-engineered, metal-clad building was selected to be cost-effective and have a long life span with relatively low maintenance.

The building will include two man-doors: one for everyday access and the second for emergency egress. The building will also include a 10-foot, roll-up door to allow access for moving the filter cake roll-off bin in and out of the building, and a second 8-foot roll-up door to allow access for bulk chemical deliveries and to move equipment in and out of the building for maintenance purposes. The building will have electric heating to maintain the interior temperature above a minimum of 50°F during winter conditions. The building will be insulated with a minimum of R15 insulation for the walls and R20 for the roof. An exhaust fan will be utilized to prevent excess heat build-up in the summer.

The building will have a concrete containment area integrated into the building pad/foundation. The curb will provide secondary containment for any spills or leaks within the building. Steps will be provided as appropriate to allow access and egress. A sump will be included to collect spills and wash water generated during maintenance. Water collected in the sump will be pumped to the influent tank for subsequent treatment in the treatment process. As noted on Drawing M-01 separate secondary containment will be provided for the lime slurry tank. Utilities for the building are described below.

3.3.2.3 Building Layout

The preliminary building layout is shown in Drawing M-01 and M-02. The building layout was developed so the process equipment was in a logical sequence to minimize piping lengths and to support system operations and maintenance. The rationale for the layout is as follows:

- The filter press was positioned near the outside wall to allow easy movement of the dewatered sludge to roll-off containers.
- The acid was stored near the door for easier handling and delivery of the bulk chemical totes.

The preliminary building layout will be subject to change as final equipment dimensions are determined and the detailed mechanical design is developed.

3.3.2.4 Utilities

Power for the building, including three-phase power for large motors and single-phase power for small motors, lighting, and instrumentation, will be brought into the electrical room at the southeast corner of the building via overhead wires from the existing power pole near the southeastern corner of the Landfill. The electrical room within the building will house the required transformers, breakers, distribution panels, and motor starters. Power will be supplied to each of the wells through buried utility trenches from a distribution panel in the electrical room.

Potable water will be brought into the building from the municipal supply lines along Fife Way. Potable water is required for preparing the $KMnO_4$ solution and polymer solution, cleaning, instrument cleaning/maintenance, on-site analyses, and the sanitary use in the washroom.

A small sewer connection will be made via underground piping to the local sanitary sewer service. The only sources of sewage will be a single toilet, the sink drain in the washroom, and the sink drain at the laboratory counter. If necessary, based on building and sewer line elevations, a small lift station may be necessary to transfer sanitary wastewater to the sewer line.

A phone line connection will be brought in from Fife Way. The phone line will be used for an internet connection to support remote monitoring of the control system, for alarm call-outs to the operator's mobile phone, and for office use by system operators.

3.3.2.5 Security

Due to concerns over potential property damage or malicious interference, all critical process equipment and chemical storage tanks will be housed inside the treatment building. The treatment building doors will remain locked at all times when an operator is not present. The building will have protected windows to minimize the potential for vandalism or unauthorized building entry. The roll-off containers for the solids storage will be stored indoors. The well heads will each be contained in a well vault with a steel lid fastened by a 5-sided bolt to prevent intrusion without the proper tool.

4.0 Construction Plan

This section provides an overview of the permitting process for planned construction and a general description of the construction sequence and procedures. The actual steps and procedures will be established by the Construction Contractor with concurrence from the design team to verify that the steps and procedures meet the project intent and requirements, including the plans and specifications.

4.1 PERMITTING AND APPROVAL REQUIREMENTS

This cleanup action is being conducted under an Ecology Consent Decree and, therefore, is exempt from certain procedural and permitting requirements of certain Washington laws and regulations and all local permits (WAC 173-340-710[9][a]); however, implementation of the cleanup action must comply with the substantive requirements of these laws and permits. Table 7.1 of the EDR provides a summary of general permitting and substantive requirements. This cleanup action will meet the substantive requirements for applicable regulations and standards, and will fully comply with all action-, chemical-, and location-specific Applicable or Relevant and Appropriate Requirements (ARARs) as described in the 2008 CAP.

The permitting exemption does not apply to permits required under federal programs or some state-administered federal permitting programs. A portion of the construction work addressed by this Addendum will be conducted within, and will impact, jurisdictional wetlands; therefore, the USACE administered wetland permitting program will apply to the portion of the groundwater recovery system that will be constructed within wetlands. A wetlands permit must be obtained from the USACE for the wetlands work. Wetlands permitting requirements are discussed below.

For Washington-administered federal programs, only permits for stormwater or treated water discharge are required when cleanup work is implemented under a MTCA Consent Decree. The work addressed by this Addendum will require a NPDES Construction Stormwater General Permit to cover stormwater during construction activities and an individual NPDES discharge permit to cover discharges from the groundwater treatment system. Both permits are issued by Ecology. Details regarding these permits are discussed below. Additionally, permits and/or approvals will be obtained as appropriate from local governmental agencies to facilitate substantive compliance with local permitting requirements and ARARs.

A State Environmental Policy Act (SEPA) checklist was done as part of the 2008 CAP public review process. As lead agency, Ecology made a determination of non-significance for the activities identified in the CAP. The work being done under this addendum was specified under the 2008 CAP and therefore is covered under that determination. A review of this determination will be conducted prior to preparing final plans and specifications to assess the need for an addendum to this determination based on current plans and project understanding.

This cleanup action will meet the substantive requirements for all applicable regulations and standards, and will fully comply with all action-, chemical-, and location-specific ARARs as described in the final 2008 CAP (Ecology 2008).

4.1.1 Wetlands Permit

Wetlands permitting is required to cover the portion of the work that will be conducted within jurisdictional wetlands. This will include placement of groundwater recovery wells, monitoring wells, and trenches for installation of collection piping, power, and control wiring. Based on preliminary discussions with the USACE, it is expected that the work would be covered under a Nationwide Permit #38 (NWP 38) that was designed to cover remediation work conducted in wetlands. A Joint Aquatic Resources Permit Application (JARPA) has been prepared to obtain approval under NWP 38 and has been submitted to the USACE. It will be necessary to receive the permit prior to commencing construction work in the wetlands.

4.1.2 Stormwater

A NPDES Construction Stormwater General Permit will be obtained from Ecology to cover construction work addressed by this Addendum. This permit will be obtained prior to starting construction and will be maintained until disturbed soils are fully stabilized. A Spill Prevention and Containment Plan (reserved as Appendix 3D) and a Stormwater Pollution Prevention Plan (reserved as Appendix 3E) will be prepared as part of the plans and specifications package. Best management practices (BMPs), prepared in accordance with the stormwater permit and the 2005 Stormwater Management Manual for Western Washington, will be included in the Stormwater Pollution Prevention Plan. These plans will be implemented for construction of the remedy components addressed by this Addendum.

Because the Landfill is capped and closed, stormwater is not exposed to contaminants beneath the cap nor exposed to untreated groundwater; therefore, it is assumed that following construction and stabilization of disturbed areas, the Construction Stormwater General Permit will be terminated and stormwater at the Site will no longer require management under permit. Consultation with Ecology permit specialists have been initiated and additional sampling effort is underway to confirm this assumption.

4.1.3 Treated Water Discharge

It will be necessary to obtain an individual NPDES permit to cover discharge of treated groundwater; this permit will be issued by Ecology. Preliminary permitting discussions regarding discharge permitting have been conducted with the Ecology permit engineer/specialist for this project. An application for the individual NPDES permit has been submitted to Ecology. A discharge permit must be obtained prior to startup and commissioning of the groundwater treatment system.

4.1.4 Local Permitting and Approval Requirements

The local permitting requirements for the planned work under this Addendum fall within the jurisdiction of Pierce County, as the B&L Property is within unincorporated Pierce County. Preliminary project information has been provided to Pierce County for their review. A meeting to discuss substantive permitting requirements for the work to be completed under this Addendum will be held with Pierce County representatives in late March 2011. This meeting will identify substantive requirements for permitting and city inspection for construction of the building and treatment system, and confirm the process to ensure that the requirements are met. It is expected that a building permit will be obtained from Pierce County to facilitate meeting substantive requirements for building and electrical inspections.

Potential impacts of the planned work on local roadways and traffic will be assessed during preparation of the plans and specifications for the work. Pierce County representatives will assess the work for potential traffic and roadway impacts to Fife Way and surrounding roads after estimates are available. Plans for controlling dust and soil transport from the work area and for protecting the roadway at the entrance to the B&L Property will be provided to Pierce County for review and comment. Access will also be provided to Pierce County staff to conduct inspections as needed. Any project-related road damage to surrounding roadways or the Interurban Trail will be repaired either by project contractors to the satisfaction of the local agency or by the agency itself with reimbursement by the Trust.

Utilities in the vicinity of the project are under both Pierce County and City of Milton jurisdiction. Potable water service will be provided to the groundwater treatment plant building for sanitary and utility use. Approval will be obtained from Pierce County for sanitary sewer service, which will be necessary for sanitary facilities and for sink drains. Approvals will be obtained from the City of Milton for provision of potable water and power. The City of Milton also has jurisdiction over the Interurban Trail. Approval for trenching through the Interurban Trail and requirements for repair of the Trail will be obtained from the City of Milton.

4.1.5 Other Requirements

The community right-to-know provisions of the Emergency Planning and Community Right-to-Know Act (EPCRA) will apply to the groundwater treatment facility because hazardous materials will be stored at the facility and used in the groundwater treatment process. In Washington State, EPCRA requirements are administered by Ecology. EPCRA report forms covering the chemicals to be used for the groundwater treatment process will be completed and filed with Ecology with the final plans and specifications. These forms will cover storage and use of concentrated sulfuric acid and other process chemicals that are covered by the rules.

4.2 CONSTRUCTION ACTIVITIES

The construction activities and sequencing are described in this section. The equipment used, actual sequencing, and approach will be established and mutually agreed upon by the Construction Contractor, Engineer, and Construction Manager prior to contractor mobilization to the B&L Property. The Trust will retain the services of a Construction Manager and an Engineer to oversee the field construction and ensure the requirements specified in the construction contract documents (including the plans and specifications prepared under the Consent Decree are addressed. The Construction Manager will be supported by the Engineer responsible for construction and other field staff as appropriate. The construction will be planned to commence during the summer dry season and to complete and fully stabilize earthwork prior to the rainy season.

4.2.1 Mobilization

The Construction Contractor will use the available space east of the fenced area between the landfill access road and Wetland B for staging and storage areas. Due to the pad and building construction activities, the building pad area immediately to the northeast of the access ramp will remain clear. Some material may be stored on the landfill cap, so long as the equipment is determined to not damage the cap, as approved by the Construction Manager directing the work. The Construction Contractor will decide whether to spread a layer of crushed rock as firm, competent surface prior to mobilizing equipment or to use an alternate method to provide a competent surface. Also, due to the elevation differences between the staging area and the landfill access ramp, the Construction Contractor may deem it necessary to expand or modify the ramp to improve access and the turnaround area for the trucks performing the work. Once the staging area is prepared to the satisfaction of the Construction Contractor, equipment and trailers will be mobilized to the B&L Property and the contractor will begin site setup.

4.2.2 Site Setup

The existing 3-phase power and phone/internet services can be utilized by the Construction Contractor for temporary power and communication for the construction phase of the project. Construction trailers and equipment will be mobilized to the Site and setup within the staging area prepared during mobilization.

Temporary fencing will be installed around the staging area, along access points to the Interurban Trail, and along the work area for the Agricultural Field Plume on the west side of the Landfill. Existing fencing will be utilized to the extent possible to minimize temporary fencing needs.

The work will be completed under the terms of a Construction Stormwater Permit. To the extent possible, earthwork will be completed during summer dry months to minimize the potential for surface impacts related to construction. The existing stormwater drainage in the landfill area will be utilized for stormwater runoff during the construction period. The work will be conducted in accordance with stormwater plans and pollution prevention plans that will be part of the construction plans and specifications for this work and will be included as Appendix 3F. Stockpiled material from the trench construction will be covered with plastic sheeting to prevent soil erosion. Silt fencing, wattles, and other best management practices will be implemented to ensure any runoff form the work areas meets the requirements under the stormwater permit.

4.2.3 Groundwater Recovery System Construction

4.2.3.1 Well Installation

The new monitoring and extraction wells will be drilled to place the well screen within the USAq by a driller licensed in the State of Washington. Variances from standard well design will be obtained from Ecology as appropriate. A geologist licensed in the State of Washington will oversee installation of all extraction and monitoring wells. Following well installation, connections for piping, power, and controls will be completed by the Construction Contractor. The surface completion vault or protective casing will be installed by the licensed drilling contractor. For the existing landfill wells that will be used as recovery wells, the licensed driller will modify the surface completion and install the well vault. After well installation is complete, the location and well head elevation for each extraction and monitoring well will be surveyed by a licensed surveyor.

4.2.3.2 Collection Piping

The trenches for the buried collection piping will be constructed with either an excavator or trencher, as determined by the Construction Contractor. Consideration will be given to utilizing the least intrusive trenching methods for work conducted within wetlands to minimize the impact of the construction activities. Measures will be taken to avoid damage to the landfill cap geonet and PVC liner when trenching in the landfill area, including hand excavation if the trench is extended to within 6 inches above the geosynthetic cap materials.

The groundwater collection piping will be welded HDPE pipe. Welding will be conducted according to the pipe manufacturer's recommended procedures by qualified contractor personnel. The generalized procedure for buried pipe installation will be as follows:

1. Trench excavation with sheeting and shoring as required.
2. Place bedding pea gravel.
3. Weld and place pipe, working in up-grade direction.
4. Leak testing and inspection.
5. Place and compact pipe embedment pea gravel in lifts with mechanical compaction.
6. Place and compact fill in lifts with mechanical compaction.

Cleanouts will be installed at regular intervals (as determined by design-build contractor) along the collection piping runs.

4.2.3.3 Electrical and Controls

Power for the well pumps will be distributed from the electrical room in the treatment building. The power cables will be installed in common trenches with groundwater piping. The power cables will be installed in PVC conduit. All junctions and terminations will be made in either a well vault or buried-service electrical junction box. Control wiring for the groundwater recovery wells will also be terminated at the electrical room in the treatment building.

The control signals for the piezometer transducer outputs will be also be terminated at the electrical room of the treatment building. Control cables and power will be brought in trenches from the groundwater pipe trench network to each of the piezometer locations.

The control algorithm for the extraction wells will be programmed in the PLC software and tested before installation. Generally, the landfill extraction wells will be controlled based on a comparison of the groundwater levels inside and outside the barrier wall as measured by pairs of piezometers. Based on the measured difference at the different piezometer pair locations, different wells within the Landfill will be directed by the PLC to increase or decrease the speed of the extraction well pumps. An appropriate strategy for determining which recovery wells would be pumped will be developed for the final design. The groundwater model will be used to develop the control strategy for controlling the landfill extraction wells.

4.2.4 Building Pad Construction

The building pad is being installed to raise the elevation of the area surrounding the new treatment building to ensure the treatment system is not flooded and is accessible during seasonal flooding in the area. The building pad will also provide room for chemical delivery trucks to turn around. Construction of the building pad is expected to be one of the first steps in the construction process.

4.2.4.1 Grading and Filling

Clean, imported fill with appropriate structural properties will be brought in by dump truck and spread by bulldozer. The fill will be mechanically compacted in 8-inch lifts (maximum). Sufficient fill will be placed to raise the elevation of the building pad area to the approximate elevation of the access road surrounding the Landfill. The pad will be graded to facilitate existing runoff patterns, with stormwater to flow north, toward the existing secondary stormwater pond. The pad will be surfaced with ¾-inch crushed rock.

A reinforced concrete pad will be constructed to provide spill containment for the lime delivery truck as it is parked to unload. The concrete pad will be constructed with a containment curb and a sump. The pad surface will be sloped so that lime slurry, if spilled, would be directed towards the sump. The pad and curb will be designed to contain the full volume of the largest style of truck expected to be utilized to deliver lime to the treatment facility.

4.2.4.2 Utilities

Power and communications lines (including phone and internet) will be brought into the treatment building electrical room via overhead wires from the existing power pole. Switches, breakers, transformers, and motor control centers (MCC) will be installed in the electrical room to provide power for all the well pumps and treatment equipment.

Sewer and potable water lines will be trenched in and installed from connection points to the respective municipal systems. Installation will follow Pierce County and/or City of Milton code requirements, as appropriate.

4.2.5 Treatment Building

The treatment building will be constructed following the recommendations of the geotechnical study of the building area. The floor of the building will be a reinforced concrete slab designed to handle the live loads of the treatment equipment and tanks. The concrete building pad will be an integral containment curb that will support the building walls. A sump will also be placed in the concrete building floor to collect process water, spills, and water generated during maintenance or cleanup. Collected water will be treated in the treatment process.

The building will be a pre-engineered steel building. The steel columns and beams will be erected, followed by the open truss or solid roof beam installation. The roof and wall panels will then be installed and insulated. Once the exterior of the building is complete, the interior walls will be erected. Finishes such as doors, electrical, plumbing, HVAC, and lighting will then be completed.

4.2.6 Process Equipment

Some large process tanks and equipment will be placed before the building is complete because some items will need to be placed by an overhead crane. A poured concrete spill containment wall will be constructed to surround the large chemical storage tanks. The concrete will be protected with an epoxy coating. The spill containment area will house the $KMnO_4$ tank, $KMnO_4$ chemical dosing skid, lime storage tank, and lime chemical dosing skid.

Steel framing will be constructed to support the oxidation and co-precipitation tanks, and will include an integrated raised walkway to allow the operator to access those tanks and the clarifier unit. The pH adjustment tank, filters, and adsorption columns will be installed on concrete housekeeping pads placed on the floor of the treatment building.

Steel framing will also be used to construct the raised support for the filter press. Steel framing will be protected with an epoxy coating. Any nicks or flaws in the coating will be touched up before final acceptance by the Construction Manager.

Once the major tanks are in place, as well as the clarifier and the filter press, the smaller equipment such as pumps, chemical feed skids, adsorber columns, and filters will be installed.

The majority of the process piping will be constructed of PVC. The piping will be supported by either the floor, the roof, or a rack, as required by local or other building codes. The piping will be cleaned, roughed, and primed before any PVC welding is conducted.

Connection of the power and control cabling will occur following the mechanical installation of the equipment.

4.2.7 Instruments and Controls

The instrumentation will be installed after the relevant process equipment is set into place. Control and device power wiring will be connected at the electrical room and terminations made at each instrument. The PLC will be installed in the electrical room. A central PLC will control the groundwater collection system and the treatment process equipment. The operator interface for the PLC will be placed as appropriate for operator access.

4.2.8 Startup and Commissioning

Startup and commissioning of the groundwater recovery and treatment system will be performed after construction has been completed and prior to final acceptance of construction. At the completion of startup and commissioning, it will be confirmed that equipment and instruments have been installed and operate in accordance with specifications and manufacturer requirements. Startup and commissioning involves the following general steps for each piece of process equipment and each instrument:

1. Check that the correct item was installed in the correct location.
2. Check general arrangement, orientation, level, etc.
3. Check for appropriate safety accessories, (e.g., guards for rotating equipment).
4. Check process piping connections.
5. Go through manufacturer’s pre-start checklist.
6. Check electrical connection and grounding.
7. Check power supply and electrical switches and controls.
8. Check continuity and proper identification of control wiring.
9. Check for proper rotation.
10. Test that equipment is functioning in accordance with equipment specifications.
11. Calibrate instrument or piece of equipment, if necessary.
12. Test equipment performance against specified parameters.

Once individual items have all been checked and any deficiencies have been corrected, entire processes can be tested for functionality during a clean-water test. Once the clean-water test is complete, the system can be run as a whole, with contaminated groundwater.

Ensuring proper communication between all instrumentation and the PLC is a critical phase of startup. The PLC must be checked to ensure alarms are registered and logged properly, and that soft interlocks are functioning as intended. The control loops must be tested and tuned if necessary. The PLC programming must also be checked to confirm it operates in accordance with the control strategy.

The commissioning will also include collection of groundwater and effluent samples to confirm proper treatment, as well as jar testing to optimize chemical dosages.

4.2.9 Site Finishing and Demobilization

After completion of the construction phase, site restoration activates will be completed prior to final demobilization. The affected portion of the Interurban Trail will be resurfaced and restored to its initial condition. Any damage made to the landfill cap during trench excavation will be repaired and restored. Excess material from the construction and any remaining debris from the construction will be removed from the B&L Property and managed in accordance with applicable regulations and standards. On completion of construction activities, disturbed areas will be hydroseeded or finished, as appropriate. The Construction Contractor may decide, with approval of the Construction Manager, to hydroseed portions of the Site as work is completed rather than waiting until all work is completed for operational reasons as well as for stormwater runoff control. Fill used in the contractor staging area may, with the approval of the Construction Manager, be left in place and hydroseeded.

4.3 CONSTRUCTION QUALITY ASSURANCE AND CONTROL

In order to construct the project components to the specified design requirements, construction quality control will be conducted by the Construction Contractor and additional construction assurance may be conducted by the Engineer. A detailed Construction Quality Assurance (CQA) Plan will be prepared as part of the plans and specifications (reserved as Appendix 3H). The plan will describe procedures to be followed by the Engineer and the Construction Contractor during the construction of the building pad, building, groundwater collection system, treatment process system, and other ancillary construction work to ensure that they are installed as designed and that they meet design specifications. The CQA Plan and contract documents will require attainment of design specifications and acceptance of the work prior to Construction Manager approval for final payment to the Construction Contractor. The quality assurance requirements to be included in the CQA Plan are summarized below.

4.3.1 Quality Assurance Plan

4.3.1.1 Piping

Material and installations will be checked to verify that the construction meets the minimum design requirements. The elements to be checked include, but are not limited to, material used, depth and elevation of installations, trench backfill compaction, and operational components. The piping, fittings, elbows, vaults, manholes, crushed rock, and geotextile will be inspected to verify compliance with the design specifications. The inspections will include evaluations to document that installations have been completed in accordance with manufacturer recommendations. The installation depths and elevations will be checked and verified as the work proceeds. Results of inspections and testing will be documented. All piping will be pressure tested to ensure there are no flawed joints, or leaks. Pressure testing of buried piping will be completed before backfilling.

4.3.1.2 Filling and Grading

The earthwork for the construction of the building pad will be routinely inspected during construction to verify that correct elevations, dimensions, soil type, placement, and compaction requirements are met. Backfill for utility trenches will be checked to ensure the soil is placed in the specified lift thickness and compacted to a firm, non-yielding surface.

Samples of the available soil types will be collected and tested by the Construction Manager or designee for gradation, moisture content, Atterberg limits, and maximum dry density. The Construction Manager will determine the appropriate soil types to be used during construction. The backfill compaction standard will be to at least 98 percent of maximum dry density, in accordance with engineering standards for the building pad.

4.3.1.3 Tanks and Vessels

Process tanks and vessels will be factory tested for leaks. The Construction Manager or designee will have the option of being on-site for tank testing. A detailed test report will be received and retained with project records.

Tanks surfaces will be inspected for damage at the time of delivery. Name plate information will be recorded and checked against the specifications. Material records will be received from the manufacturer to ensure appropriate materials of construction were utilized.

Leak testing will also be performed on-site after installation is complete during the clean water testing phase of commissioning.

4.3.1.4 Concrete and Pavement

Forms will be inspected by the Construction Manager or designee for to ensure dimensional conformance with the plans before any concrete is poured. Rebar will be checked for correct size and spacing. Each batch of concrete will be tested to meet slump requirements before it is accepted and used for the building foundation, building floor, or delivery truck parking pad.

Finished concrete will be tested for minimum load bearing requirements in sections as they are completed and cured to ensure the finished structure will meet the specifications.

4.3.1.5 Process Equipment

Wherever possible, process equipment will be factory tested by the manufacturer before delivery to ensure proper performance. Once on-site, the equipment tags will be checked to verify the proper model was delivered, the minimum specifications have been met, and the equipment was not damaged in transit. During commissioning each item will be functionally tested to ensure proper installation and proper performance.

4.3.2 Construction Documentation

The construction work, including quality assurance (QA) and quality control (QC) testing and documentation for resolution of problems, will be formally documented in the Construction Manager daily field report and QA/QC testing data sheet. The Construction Manager daily field report will document the following:

- Field conditions (weather, surface condition, surface water condition, conditions of site control features)
- Daily safety meetings
- Description of construction activities
- Equipment and personnel involved
- QA/QC observation and testing
- Type and quantity of material used
- Problems encountered and corrective measures
- Record of delivery of materials and quality documentation
- If stormwater sampling is conducted, sample location and time

In addition, health and safety sign-in sheets and visitor daily logs will be included.

The QA/QC testing data sheet shall document the following:

- Visual observation of construction quality
- Location and number of QA/QC field measurement or testing
- Field measurement and testing results
- Location and number of samples collected for laboratory analysis

4.3.3 Design or Construction Plan Modification

Any design or construction problems that are encountered, which might require modifications or mitigation measures, will be discussed with and approved by the Construction Manager prior to implementation. Depending on the nature of the issue, the matter may be discussed with the Floyd|Snider/AMEC Project Team and/or the Trust and Ecology. The resolution will be evaluated to confirm that it complies with health and safety procedures and the design intent. Any modifications to the design or installation will be documented in the field notes and reflected on the final record drawings.

4.4 STORMWATER MANAGEMENT

Stormwater management during construction will be performed in accordance with a general construction stormwater permit. Stormwater management during construction will implemented as described in the Stormwater Pollution Prevention Plan (SWPPP; reserved as Appendix 3E), which will be prepared with the final plans and specifications, and as summarized below. The stormwater management system is designed to contain the runoff from the disturbed or work areas to prevent releases to the environment. Secondary containment capability has been incorporated into the design to eliminate stormwater discharge during construction. Controls have been established for the work area, contractor staging area, and vehicles moving from the work area to other areas.

4.4.1 Work Area Controls

Containment within the work area will be achieved by installation of run-on and runoff containment berms on the outside limits of the work areas. The containment berms will be constructed by placing a layer of plastic sheeting on the ground and placing excess soil over the middle and wrapping the plastic sheet over the soil.

The temporary constructed containment berms will be of a height sufficient to contain several inches of rainfall. If the containment capacity of the bermed area is exceeded by a storm, the north pond will serve as emergency containment; stormwater would be pumped to the north pond as necessary to prevent overtopping of the berms around work area. If it is necessary to use the north pond for emergency storage of stormwater, the pond will be drained and transported for treatment and discharge in accordance with applicable regulations and standards.

A gravel pad at least 6-inches thick will be placed over the staging area to minimize the potential for disturbing surface soils and creating turbid runoff. All work and private vehicles will be parked on the gravel, which will extend over the entrance road to Fife Way. The gravel surface will be inspected weekly during construction and will be repaired as necessary to maintain an effective cover and prevent turbid runoff.

Runoff from storage areas located within the staging area will be contained. Fuels, hydraulic oils, and other potentially hazardous materials will be stored with secondary containment capable of containing at least 3 inches of rainfall. To the extent practicable, the secondary containment areas will be covered. If spills of stored materials occur, the spill will be cleaned up and recovered materials will be disposed of off-site in accordance with applicable regulations and standards. If a spill occurs while stormwater is present in the secondary containment area, the stormwater and spill materials will be removed and transported off-site for treatment and discharge in accordance with applicable regulations and standards.

4.4.2 Vehicle Egress

Provisions will be made to prevent vehicles leaving work areas from transporting mud or sediment to surfaces outside the work area. Based on the nature of the construction work to be performed other than for installation of groundwater recovery and monitoring wells, contaminated media will not be encountered; therefore, vehicles will not become contaminated. Equipment used to construct trenches for the groundwater collection system in the landfill area will be kept within the work area until the work is completed. This equipment will be cleaned within the bermed area prior to removal from the work area. If maintenance of equipment is necessary during the work, maintenance will be performed within the work area. If it is necessary to replace equipment due to malfunction, the affected equipment will be cleaned prior to removal from the work area. Cleaning materials generated during construction will be collected from within the work area and managed in accordance with applicable regulations and standards. At the end of the construction project, after the groundwater collection system has been constructed, the building pad completed, and the treatment building has be constructed, water and wastes from cleaning vehicles and equipment will be collected for off-site treatment and disposal in accordance with applicable regulations and standards.

4.4.3 Post-construction Stabilization

At the completion of construction, the disturbed areas of the landfill cap will be hydroseeded, and the disturbed portion of the perimeter road will be re-surfaced to match the current surface charateristics. Disturbed areas outside the Landfill will be restored and seeded to match existing vegetation in accordance with any permits obtained to complete the work. The drainage design will control discharges to prevent release of turbidity to the agricultural ditches draining the landfill area. The landfill cap, including the newly restored areas, will drain to the perimeter ditch system, which will direct runoff to the north infiltration pond. This pond will provide substantial storage and detention capacity, and will provide for infiltration of the runoff to the extent practicable. The pond will also allow any solids present in the runoff to settle within the pond before the water level rises to the overflow pipe and runoff discharges to the agricultural ditches.

4.5 HEALTH AND SAFETY

The project work described in this addendum will comply with the health and safety standards prescribed by the Occupational Safety and Health Act (OSHA) and the Washington Department of Occupational Safety and Health (DOSH; formerly the Washington Industrial Safety and Health Act [WISHA]). Based on the nature of the work, only drilling is expected to have significant potential for exposure to hazardous substances. A project-specific Health and Safety Plan (HASP) covering the work to be done by the Engineer and his representatives will be attached as Appendix 3I (Reserved). The Construction Contractor will prepare a HASP for the contracted work prior to mobilization and provide a copy to the Construction Manager. The HASPs will establish protection standards and mandatory safe practices and procedures for all contractor employees, subcontractors, owner's representatives, oversight personnel, and all other persons involved with the field work activities addressed by this Addendum. The HASPs will also assign responsibilities, establish standard operating procedures, and provide for contingencies that may occur during field work activities. Emergency contact information will be provided in the HASPs. Copies of the HASPs will be on-site at all times, and visitors entering the work area will be required to review and sign the HASPs.

Chemical exposure hazards are identified as exposure to arsenic-contaminated groundwater, woodwaste, and slag during installation of groundwater recovery or monitoring wells and subsurface trenches on the B&L Property. Arsenic contaminated groundwater may pose a chemical exposure hazard for installation of recovery wells, monitoring wells, and subsurface trenches in the areas outside the B&L Property. Potential routes of exposure include ingestion, inhalation, dermal contact, and eye contact. The primary route of exposure during field work is ingestion of contaminated water, soil, or dust. The possibility of a flammable or explosive release of methane is considered remote because the Landfill has ceased generation of methane, based on monitoring. Physical hazards and recommended preventative measures are identified in the HASPs and include: falling, lifting, electrical, mechanical, noise, inhalation, heat stress, cold stress, sunburn, biohazards, and traffic hazards. A HASP dedicated to drilling operations will be developed and used for well drilling. A licensed drilling contractor experienced in environmental drilling will be retained to install and complete groundwater recovery and monitoring wells.

The Construction Contractor will be specifically required to develop a detailed HASP for conducting work within subsurface trenches. Applicable DOSH, OSHA, and industry standards for conducting work in trenches will be met.

All work involving heavy equipment, including excavation, drilling and well/piezometer installation, will proceed in modified Level D personal protective equipment, including hard hat, steel-toed boots, hearing protection, eye protection, gloves, and protective work clothing (when there is potential for exposure to soil or groundwater). The level of protection may be upgraded accordingly by the site Health and Safety Officer (HSO) whenever warranted by conditions present in the work area.

5.0 Operation, Monitoring, Inspection, and Maintenance Plan

In this section, maintenance, monitoring, and inspection plans for the groundwater recovery and treatment systems are summarized. Monitoring will include commissioning of the groundwater recovery and treatment system and performance monitoring to confirm the design achieves design objectives. Long-term operations, inspection, and maintenance will commence after commissioning and performance testing have been completed.

5.1 COMMISSIONING AND PERFORMANCE MONITORING

Commissioning of the groundwater recovery and treatment system will be performed before final acceptance of the system from the Construction Contractor. Commissioning will include verifying that equipment and instruments are correctly installed and perform in accordance with manufacturer specifications. A detailed commissioning plan will be prepared as part of the final plans and specifications. Following commissioning, performance monitoring will be performed to confirm the system achieves the design objectives. An overview of system commissioning and performance monitoring is provided below.

5.1.1 System Commissioning

Commissioning of the groundwater recovery and treatment systems will be performed to confirm that the equipment, instruments, and controls have been correctly installed and perform in accordance with manufacturer specifications. Equipment and lines will be checked to confirm that they are installed at proper elevations and lines, vessels, and tanks are leak free. Manual and automatic valves will be individually tested to confirm that they operate properly and do not leak. Mechanical and electronic flow meters will be tested for functionality and accuracy. Electrical equipment and controls will be checked to confirm that they are properly powered and function correctly. Each pump will be tested to confirm that it operates in accordance with manufacturer specifications. Instruments will be tested and calibrated to confirm that they operate per manufacturer specifications. Controls such as pressure gauges, level monitors, and level switches will be tested to ensure they function correctly. The PLC will also be checked thoroughly, testing each input, each output, user interface, and remote access capability. The control program will also be installed and tested to ensure it functions per design. Building ventilation, heating, and utilities, including the air compressor, will also be tested for proper functionality.

5.1.2 Performance Monitoring

The objective of performance monitoring is to confirm that the groundwater recovery and treatment systems attain design and remediation objectives. Performance monitoring will be performed after the groundwater recovery and treatment systems have been commissioned and accepted as complete. Performance monitoring will include testing of the groundwater recovery system to confirm that the target cross-wall gradient can be attained for the Landfill and that the target recovery area (i.e., groundwater exceeding 500 µg/L) is achieved for the Wetlands Area, Eastern Boundary Mini-Plume, and Agricultural Field Plume. Performance monitoring for the groundwater treatment system will be done to confirm that each component achieves the design removal efficiency and that the process achieves the design effluent quality.

5.1.2.1 Groundwater Treatment System

Performance testing of the groundwater treatment system will be done using groundwater recovered from the landfill area, as this water is expected to represent the worst-case groundwater to be recovered from the Site. Performance testing for the treatment system will be done simultaneously with performance testing of the landfill groundwater recovery system, as described below. During this testing, no groundwater will be recovered from the areas outside the Landfill.

Performance testing for the groundwater treatment system will include the following:

- Testing of primary oxidation tank to confirm that iron and arsenic are effectively oxidized in the reaction tank, by monitoring the ORP readings.
- Testing of the co-precipitation tank to confirm that pH can be effectively controlled at the target pH for co-precipitation (approximately 8.5).
- Testing of the settler unit to confirm that it is effective in producing a clarified effluent by visual inspection, and total suspended solids (TSS) measurements of the clarifier influent and effluent.
- Testing of the secondary pH adjustment tank to confirm the pH can be effectively controlled at a pH of about 6.5.
- Testing of both cartridge filters to confirm that each filter effectively removes suspended solids following the settler by testing the TSS of the filter effluent and observation of differential pressure across the filters.
- Testing of the activated alumina adsorbers to confirm the treated water quality is below the effluent criteria for the constituents listed in Appendix 3A, Table 1 through laboratory analysis of the final effluent.
- Testing of the filter press to confirm it operates in accordance with specifications and achieves a dewatered sludge cake suitable for disposal.

5.1.2.2 Landfill Groundwater Recovery System

Performance monitoring for the landfill groundwater recovery system will be performed to confirm that the recovery system is capable of establishing and maintaining an inward directed cross-wall 0.5 ft. Additionally, the specific capacity of each well will be determined to establish a performance baseline for the wells. Groundwater level monitoring for this performance test will be done using the existing piezometer pairs located along the perimeter of the Landfill, as these piezometer pairs will be used for monitoring the cross-wall gradient during future operations. The landfill extraction wells will be operated to withdraw groundwater from the contained area, with the recovered groundwater discharged to the treatment plant.

The specific capacity of each recovery well will be determined to quantify well performance. This will be done by pumping each recovery well at the maximum pumping rate of the installed well pump for a minimum of 8 hours. Groundwater elevations will be taken in the pumping well and in nearby wells to assess drawdown for the recovery well. Specific capacity will be determined from these measurements and recorded as the baseline specific capacity for each recovery well. This measurement will be used to monitor well performance during future operations and to assess well maintenance needs. Testing will be performed simultaneously only on widely separated recovery wells, so that testing of individual wells does not cause overlapping drawdown or other interference.

Pumping for cross-wall gradient control will be initiated in the landfill recovery wells to draw down the groundwater level beneath the Landfill and achieve or exceed the cross-wall gradient performance standard, an inward gradient of 0.5 ft at all perimeter piezometer pairs. Based on numeric groundwater modeling results, the minimum cross-wall gradient is expected to occur along the east side of the Landfill, at the PZ-8 cluster. After establishing the performance standard, the recovery system will be operated for a minimum of 72 hours to assess its capability to maintain the cross-wall gradient performance standard. The automated control system will be used to operate the groundwater recovery wells and to monitor and record groundwater levels in the piezometers. If the system is able to establish the specified cross-wall gradient and maintain it for 72 hours, performance testing will be complete. At the beginning of the cross-wall gradient control testing, the total groundwater recovery system flow rate may approach the design average flow of 40 gpm to more quickly establish the target cross-wall gradient. Groundwater recovered during recovery system performance testing will be treated in the groundwater treatment system.

5.1.3 Outside Area Groundwater Recovery System

The groundwater recovery system for the outside areas will be testing to confirm groundwater within the target area (i.e., groundwater exceeding 500 µg/L arsenic) is captured. Performance testing will include measuring the specific capacity of each recovery well. Testing will be done by pumping the recovery wells and measuring groundwater elevations in the pumping well and in nearby wells. The measured drawdown characteristics will be used to determine the specific capacity and the radius of influence for the recovery system.

The specific capacity of each recovery well will be determined to quantify well performance. This will be done by pumping each recovery well at the maximum pumping rate for a minimum of 8 hours. Groundwater elevations will be taken in the pumping well and in nearby wells to assess drawdown for the recovery well. Specific capacity will be determined from these measurements and recorded as the baseline capacity for each recovery well. This measurement will be used to monitor recovery well performance during future operations and to assess well maintenance needs. Testing will be performed simultaneously only on widely separated recovery wells, so that testing of individual wells does not cause overlapping drawdown or other interference.

5.2 GROUNDWATER RECOVERY SYSTEM OPERATIONS

The groundwater recovery system consists of a network of wells both inside and outside the contained area, coupled with a piping network to transport recovered groundwater to the treatment building to undergo treatment and ultimate discharge. There are two main purposes of the groundwater recovery system. The first is to maintain an inward hydraulic gradient in groundwater across the barrier wall to hydraulically contain contaminated groundwater beneath the Landfill. The second is to recover groundwater from the USAq in the plumes emanating from the Landfill to remove arsenic contamination and achieve the cleanup levels specified in the CAP.

Pairs of piezometers are situated around the barrier wall to measure the groundwater levels and determine the cross-wall gradient. The comparison of those levels provides a control input that will be used by the control system to adjust the speed of the landfill extraction well pumps up or down to maintain the target hydraulic gradient. The majority of the landfill well pumps will be running frequently or nearly continuously.

The outside area wells will be manually set to pump at a constant, preset rate. These wells will be started or stopped by the PLC, as appropriate, based on operator instruction. After several years of operation, depending on an assessment of the effectiveness of the system, use of the outside area extraction wells will be discontinued and only the landfill wells will be operated. The landfill wells are expected to be in operation for the foreseeable future.

During normal operation the well pumps will be automatically controlled by the treatment system PLC. Automatic control for the recovery wells within the Landfill area will include on/off and flow control. Automatic control for the wells located in outside areas will be limited to on/off control; flow control for outside area recovery wells will be done manually. The ooperator will have the capability to put any number of individual well pumps in manual mode to override the automatic control for maintenance or special circumstances.

The total flow from all the well pumps will be measured by the treatment system influent flow meter. The total flow can be compared against the design values to detect possible problems with the collection system or signal varying groundwater conditions which may require further investigation.

The groundwater quality will be monitored on an ongoing basis to track trends in the groundwater contaminant concentrations. Groundwater quality monitoring will include manual collection of samples and either laboratory or field testing. Field testing capabilities will include pH, specific conductance, ORP, and field test kits for arsenic, iron, and manganese. Field testing will be approximate. Laboratory testing will be done when it is necessary to accurately characterize untreated groundwater.

5.3 GROUNDWATER TREATMENT SYSTEM OPERATION

The groundwater treatment system was designed to remove contaminants (principally arsenic) from the groundwater recovered from the extraction wells in the Landfill and outside areas. The system was designed for automated operation to the extent possible, but there are still many tasks which will require operator attention and input. It is expected that an operator will need to be on-site for 2 days per week, perhaps more often during periods of peak flow.

The main treatment unit operations occur in series, on a continuous basis, and will generally operate 24 hours per day, 365 days per year. The groundwater is collected in the collection tank where it will flow by gravity to the oxidation tank. The oxidized groundwater will flow by gravity to the co-precipitation tank, through the clarifier unit, and to the pH adjustment tank. The groundwater is then pumped, based on level control, through the filters and the adsorption columns, for eventual discharge at the north pond.

The majority of the operator effort will be involved with the chemical feed systems and sludge processing. The oxidation system will require $KMnO_4$ solution to be made up by the operator on a batch basis. This is a manual operation which will require adding a certain amount of $KMnO_4$ powder to the storage tank, along with a measured quantity of water to achieve the correct solution concentration. New $KMnO_4$ will have to be ordered as needed. The level in the $KMnO_4$ storage tank will be monitored by a continuous level sensor and the PLC will indicate warnings when the level is low enough to require a new batch be made up.

The level in the lime storage tank will also be monitored by a level sensor tied to the PLC. There will be level alarms in the PLC to indicate when a new load of liquid lime slurry is required. Alarms will be relayed to the operations staff; backup operations staff will be designated in the event the primary operator cannot be reached by the PLC. The lime dosing system will run automatically, requiring only periodic operator attention for maintenance purposes.

The polymer make-down system will carry out automatic preparation of dilute polymer feed solution. The level in the polymer day tank will be monitored and the PLC will indicate when the level is low. This will initiate a new batch to be made automatically with the polymer dilution system. It will add the correct volume of water, mixed with the correct proportion of neat polymer. The mixer in the day tank will automatically run for 30 minutes to an hour after making the solution, but it should not run continuously to prevent disruption of the polymer chains.

The acid dosing system will function automatically; however, the operator will be required to replace the chemical tote when one is empty. A level sensor will be installed as a tote is put into service so that the level can be monitored by the PLC.

The PLC will monitor and alarm when differential pressure across the cartridge filters has reach the setpoint to signal that the cartridges are clogged and require replacement. Cartridge replacement must be done by the operator.

The operator will need to collect treated water samples after the first adsorption column and analyze them for arsenic on a regular basis in order to detect breakthrough from the first column. If significant breakthrough is detected, the spent media must be replaced and the second column will become the primary column. Breakthrough samples can be tested using field analyses.

Sludge processing cannot be automated; therefore, it will rely exclusively on manual operations that must be performed on a regular basis to manage sludge storage capacity. It is estimated that two cycles of the filter press operation will be required to treat the solids produced each week under the average design flow (40 gpm). The operator will need to monitor the level in the sludge tank to determine how often solids will need to be processed. The sludge tank will be equipped with a level sensor tied to the PLC. The PLC will issue an alarm to operations personnel at high sludge levels. The operator will manually initiate the filter press cycles. The filter press operation requires operator attention before and after each cycle. The operator will monitor the level of solids in the solids roll-off bin and replace the bin as required.

5.4 INSPECTION AND MAINTENANCE SCHEDULE

The following summarizes the major inspection and maintenance activities, broken down by frequency:

Frequency	Activity
Daily	• Remotely log into PLC system to check for alarms and warnings.
Twice per week	• Perform walk-through inspection of treatment system: o Check for leaks, spills, physical problems. • Check for proper alignment of mixers and pumps; listen for unusual sounds. • Make $KMnO_4$ solution; order more powder if necessary. • Check lime slurry levels and order if necessary. • Check acid system; order and replace tote if necessary. • Check polymer system; replace neat polymer if necessary. • Check pressure drop across cartridge filters; replace if necessary. • Process sludge; order solids roll-off bin replacement if necessary.
Monthly	• Inspect extraction wells (as accessible): o Check for proper well pump operation. o Check vault for leaking pipe connections. • Inspect piezometers; check for proper operation. • Calibrate instruments (pH, ORP).
Semiannually	• Replace piezometer batteries as required. • Carry out preventative maintenance on rotating equipment based on manufacturer’s recommendations (lubrication, bearings, seals, etc.). • De-scale lime system.
Annually	• Touch up epoxy coating on structural steel. • Inspect building roof and walls; repair and touch up paint as required.

5.5 OPERATIONS MONITORING

Performance of the treatment system will be evaluated from analysis of effluent samples. The laboratory analytical results will be compared to water quality targets and effluent quality limits established in the discharge permit.

The PLC system will be able to remotely monitor, via an internet connection, for real-time observation of the treatment system. The PLC system will also log all instrumentation output to provide data trends over time.

The following summarized the operations monitoring activities to verify proper performance of the treatment system:

Frequency	Activity
Daily	• Remotely log into PLC system to check for alarms and warnings, and check instrument output for proper system performance.
Twice per week	• Perform walk-through inspection of treatment system: o Visually check water quality at each stage of treatment process.
Weekly	• Collect groundwater samples for analysis. • Collect final effluent samples for analysis. • Collect sample after first adsorption column to monitor for breakthrough.
Monthly	• Record total flow reading from flow meter at each groundwater extraction well.

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6.0 Schedule and Reporting

6.1 PROJECTED CONSTRUCTION SCHEDULE

A summary of the projected construction schedule is presented below. This schedule is preliminary, and may be modified due to permitting, property access issues, and/or Construction Contractor recommendations.

Key milestones from the projected construction schedule include the following:

- Permitting, approval, and property access requirements are projected to be completed by June 30, 2011.
- A notice to proceed with construction is expected by June 24, 2011.
- Mobilization and site preparation are scheduled to be completed by August 1, 2011.
- Construction of the building pad and civil work for the treatment building and site drainage is scheduled to be completed in June 2011.
- Construction of the groundwater recovery wells, collection network, and controls for both the Landfill and outside areas is projected for completion by September 21, 2011.
- Completion of the treatment building is projected for November 7, 2011.
- Installation of the groundwater treatment process equipment and controls is projected for completion by December 21, 2011.
- Startup and commissioning of the groundwater recovery and treatment system is expected to be completed by January 27, 2012.

The final Completion Report for the groundwater recovery and treatment system is projected to be submitted to Ecology by July 5, 2012.

6.2 REPORTING

6.2.1 Progress Meetings

Progress meetings with the Floyd|Snider/AMEC Project Team, representatives of the Trust, and Ecology will be held as needed prior to mobilization for construction. After mobilizing to the work site, weekly progress meetings will be held with the Floyd|Snider/AMEC Project Team, Ecology, the Trust, and the Construction Contractor. Additional meetings may be held as needed to address specific issues that arise during the work. Minutes of the meetings summarizing the discussions and identifying any action items will be prepared and distributed to attendees. During the weekly progress meetings, the planned construction schedule will be reviewed and compared with construction progress. Actions needed to address progress issues will be identified and discussed during the meetings.

6.2.2 Design Submittals

Submittal of the Final Addendum 3, draft plans and specifications, and final plans and specifications will follow submittal of the Draft Addendum 3. The plans and specifications package will include several attachments, including the SWPPP, a spill plan, a detailed Performance Monitoring Plan (Appendix 3J), the HASP, and CQA Plan. Additional submittals will be made by the contractor as part of the design build process.

6.2.3 Groundwater Recovery and Treatment System Completion Report

A Phase 2, Part 1 Construction Completion Report for the groundwater recovery and treatment system (to include all construction elements included as part of this Addendum) will be prepared in accordance with WAC 173-340-400(6)(b) and Exhibit B to the Consent Decree. The Phase 2 Part 1 Construction Completion Report will include record drawings for the constructed components, documentation of construction activities, and documentation that the cleanup action was constructed in substantial compliance with the plans and specifications and related documents. Substantial deviations from the plans and specifications will be reviewed with Ecology prior to implementation and will be documented in the Construction Completion Report. The final report will be stamped by a Professional Engineer registered in the State of Washington.

Additional construction completion reports will be prepared for the other 2008 CAP remedial components. The ditch sediment cleanup will be addressed in Addendum 4, which is scheduled for submittal to Ecology in 2012. A separate work plan will be prepared for implementation of the area-based, in-situ treatment pilot study.

6.2.4 Other Reports

In accordance with Exhibit B to the Consent Decree, Construction Oversight Reports for the groundwater recovery and treatment system will be prepared and submitted to the Trust with copies to Ecology. Other regularly scheduled reports will continue to be submitted, including semiannual compliance monitoring reports submitted to Ecology in accordance with the Interim Compliance Monitoring Plan (ICMP) and semiannual progress reports submitted to Ecology in accordance with Exhibit B to the Consent Decree.

7.0 References

Floyd|Snider/AMEC Geomatrix (Floyd|Snider/AMEC). 2009a. *B&L Woodwaste Site Engineering Design Report (EDR).* July.

_____. 2009b. *Engineering Design Report (EDR) Addendum 1, Phase 1 Part 1 Remediation Design Report, Barrier Wall and Interceptor Trench.* April.

_____. 2009c. *Engineering Design Report (EDR) Addendum 2, Phase 1 Part 2 Remediation Design Report, End-of-Plume In-situ Treatment.* December.

_____. 2010. *Engineering Alternatives Evaluation.* December.

Dean, J.A. 1999*. Lange's Handbook of Chemistry, 15th Edition.* New York, New York: McGraw-Hill.

MGS Engineering Consultants, Inc., Montgomery Water Group, Inc., GeoEngineers, Kirsty Burt Geographic Information Services. 2004. *Analysis of the SR-167 Extension and Riparian Restoration Proposal in the Hylebos Watershed Hydrology, Hydraulics and Geomorphology.* Prepared for Washington State Department of Transportation. November.

Washington State Department of Ecology (Ecology). 2008. *Final Cleanup Action Plan B&L Woodwaste Site*. January.

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B&L Woodwaste Site
Pierce County, Washington

Engineering Design Report (EDR)
Addendum 3

Phase 2 Part 1 Remediation Design Report

Groundwater Recovery and Treatment System

Table

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Table 1.1
Engineering Design Report (EDR) Accordance with the Model Toxics Control Act (MTCA) Requirements—
General EDR and Addendum 3

EDR Regulatory Requirements MTCA WAC 173-340-400(a)		Information Location		
		General EDR	Addendum 3	Summary
(i)	Goals of the cleanup action including specific cleanup or performance requirements	Section 1.3		EDR Section 1.3 provides a description of the Remedial Action Objectives and cleanup levels for each Cleanup Action Area (CAA).
(ii)	General information on the facility including a summary of information in the remedial investigation/feasibility study	Sections 2.1, 2.2, 2.4, and 3.4		EDR Sections 2.1, 2.2, and 3.4 provide general site information including physical site description, land use, and development issues. Section 2.4 provides a summary of the site history and previous remedial investigations, feasibility studies, and cleanup activities.
(iii)	Identification of who will own, operate, and maintain the cleanup action during and following construction	Sections 1.4 and 2.3		EDR Section 1.4 describes responsibility for the cleanup action; Section 2.3 describes the property ownership.
(iv)	Facility maps showing existing site conditions and proposed location of the cleanup action	Figures 1.1, 3.2, and 4.3	Drawings	EDR Figure 1.1 shows the Site based on the extent of contamination, the CAAs, the interim compliance monitoring network, and other features. EDR Figure 3.2 illustrates contaminant concentration contours. EDR Figure 4.3 illustrates delineated wetlands areas. Addendum 3 includes detailed drawings showing the specific locations and design of the barrier wall and groundwater management system.
(v)	Characteristics, quantity, and location of materials to be treated or otherwise managed, including groundwater containing hazardous substances	Sections 1.1, 2.1, and 4.1; Appendix A	Sections 3.1.1 and 3.2.1, and Drawings	EDR Section 2.1 describes the quantity and characteristics of the woodwaste inside the Landfill that is to be contained. EDR Section 4.1 and EDR Appendix A describe the characteristics and location of the groundwater plume to be treated or contained, including the areal extent and thickness of the contaminated aquifer for all CAAs. EDR Section 1.1 includes the estimated volume of groundwater to be treated as part of the Wetlands Area cleanup. The location of the groundwater plume to be addressed by the remedy components covered in Addendum 3 are shown in Addendum 3, Figure 2.1. The locations for groundwater recovery and treatment components are shown in the Addendum 3 Drawings. The anticipated volumes to be pumped from landfill recovery wells are presented in Addendum 3 Section 3.1.1, and the anticipated volumes to be pumped from outside area recovery wells are given in Addendum 3 Section 3.2.1.
(vi)	A schedule for final design and construction	Section 7.3	Section 6.1	EDR Section 7.3 presents a projected implementation schedule for the 2008 Cleanup Action Plan (CAP). A schedule for final design and construction for Addendum 3 is presented in Addendum 3 Section 6.1.
(vii)	A description and conceptual plan of the actions, treatment units, facilities, and processes required to implement the cleanup action including flow diagrams		Section 3.0 and Drawings	Addendum 3 Section 3.0 describes the design. The drawings present design details and include a flow diagram and a process and instrumentation diagram (P&ID) for the groundwater recovery and treatment system.
(viii)	Engineering justification for design and operation parameters including:			Refer to specific Sections for (viii)(A) through (viii)(C) below.
(viii)(A)	Design criteria, assumptions and calculations for all components of the cleanup action		Section 2.0; Appendices 3A, 3B, and 3C	The design basis, design criteria, and rationale for key design features are discussed in Addendum 3, Section 2.0. The calculations and supporting information are included in Addendum 3 Appendices 3A, 3B, and 3C.
(viii)(B)	Expected treatment, destruction, immobilization, or containment efficiencies and documentation on how that degree of effectiveness is determined		Sections 2.1; Appendices 3A and 3B.	Addendum 3 Section 2.1 and Appendices 3A and 3B discuss the expected effectiveness of the groundwater recovery and treatment system for attaining design objectives and achieving a high quality effluent meeting environmental protection criteria.
(viii)(C)	Demonstration that the cleanup action will achieve compliance with cleanup requirements by citing pilot or treatability test data, results from similar operations, or scientific evidence from the literature		Sections 2.1 and 3.3; Appendices 3A and 3B	Addendum 3 Section 2.1 Apppendix 3A discuss the predicted effectiveness of the groundwater recovery system and modeling done to predict effectiveness. Addendum 3 Section 3.3 and Appendix 3B describes the expected effectiveness of the groundwater treatment system and treatability testing done to develop the treatment process.
(ix)	Design features for control of hazardous materials spills and accidental discharges (for example, containment structures, leak detection devices, run-on and run-off controls)		Sections 2.2.2, 3.3.2, 4.3; and Drawings	Addendum 3 Sections 2.2.2 and 3.3.2 describe measures and precautions that will be implemented for environmental protection, including spill prevention and containment. Addendum 3 Section 4.3 describes provisions for environmental protection during construction. The P&IDs show provisions for spill detection and alarms.
(x)	Design features to assure long-term safety of workers and local residences (for example, hazardous substance monitoring devices, pressure valves, bypass systems, safety cutoffs)	Appendix E	Sections 3.3 and 5.3; Drawings PID00 to PID05	Addendum 3 Section 3.3 describes the system design and control strategy for the groundwater recovery and treatment system to prevent and detect spills and process failure. Monitoring instrumentation is also described in these sections and in the P&IDs (Drawings PIC00 to PID05). Monotoring and operations for the groundwater recovery and treatment system are described in Addendum 3 Section 5.3. EDR Appenidx E describes groundwater and surface water monitoring plans.

EDR Regulatory Requirements		Information Location		
MTCA WAC 173-340-400(a)		**General EDR**	**Addendum 3**	**Summary**
(xi)	A discussion of methods for management or disposal of any treatment residual and other waste materials containing hazardous substances generated as a result of the cleanup action		Sections 2.2, 4.1.3, 5.3, and 5.5	Addendum 3 Section 2.2 describes the environmental protection basis of system design. Addendum 3 Section 4.1.3 presents a description of how all contaminated media generated during construction of groundwater recovery and monitoring wells will be managed. Addendum 3 Sections 5.3 and 5.5 describe how residuals from groundwater treatment will be monitored and managed during operations.
(xii)	Facility specific characteristics that may affect design, construction, or operation of the selected cleanup action, including:			Refer to specific Sections for (xii)(A) through (xii)(C) below.
(xii)(A)	Relationship of the proposed cleanup action to existing facility operations	Sections 2.2 and 3.3		EDR Section 2.2 describes current site use. EDR Section 3.3 describes landfill gas production. There are no ongoing facility operations at the Site.
(xii)(B)	Probability of flooding, probability of seismic activity, temperature extremes, local planning and development issues	Sections 3.1.2.3, 3.1.3, 3.2, and 3.4		EDR Section 3.1.2.3 describes flooding potential and flooding records. EDR Section 3.1.3 describes area seismicity. EDR Section 3.2 describes site climate. EDR Section 3.4 describes site planning and development issues.
(xii)(C)	Soil characteristics and groundwater system characteristics	Sections 3.1.1 and 3.1.2; Appendices B and C		EDR Section 3.1.1 describes local geology and Section 3.1.2 describes local hydrogeology. EDR Appendix C describes the groundwater conceptual model in the context of numerical modeling. EDR Appendix B describes the results of the geotechnical investigation along the barrier wall alignment.
(xiii)	A general description of construction testing that will be used to demonstrate adequate quality control		Section 4.2	Addendum 3 Section 4.2 summarizes the construction quality assurance measures for the planned construction.
(xiv)	A general description of compliance monitoring that will be performed during and after construction to meet the requirements of WAC 173-340-410	Section 5.0	Sections 5.1 and 5.5	EDR Section 5.0 summarizes compliance monitoring to address requirements in the Consent Decree and MTCA, describes the ongoing compliance monitoring program and conditional point of compliance, and presents an overview of the groundwater and surface water monitoring network. Addendum 3 Section 5.1 describes the performance monitoring program for the groundwater recovery and treatment system. Addendum 3 Section 5.5 presents an overview of operations monitoring for the groundwater recovery and treatment system.
(xv)	A general description of construction procedures proposed to assure that the safety and health requirements of WAC 173-340-810 are met		Sections 4.4	Addendum 3 Section 4.4 provides an overview of health and safety concerns for construction of the groundwater recovery and treatment system.
(xvi)	Any information not provided in the remedial investigation/feasibility study needed to fulfill the applicable requirements of SEPA (chapter 43.21 RCW).	Section 4.4 and 4.5; Appendix D		A SEPA checklist was prepared for the 2008 CAP, resulting in a determination of non-significance. Tribal comments for the draft CAP requested a cultural resources survey prior to earth disturbance, to which Ecology agreed. The cultural resource findings are summarized in EDR Section 4.5. The cultural resources survey has been submitted to the Department of Archaeological and Historical Preservation and the Puyallup Tribe. Additionally, the U.S. Army Corps of Engineers Joint Aquatic Resources Permit Application (JARPA) process required a Critical Areas Study (CAS) to delineate wetlands in the project area. EDR Section 4.4 summarizes the CAS prepared for the project area. EDR Appendix D presents the CAS report.
(xvii)	Any additional information needed to address the applicable state, federal and local requirements including the substantive requirements for any exempted permits; and property access issues which need to be resolved to implement the cleanup action	Section 7.1 and Table 7.1	Section 4.1	EDR Section 7.1 and Table 7.1 outline the applicable state, federal, and local requirements for the cleanup action, including substantive requirements for MTCA exempted permits. Specific requirements for Addendum 3 construction are given in Addendum 3 Section 4.1.
(xviii)	For sites requiring financial assurance and where not already incorporated into the order or decree or other previously submitted document, preliminary cost calculations and financial information describing the basis for the amount and form of financial information describing the basis for the amount and form of financial assurance and, a draft financial assurance document.	Not Applicable		Financial assurance is not required for the Site.
(xix)	For sites using institutional controls as part of the cleanup action and where not already incorporated into the order or decree or other previously submitted documents, copies of draft restrictive covenants and/or other draft documents establishing these institutional controls	Section 6.0		EDR Section 6.0 describes the existing institutional controls and describes additional restrictive covenants that will be developed prior to finalizing the EDR during Phase 2 of the 2008 CAP implementation. As the current work is the first portion of the implementation process, it is premature to prepare comprehensive documentation for institutional controls.
(xx)	Other information as required by the department	Not Applicable		No additional information has been requested.

B&L Woodwaste Site
Pierce County, Washington

Engineering Design Report (EDR)
Addendum 3

Phase 2 Part 1 Remediation Design Report

Groundwater Recovery and Treatment System

Figure

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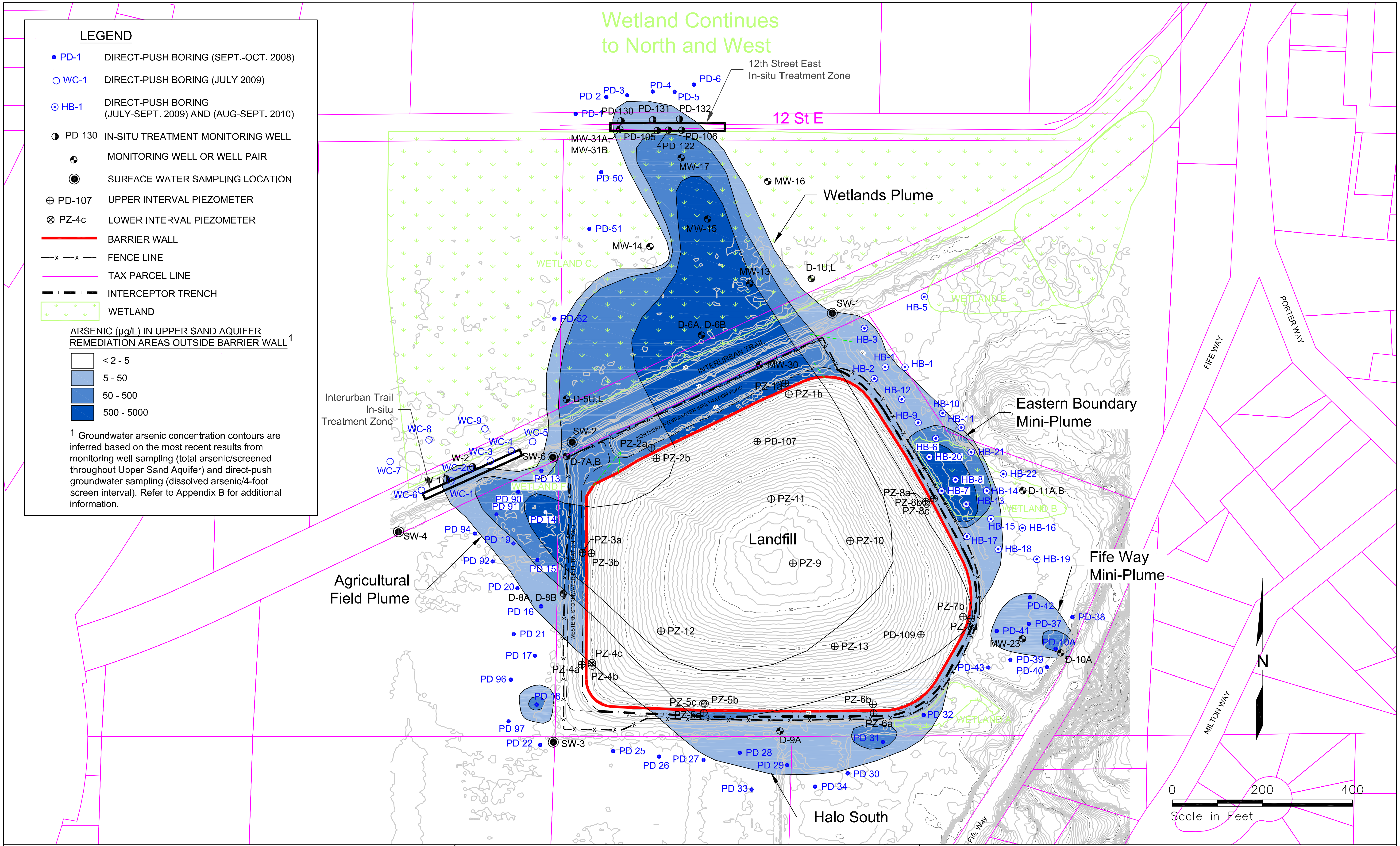

FLOYD | SNIDER
strategy ▪ science ▪ engineering
AMEC Geomatrix

EDR Addendum 3
B&L Woodwaste Site
Pierce County, Washington

Figure 2.1
Groundwater Remediation Areas

DWG NAME: G:\project\Clients\Floyd and Snider\BandL\BandL078revDec2010.dwg
DATE: 3/17/2011 11:29 AM

B&L Woodwaste Site
Pierce County, Washington

Engineering Design Report (EDR) Addendum 3

Phase 2 Part 1 Remediation Design Report

Groundwater Recovery and Treatment System

Appendix 3A

Design Basis Memorandum

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ROUTING SLIP

SF 80 F

DATE 12-10-10

TO BRETT BEAULIEU
FLOYD-SNIDER

ADDRESS 601 UNION ST., SUITE 600
SEATTLE, WA 98[illegible]101

MAIL STOP

FROM
DOM REALE

MAIL STOP

PHONE (360) 407 6266

FAX ( )

☐ For Action
☐ For Approval
☐ For Signature
☒ Per Your Request
☐ Read and Return
☐ For Your Information
☐ Per Our Conversation
☐ Read & Route to Files
☐ For Your Comments

RECEIVED
DEC 14 2010
BY:

AMEC Geomatrix
600 University Street, Suite 1020 Seattle, WA 98101

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601 Union Street, Suite 600 Seattle, WA 98101

RECEIVED
DEC 10 2010
WA State Department
of Ecology (SWRO)

Memorandum

To: Dom Reale, Washington State Department of Ecology
Teri Floyd, Floyd|Snider

Copies: Dan Silver, Dan Silver Associates
Tina Gary, Floyd|Snider

From: Larry McGaughey, AMEC Geomatrix
Bill Malyk, AMEC Geomatrix
Brett Beaulieu, Floyd|Snider

Date: December 3, 2010

Project No: B&L RIM

Re: **Design Basis, Phase 2 Groundwater Remedy,**
B&L Woodwaste Site Cleanup Action Plan Implementation

The remedy specified in the 2008 Cleanup Action Plan (2008 CAP) for the B&L Woodwaste Site (Site) is being implemented in a phased program. Phase 1, which has been completed, included design and construction of remedy components to create a physical barrier enclosing groundwater beneath the B&L Landfill and an in-situ treatment program to stabilize the leading edge of the contaminant plume emanating from the Landfill. Phase 2, which is presently being implemented, includes design and construction of a groundwater recovery system, a groundwater treatment system, and other components of the groundwater remedy outside the barrier wall. The purpose of this technical memorandum is to document the key assumptions and basis for design of the Phase 2 groundwater remedy components to be constructed in 2011 for the Site. The assumptions and basis presented in this memorandum will be used to complete the design, engineering, plans, and specifications for 2011 construction. Any changes to the assumptions or basis after approval of this document may result in a revised implementation schedule and increased engineering costs.

This memorandum applies only to the design and operation of the following remedy components from the 2008 CAP:

- Groundwater recovery system for the contained area beneath the Landfill
- Groundwater recovery system for the groundwater plumes located outside the barrier wall
- Groundwater treatment system
- Wetlands area in-situ treatment pilot study

The groundwater recovery systems and groundwater treatment system are components of the remedies for the Landfill CAA and the Wetlands CAA, as defined in the 2008 CAP. The Wetlands in-situ treatment pilot study is a predesign study to support potential future remediation to shorten the restoration time. Phase 2 remedy components not listed above, including excavation of contaminated ditch sediments, will be addressed separately in future design documents.

As described in the Groundwater Remediation Work Plan (GRWP; Floyd|Snider/AMEC 2009) and the GRWP Addendum (Floyd|Snider/AMEC 2010a), Phase 2 predesign studies and groundwater modeling have been performed to further characterize site groundwater and hydrogeology, evaluate treatment technologies, and develop information needed for design of groundwater recovery and treatment systems. This work has identified a feasible groundwater treatment approach and has developed preliminary estimates of groundwater recovery rates needed to attain the Remedial Action Objectives (RAOs) specified in the 2008 CAP. The results of the Phase 2 predesign studies are documented in the Engineering Alternatives Evaluation (EAE) Report (Floyd|Snider/AMEC 2010b). The EAE Report also presents an evaluation of alternate approaches for implementing the site groundwater remedy specified in the 2008 CAP. Based on the evaluation of the EAE Report, it has been decided that the Phase 2 groundwater remedy will include the following elements:

- Groundwater recovery system for the contained area beneath the Landfill.
- Groundwater recovery system for high-concentration areas in the plumes outside the Landfill.
- Groundwater treatment system discharging to the north stormwater pond and subsequently overflowing to the agricultural ditch network.
- A pilot study to assess the effectiveness of in-situ treatment within the wetlands area north of the Landfill.

The above elements will be included in the scope of Phase 2 design and construction. Modifications may be made during future operations if deemed appropriate by the Washington State Department of Ecology (Ecology) to achieve the RAOs. The design for the above elements will be included in Addendum 3 to the Engineering Design Report (EDR) for the Site.

The design of the groundwater recovery and treatment systems will be based on the following:

1. Groundwater recovery within the contained area beneath the Landfill achieving a minimum head differential across the barrier wall of 0.5 feet
2. Groundwater recovery will occur in the areas outside the barrier wall with estimated current arsenic concentrations exceeding 500 µg/L, as depicted in the attached Figure 1.
3. The total pumping capacity for the groundwater recovery systems will be at least 150 percent of the estimated recovery rates to achieve the design objectives identified in Items 1 and 2, above.
4. The groundwater treatment system will be designed for a continuous, average flow capacity of 40 gallons per minute (gpm). This design capacity is based on the following:
    - A groundwater recovery rate of 17 gpm for the contained area, which was predicted to achieve the head differential described in Item 1 above using the numerical groundwater flow model developed for the Site.

  - A groundwater recovery rate of 13 gpm for the groundwater plumes outside the barrier wall, which is predicted to achieve the performance criterion described in Item 2, above, using the numerical groundwater flow model developed for the Site.
  - An additional design capacity of 10 gpm, which is based on 33 percent excess treatment capacity.

5. The groundwater treatment system will be designed to operate at a minimum continuous flow rate of 15 gpm and a maximum, short-term flow rate of 60 gpm to accommodate a range of potential operations.
6. The groundwater treatment system will be designed to receive the groundwater quality presented in Table 1, which is considered as reasonable worst case groundwater quality that will be recovered from either inside and outside the barrier wall. The data shown in Table 1 are based on groundwater sampling from beneath the Landfill that was conducted in the spring/summer of 2010, as presented in Appendix A to the EAE Report.
7. The groundwater treatment system will be designed to achieve the anticipated groundwater quality criteria listed in Table 2 in the treated effluent.
8. The groundwater treatment process will consist of a primary treatment process using chemical oxidation with potassium permanganate, pH adjustment/precipitation and settling, followed by a secondary treatment consisting of pH adjustment, filtration, and adsorption.
9. The groundwater treatment system will include an automated control and data acquisition system, and will be designed to operate automatically, with minimal direct operator attention during normal operations. The control and data acquisition system will monitor the groundwater level in selected observation wells/piezometers, and will allow remote monitoring of operations and groundwater levels. The control and data acquisition system will include the following, at a minimum:
   - Automatic control of the groundwater recovery pumps for the contained area and the areas outside the Landfill.
   - Automatic control of the groundwater treatment plant.
   - Monitoring of transducers in selected groundwater wells and piezometers.
   - Monitoring and supervisory control for the existing interceptor trench pump control system.
   - Remote autodialing and alarm capability.
   - Data logging/recording capability.
   - The capability for monitoring from a remote computer located off-site the groundwater recovery pumps, treatment system operations, level monitoring instruments, and other relevant system information.
10. Groundwater will initially be discharged to surface water (via the north stormwater pond). The design must support potential future modifications to redirect the discharge to subsurface infiltration or to wetlands areas.
11. The design will provide adequate security to reasonably protect process equipment, chemicals, and controls from vandalism.

12. The design shall include a pilot testing program to evaluate in-situ treatment of contaminated groundwater in the additional areas outside the barrier wall.
13. The design shall be for a permanent facility suited for reliable, long-term operations.
14. The design shall not adversely affect the Landfill, barrier wall, or interceptor trench.
15. The design shall be consistent with current and anticipated future land uses near the B&L Property.
16. The design shall support compliance monitoring and monitoring of facility operations.

By signing below, the Project Coordinators have approved this basis for design of the B&L groundwater recovery system, groundwater treatment system, and wetlands in-situ treatment pilot study.

Dominick Reale Date: 12-10-10

Dominick Reale
Project Coordinator
Washington State Department of Ecology

Teri A Floyd Date: 12/08/2010

Teri Floyd
Project Coordinator
Floyd|Snider

REFERENCES

Floyd|Snider/AMEC Geomatrix (Floyd|Snider/AMEC) 2009. *Groundwater Remediation Work Plan*. January.

Floyd|Snider/AMEC Geomatrix (Floyd|Snider/AMEC) 2010a. *Groundwater Remediation Work Plan Addendum*. May.

Floyd|Snider/AMEC Geomatrix (Floyd|Snider/AMEC) 2010b. *Ecology Review Draft Engineering Alternatives Evaluation*. October.

Encl.: Table 1 Groundwater Quality Basis
Table 2 Design Discharge Criteria
Figure 1 Groundwater Remediation Areas

Tables

Table 1
Groundwater Quality Basis
B&L Woodwaste Site Phase 2 CAP Implementation

													PZ-11						PD-107				
Parameter	**Units**	**PZ-1B**	**PZ-2B**	**PZ-3B**	**PZ-4B**	**PZ-4C**	**PZ-5B**	**PZ-6B**	**PZ-7B**	**PZ-8B**	**PZ-8C**	**PZ-10**	**Apr-10**	**Jun-10**	**PZ-13**	**PD-109**	**PZ-9**	**PZ-12**	**Apr-10**	**Jun-10**	**Minimum**	**Maximum**	**Average[1]**
Anions																							
Chloride	mg/L	----	----	----	5.7	----	----	----	----	7.8	----	----	----	----	----	17.2	20.6	60.3	11.3	----	5.7	60.3	20.5
Bromide	mg/L	----	----	----	0.1 U	----	----	----	----	0.1 U	----	----	----	----	----	0.9	0.1	1	0.1 U	----	ND	1	0.7
Nitrogen as Nitrate	mg-N/L	----	----	----	0.1 U	----	----	----	----	0.1 U	----	----	----	----	----	0.1 U	0.1 U	0.1	0.2	----	ND	0.2	--
Nitrogen as Nitrite	mg-N/L	----	----	----	0.1 U	----	----	----	----	0.1 U	----	----	----	----	----	0.1 U	0.1 U	0.1 U	1 U	----	ND	ND	--
Ortho-phosphorus	mg/L	----	----	----	0.1 U	----	----	----	----	0.3	----	----	----	----	----	0.1 U	0.1 U	0.1 U	0.1 U	----	ND	0.3	--
Sulfate	mg/L	----	----	----	2.4	----	----	----	----	3.1	----	----	----	----	----	0.1 U	0.1 U	0.4	0.1 U	----	ND	3.1	2.0
Fluoride	mg/L	----	----	----	0.3	----	----	----	----	0.3	----	----	----	----	----	1.0 U	0.1 U	1 U	1.6	----	ND	1.6	0.7
Total Metals																							
Antimony	µg/L	----	----	----	50 U	----	----	----	----	50 U	----	----	----	----	----	50 U	50 U	50 U	50 U	----	ND	ND	--
Arsenic	µg/L	1,610	172	1,130	2.0	1.2	262	9.7	78.9	18.1	13.7	1,860	1,880	1,630	273	190	1,920	1,550	4,150	4,540	1.2	4,540	1,121
Barium	µg/L	----	----	----	28	----	----	----	----	25	----	----	----	----	----	168	128	80	146	----	25	168	96
Beryllium	µg/L	----	----	----	1 U	----	----	----	----	1 U	----	----	----	----	----	1 U	1 U	1 U	1 U	----	ND	ND	--
Cadmium	µg/L	----	----		2 U	----		----	----	2 U	----	----	----	----	----	2 U	2 U	2 U	2 U	----	ND	ND	--
Calcium	µg/L	74,500	102,000	109,000	----	15,800	18,600	85,500	75,100	----	14,600	119,000	96,400	79,100	139,000	----	----	----	----	139,000	14,600	139,000	82,100
Chromium	µg/L	----	----	----	5 U	----	----	----	----	7	----	----	----	----	----	5 U	5 U	5 U	5 U	----	ND	7	--
Copper	µg/L	0.8	1.1	1.0	2 U	0.5 U	1.1	0.9	0.7	5	0.7	1.4	0.7		47.0	2 U	7	5	10	----	ND	47	6.3
Iron	µg/L	88,500	58,600	60,600	8,550	7,590	2,060	22,000	21,500	2,720	130	62,300	44,700	71,900	55,000	69,600	77,900	24,400	48,300	56,200	130	88,500	41,200
Lead	µg/L	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U		12	1 U	3	1	7	----	ND	12	5.8
Magnesium	µg/L	49,400	54,900	58,100	----	8,720	9,630	51,300	39,700	----	15,700	108,000	70,500	38,000	47,900	----	----	----	----	104,000	8,720	108,000	50,500
Manganese	µg/L	2,610	5,740	5,470	271	307	1,310	4,550	4,350	879	188	2,680	2,900		4,100	2,160	4,060	4,380	3,260	3,460	188	5,740	2,926
Mercury	µg/L	----	----	----	0.1 U	----	----	----	----	0.1 U	----	----	----	----	----	0.1 U	0.1 U	0.1 U	0.1 U	----	ND	ND	--
Nickel	µg/L	----	----	----	10 U	----	----	----	----	10	----	----	----	----	----	10	10 U	20	30	----	ND	30	18
Selenium	µg/L	----	----	----	0.5 U	----	----	----	----	0.5 U	----	----	----	----	----	2 U	2 U	2 U	2 U	----	ND	ND	--
Silver	µg/L	----	----	----	3 U	----	----	----	----	3 U	----	----	----	----	----	3 U	3 U	3 U	3 U	----	ND	ND	--
Thallium	µg/L	----	----	----	0.2 U	----	----	----	----	0.2 U	----	----	----	----	----	0.2 U	0.2 U	0.2 U	0.2 U	----	ND	ND	--
Zinc	µg/L	4 U	15	5	10 U	4 U	4 U	4 U	4 U	10 U	4 U	4 U	4 U	----	59	10 U	20	20	80	----	ND	80	33
Dissolved Metals																							
Antimony	µg/L	----	----	----	50 U	----	----	----	----	50 U	----	----	----	----	----	50 U	50 U	50 U	50 U	----	ND	ND	--
Arsenic	µg/L	----	----	----	2.2	----	----	----	----	16.8	----	----	----	----	----	190	1,710	1,360	4,260	----	2.2	4,260	1,260
Dissolved Arsenic Speciation																							
Arsenic III	µg/L	----	----	----	1.54	----	----	----	----	11.7	----	----	----	----	----	146	1,460	662	2,960	----	1.54	2,960	874
Arsenic V	µg/L	----	----	----	0.71	----	----	----	----	4.33	----	----	----	----	----	60	777	884	1,750	----	0.71	1,750	579
Dimethylarsinic acid/DMAs	µg/L	----	----	----	0.35 U	----	----	----	----	0.35 U	----	----	----	----	----	6.9 U	6.9 U	6.9 U	6.9 U	----	ND	ND	--
Monomethylarsonic acid/MMAs	µg/L	----	----	----	0.35 U	----	----	----	----	0.35 U	----	----	----	----	----	6.9 U	6.9 U	6.9 U	6.9 U	----	ND	ND	--
Barium	µg/L	----	----	----	24	----	----	----	----	9	----	----	----	----	----	164	109	72	129	----	9	164	85
Beryllium	µg/L	----	----	----	1 U	----	----	----	----	1 U	----	----	----	----	----	1 U	1 U	1 U	1 U	----	ND	ND	--
Cadmium	µg/L	----	----	----	2 U	----	----	----	----	2 U	----	----	----	----	----	2 U	2 U	2 U	2 U	----	ND	ND	--
Calcium	µg/L	----	----	----	17,600	----	----	----	----	14,200	----	----	----	----	----	59,000	116,000	69,100	130,000	----	14,200	130,000	67,700
Chromium	µg/L	----	----	----	5 U	----	----	----	----	5 U	----	----	----	----	----	5 U	5 U	5 U	5 U	----	ND	ND	--
Copper	µg/L	----	----	----	2 U	----	----	----	----	2 U	----	----	----	----	----	2 U	2 U	2 U	2 U	----	ND	ND	--
Iron	µg/L	----	----	----	7,990	----	----	----	----	530	----	----	----	----	----	69,500	76,100	23,000	46,700	----	530	76,100	37,300
Lead	µg/L	----	----	----	1 U	----	----	----	----	1 U	----	----	----	----	----	1 U	1 U	1 U	1 U	----	ND	ND	--
Magnesium	µg/L	----	----	----	9,300	----	----	----	----	13,000	----	----	----	----	----	39,600	66,100	41,600	103,000	----	9,300	103,000	45,400
Manganese	µg/L	----	----	----	271	----	----	----	----	850	----	----	----	----	----	2,160	3,950	4,480	3,320	----	271	4,480	2,510
Mercury	µg/L	----	----	----	0.1 U	----	----	----	----	0.1 U	----	----	----	----	----	0.1 U	0.1 U	0.1 U	0.1 U	----	ND	ND	--
Nickel	µg/L	----	----	----	10 U	----	----	----	----	10 U	----	----	----	----	----	10 U	10 U	20	20	----	ND	20	20
Potassium	µg/L	----	----	----	4,680	----	----	----	----	3,280	----	----	----	----	----	6,360	12,200	11,900	20,600	----	3,280	20,600	9,800
Selenium	µg/L	----	----	----	0.5 U	----	----	----	----	0.5 U	----	----	----	----	----	2 U	2 U	2 U	2 U	----	ND	ND	--
Silicon	µg/L	----	----	----	21,100	----	----	----	----	19,700	----	----	----	----	----	28,000	30,600	24,200	37,500	----	19,700	37,500	26,900
Silver	µg/L	----	----	----	3 U	----	----	----	----	3 U	----	----	----	----	----	3 U	3 U	3 U	3 U	----	ND	ND	--
Sodium	µg/L	----	----	----	21,400	----	----	----	----	19,500	----	----	----	----	----	29,300	68,000	86,300	37,500	----	19,500	86,300	43,700
Thallium	µg/L	----	----	----	0.2 U	----	----	----	----	0.2 U	----	----	----	----	----	0.2 U	0.2 U	0.2 U	0.2 U	----	ND	ND	--
Zinc	µg/L	----	----	----	10 U	----	----	----	----	10 U	----	----	----	----	----	10 U	10 U	10	40	----	ND	40	--
Phenols		----	----	----		----	----	----	----		----	----	----	----	----					----			
Phenol	µg/L	----	----	----	----	----	----	----	----	----	----	----	----	----	----	1 U	1 U	1 U	1 U	----	ND	ND	--
2-Methylphenol	µg/L	----	----	----	----	----	----	----	----	----	----	----	----	----	----	1 U	1 U	1 U	1 U	----	ND	ND	--
4-Methylphenol	µg/L	----	----	----	----	----	----	----	----	----	----	----	----	----	----	1 U	42	360	1 U	----	ND	360	201
2,4-Dimethylphenol	µg/L	----	----	----	----	----	----	----	----	----	----	----	----	----	----	1 U	1.8	1 U	1 U	----	ND	1.8	--
General Chemistry		----	----	----		----	----	----	----		----	----	----	----	----	----	----	----	----	----			
Total Alkalinity	mg/L	545	627	688	135	129	157	538	525	138	144	923	660	470	567	464	812	499	875	867	129	923	514
Bicarbonate Alkalinity	mg/L	545	627	688	135	129	157	538	525	138	144	923	660	470	567	464	812	499	875	867	129	923	514
Carbonate Alkalinity	mg/L	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	ND	ND	--
Hydroxide Alkalinity	mg/L	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	ND	ND	--
Sulfide	mg/L	----	----	----	0.05 U	----	----	----	----	0.05 U	----	----	----	----	----	0.05 U	0.05 U	0.05 U	0.05 U	----	ND	ND	--
5-Day Biochemical Oxygen Demand (BOD_5)	mg/L	----	----	----	----	----	----	----	----	----	----	----	----	----	----	14.9	18.4	9.5	18.0	----	9.5	18.4	15.2
Total Organic Carbon (TOC)	mg/L	----	----	----	4.27	----	----	----	----	1.70	----	----	----	40.2	----	24	57.6	42.8	36.4	50.8	1.7	57.6	32.2
Dissolved Organic Carbon (DOC)	mg/L	----	----	----	----	----	----	----	----	----	----	----	----	----	----	23.4	56.8	46.8	36	----	23.4	56.8	40.8
pH	pH units	----	----	----	6.66	----	----	----	----	7.13	----	----	----	----	----	6.51	6.46	6.42	6.44	----	6.42	7.13	6.6
Total dissolved solids (TDS)	mg/L	549	925	737	206	164	228	630	553	201	163	937	649	----	633	532	909	686	889	----	163	937	564
Field Parameters																							
pH	pH units	6.29	6.1	6.23	7.01	6.82	5.7	6.14	6.1	7.28	7.0	6.09	6.25	----	6.04	6.52	6.12	6.27	5.97	----	5.7	7.28	6.3
Specific Conductivity	mS/cm	1.2	1.38	1.5	0.305	0.260	0.364	1.3	1.15	0.280	0.297	1.599	1.177	----	1.328	1.040	1.778	1.044	1.494	----	0.26	1.778	1.0
Temperature	°C	12.6	12	12.3	11.5	12.28	11.9	11.7	11.6	11.4	12.1	13	12.95	----	12.86	11.8	13.0	12.7	12.7	----	11.4	13	12.3
Oxidation-reduction potential (ORP)	mV	-114	-28	-101	-129	-151	28	-69	-17	-53	26	-145.7	-160	----	-110	-130	-232	-92	-106	----	-232	28	-93.2

Notes:

Except where noted, all samples were collected in April 2010. Refer to the Engineering Alternatives Evaluation, Appendix A, Treatability Study Report, for additional information.

[1] The average concentrations are based only on results that were greater than the laboratory reporting limits. The average was not calculated unless there were at least 2 detected results.

Qualifier:

U Result was less than the laboratory reporting limit.

Table 2
Design Discharge Criteria
B&L Woodwaste Site Phase 2 CAP Implementation

Parameter	Surface Water Discharge[1]	Infiltration[2]	Wetlands Discharge[1]	Design Discharge Criteria
pH (std. units)	6.5–8.5	6.5–8.5	6.5–8.5	6.5–8.5
Arsenic[3] (µg/L)	5	5	5	5
Copper (µg/L)	54	592	54	54
Iron (µg/L)	--	300	--	300
Lead (µg/L)	2.5	50	2.5	2.5
Manganese (µg/L)	--	50	--	50
Nickel (µg/L)	43	100	43	43
BOD[4] (mg/L)	30	--	30	30
TDS (mg/L)	--	500	--	--
TSS[4] (mg/L)	30	--	30	30

Notes:

1 The surface water and wetlands discharge criteria are the minimum of the federal and state surface water quality criteria, as described in the Engineering Alternatives Evaluation Report.

2 The infiltration criteria are the minimum of federal and state Maximum Contaminant Levels, MTCA Method B potable water cleanup levels, and Washington Groundwater Quality Standards, as described in the Engineering Alternatives Evaluation Report.

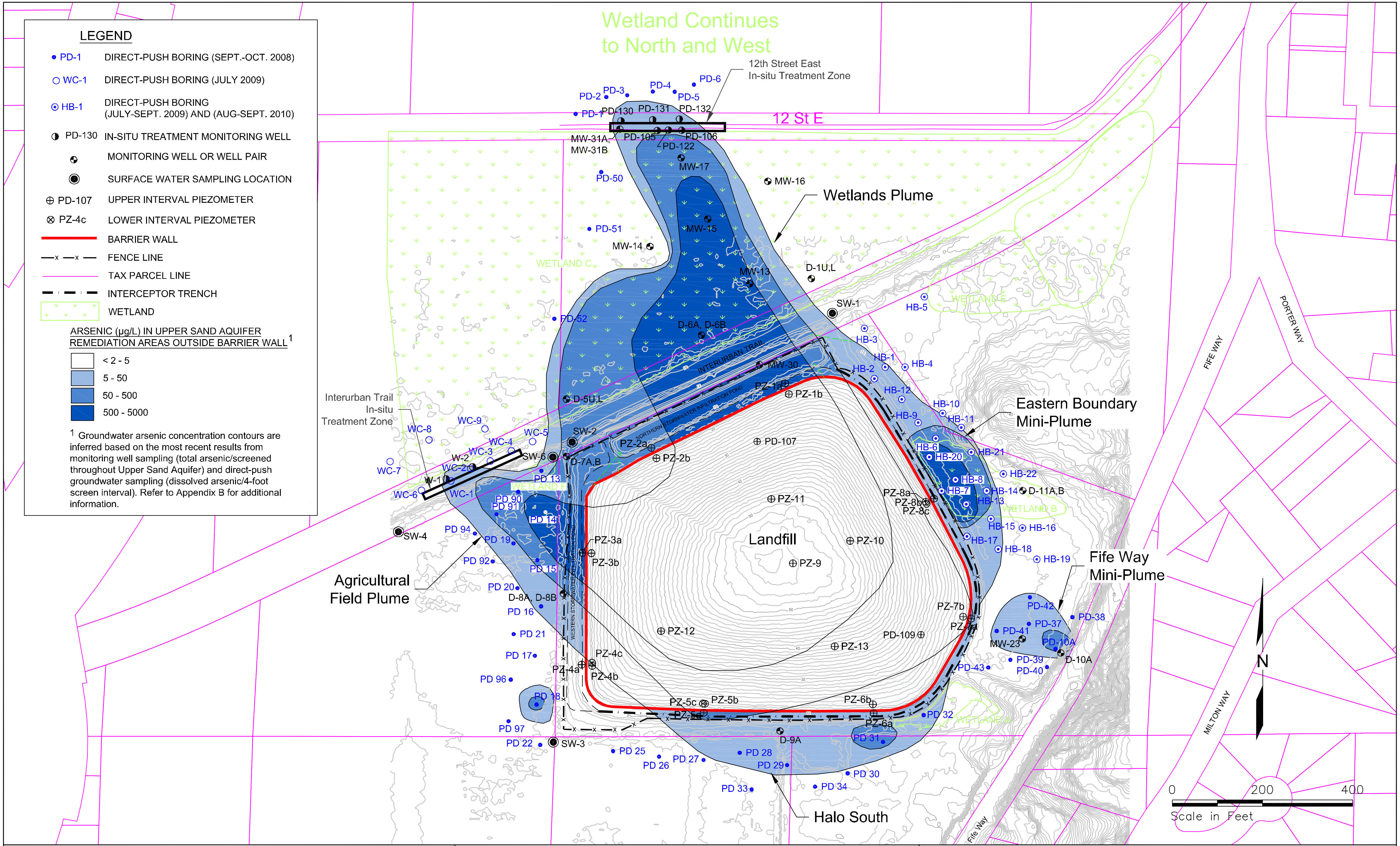
3 The arsenic criteria are based on the cleanup level established in the B&L Woodwaste Site 2008 Cleanup Action Plan, which is based on the background concentration for groundwater.

4 The criteria for BOD and TSS are based on federal regulatory standards for seconday treatment.

Abbreviations:

BOD	5-day biochemical oxygen demand
TDS	Total dissolved solids
TSS	Total suspended solids

Figures



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Design Basis Memorandum
B&L Woodwaste Site
Pierce County, Washington

Figure1
Groundwater Remediation Areas

DWG NAME: G:\project\Clients\Floyd and Snider\BandL\BandL078revDec2010.dwg
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B&L Woodwaste Site
Pierce County, Washington

Engineering Design Report (EDR) Addendum 3

Phase 2 Part 1 Remediation Design Report

Groundwater Recovery and Treatment System

Appendix 3B
Groundwater Treatability Study Report

(Provided on CD-ROM)

FINAL

B&L Woodwaste Site
Pierce County, Washington

Engineering Alternatives Evaluation

Appendix A
Treatability Study Report

FINAL

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List of Abbreviations and Acronyms

Abbreviation/Acronym	Definition
AMEC	AMEC Geomatrix, Inc.
BOD	Biological oxygen demand
C	Celsius
CAA	Cleanup Action Area
CAP	Cleanup Action Plan
DO	Dissolved oxygen
DOC	Dissolved organic carbon
EBCT	Empty Bed Contact Time
Ecology	Washington State Department of Ecology
$FeCl_3$	Ferric chloride
gpm	Gallons per minute
GRWP	Groundwater Remediation Work Plan
H_2O_2	Hydrogen peroxide
$KMnO_4$	Potassium permanganate
Landfill	B&L Woodwaste Landfill
L	Liter
mg	Milligram
mL	Milliliiter
mV	Millivolt
NaOH	Sodium hydroxide
ORP	Oxidation-reduction potential
QAPP	Quality Assurance Project Plan
SAP	Sampling Analysis Plan
Site	B&L Woodwaste Site
TSS	Total suspended solids
TSWP	Treatability Study Work Plan
µS/cm	Microsiemen/centimeter
USEPA	U.S. Environmental Protection Agency

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1.0 Introduction

Floyd|Snider and AMEC Geomatrix Inc. (AMEC) were retained to prepare a comprehensive design for groundwater recovery and treatment at the B&L Woodwaste Site (Site). A key element of the design process are field studies aimed at collecting design data; these predesign studies were described in the Groundwater Remediation Work Plan (GRWP) Addendum (Floyd|Snider/AMEC 2010), which was approved by the Washington Department of Ecology (Ecology). The GRWP Addendum included a Groundwater Treatability Study Work Plan (TSWP) that presented details for field treatability studies conducted on site groundwater. This report summarizes the results of the Groundwater Treatability Study conducted in the spring and summer of 2010.

As described in the 2008 Cleanup Action Plan (CAP) for the Site (Ecology 2008), the Site is defined as follows:

- The B&L Woodwaste Landfill (Landfill), where the wood waste was consolidated and capped in 1992 to 1993.
- The B&L Property, where the Landfill is located.
- The off-site properties that have been affected by the groundwater plume associated with the Landfill.

Phase 1 of the remedial action installed a barrier wall around the landfill contents, leachate within and beneath the landfill, and groundwater in the Upper Aquifer beneath the Landfill. After construction of the barrier wall, the landfill cap was re-installed and tied to the wall. The base of the barrier wall is tied into a silt confining layer; however, it is known that the silt contains gaps and it is leaky, allowing water to move between the Upper and Lower Sand Aquifers when the potentiometric heads are different. To decrease the potential for contamination to leave the enclosed landfill, hydraulic controls are being installed as part of Phase 2 construction at the Landfill. The hydraulic controls will extract contaminated groundwater and leachate from within the barrier wall. The extracted water will require treatment prior to discharge.

Phase 2 of the remedial action also involved extraction of historically contaminated groundwater from outside the barrier wall. This groundwater is generally less contaminated than water within the barrier wall, but will still require treatment prior to discharge.

1.1 SYSTEM REQUIREMENTS

The treatment system component for the remedial action must meet the following requirements:

- Remove arsenic at concentrations up to approximately 5,000 µg/L.
- Obtain discharge limits for arsenic as low as 5 µg/L.
- Have sufficient capacity to accept extracted water from the barrier wall system and extraction system for the historical groundwater plume.
- Meet additional discharge requirements for discharge into adjacent surface water or wetlands or infiltration into the groundwater system (discharge requirements vary depending on the point of discharge).

- Operate in a robust manner that allows for easy operation and maintenance by part-time staff with little risk of treatment plant upsets.
- Allow for variable inflows both seasonally and over time as the need for extraction of groundwater outside the barrier wall decreases.

1.2 SCOPE OF STUDY

The treatability study described in the TSWP was designed to collect information needed for design of a treatment system capable of achieving these goals. The treatability study included sampling and analysis of selected groundwater monitoring wells and piezometers completed within the Landfill to establish appropriate and representative groundwater quality information for the treatment process design. These samples were analyzed for a variety of analytes and water chemistry parameters to assess the nature of site groundwater and the variability of water chemistry, and to select the well that was used to supply reasonable worst case groundwater for bench scale testing.

The treatability study included bench scale treatability testing to screen potential treatment options. The objectives of the bench scale testing program were the following:

- Identify a primary treatment process that will remove the majority of the arsenic from recovered groundwater.
- Identify a polishing treatment process that will remove the remaining arsenic to a concentration less than 5 µg/L in groundwater treated by the primary treatment step.
- Identify influent water quality issues for the different groundwater recovery areas that may interfere with treatment process performance.
- Identify treatment process issues that will influence process design and make recommendations as to how these can be addressed.
- Estimate other important engineering design parameters including:
    - chemical dosing and consumption requirements,
    - residuals quantity and quality,
    - media and chemical consumption rates, and
    - reaction times.

The field bench scale treatability studies were performed in general accordance with the TSWP. Field testing was completed in two phases. The first phase identified and screened potential primary treatment approaches, including oxidation and oxidation followed by co-precipitation and settling. The goal of the primary treatment was removal of the majority of the arsenic from the groundwater (80 to 95 percent). The second phase screened potential secondary treatment methods to polish the groundwater and achieve the anticipated discharge limit of 5 µg/L of arsenic. These treatability study phases were completed at the Site so that representative groundwater could be used. Subsequent testing will be done to collect data needed for final system design; this portion of the work will be completed at the AMEC Waterloo treatability laboratory.

This report was prepared to document the results of the field sampling and the Phase 1 and Phase 2 bench scale treatability studies completed at the Site. The purpose of this report is the following:

- Summarize the observations made during the testing events, which occurred from May 10 to 14, 2010 and June 1 to June 5, 2010.
- Present the analytical data from samples taken during the testing events.
- Provide conclusions related to the design basis development of a full scale treatment system.

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2.0 Landfill Groundwater Sampling

Sampling of the groundwater beneath the Landfill was conducted to provide a representative characterization of the groundwater quality beneath the Landfill and to determine a suitable well to obtain groundwater for treatability testing. Groundwater from the Upper Sand Aquifer beneath the Landfill was sampled and analyzed to characterize contaminant concentrations and groundwater chemistry in accordance with the GRWP Sampling and Analysis Plan/Quality Assurance Project Plan (SAP/QAPP; Floyd|Snider/AMEC 2009a), with specific analytical methods listed in Table B.3 of the TSWP.

Samples were collected in two rounds. In Round 1 on April 15, 2010, a limited number of groundwater samples were collected for analysis of the full suite of parameters to characterize groundwater chemistry, water quality parameters, and potential contaminants that may be relevant to treatment and discharge to surface water. In Round 2 on April 27, 2010, sampling included a larger number of piezometers located within the Landfill with a shorter list of analytes than Round 1. The shorter list of analytes in Round 2 was designed with a focus on potential contaminants and relevant water chemistry parameters.

A Level 1 data quality review was performed on the analytical results. The data were determined to be of acceptable quality for use and no data qualifiers were added. A data validation memorandum is included as Appendix A.1.

Tabulated results from landfill groundwater sampling are presented in Table A.2.1 for Round 1 and Table A.2.2 for Round 2 in Attachment A.2. Laboratory analytical results are presented in Attachment A.3. Refer to the Engineering Alternatives Evaluation Figure 2.2 for the locations of piezometers and wells sampled.

Contaminant levels in the groundwater samples were generally consistent with previous results collected for the Site. Although arsenic concentrations were more variable than expected, ranging from 1 to almost 2,000 ug/L, with an average of 660 ug/L,, a favorable ratio of iron to arsenic was observed in the samples. Field parameters and laboratory results indicate that groundwater beneath the Landfill is present under reducing conditions. Sampling results indicate that significant levels of dissolved organic carbon (DOC) are present in Site groundwater (up to 60 mg/L). However, the biochemical oxygen demand (BOD) results indicate that the organics are not readily biodegraded.

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3.0 Phase 1 Treatability Testing

Phase 1 testing was completed at the Site from May 10 to 14, 2010. The testing completed during Phase 1 included groundwater oxidation using aeration, hydrogen peroxide (H_2O_2), and potassium permanganate ($KMnO_4$). Based on the results of landfill groundwater sampling, water was collected each day from Well PD-107. This well contained groundwater with some of the highest levels of arsenic on the Site and, therefore, it was determined that water from this well would be used as a reasonable worst case scenario to assess the alternate oxidation methods.

3.1 AERATION

Water for the aeration tests was collected on May 12, 2010 from Well PD-107. Two tests were conducted with each using 1.5 liters (L) of water. Two beakers were each filled with 1.5 L of the groundwater and a 4-inch aeration stone was placed in the bottom of each beaker. The aeration stone was connected to a small aquarium air pump, which was used to provide air to the stone. Aeration provided both mixing and an oxidant for the iron and arsenic in the groundwater.

The first test aerated the 1.5 L of sample for approximately 30 minutes. The dissolved oxygen (DO) concentration was recorded throughout this period. Figure A.4.1 (Attachment A.4) shows the dissolved oxygen concentration over time. After approximately 30 minutes, it appeared as though oxygen saturation (approximately 10 mg/L) was reached in the sample. A second aeration test was completed using the same apparatus and allowing 1.5 L of sample to be aerated for 3 hours. Figure A.4.2 presented in Attachment A.4, shows the dissolved oxygen concentration over time for this test.

The initial and final concentrations of iron and arsenic for the aeration tests are shown in Table A.1, along with field parameters measured using a HORIBA U-22XD multi-parameter instrument. The field concentrations of arsenic were measured using a HACH low-range arsenic kit (HACH Catalogue #28000). The field measurements for total and ferrous iron were measured with Methods #8008 and #8146, respectively, using a HACH DR890 spectrophotometer kit.

Table A.1
Aeration Testing

Parameter	Initial Conditions		Aeration after 30 minutes		Aeration after 3 hours	
	Field	Lab	Field	Lab	Field	Lab
Total Arsenic (µg/L)	3,000	4,540	2,500	2,750	2,000	2,180
Total Iron (mg/L)	57.4	56.2	17	22.2	15.5	15.3
Total Ferrous Iron (mg/L)	36.6		0.4		0.4	
Dissolved Oxygen (mg/L)	>1.2		10.0		9.4	
pH[1]			8.3		8.6	
Conductivity (µS/cm)	1.73		1.46		1.2	
ORP (mV)	-52		72		74	
Temperature (˚C)	13		17.1		21.6	

Note:

1 The initial pH condition was not recorded due to instrument error. Field measurements from PD-107 during lLandfill groundwater sampling on April 15, 2010 indicate an initial pH of approximately 6 for this groundwater.

During the aeration tests, the water changed color from a grayish yellow to brownish yellow with dark brown precipitate. Humus-like odors (consistent with the presence of bark and wood debris at the Landfill) were quite noticeable.

3.2 POTASSIUM PERMANGANATE

As noted in the TSWP, $KMnO_4$ was selected as one of the oxidation chemicals to be evaluated for treatment of the groundwater as it is a strong oxidant capable of oxidizing iron, manganese, and arsenic; and is recognized by the U.S. Environmental Protection Agency (USEPA) as a recommended treatment chemical for arsenic-contaminated water.

The oxidant dosage must satisfy the oxidant demand of the water to be treated. Based on the groundwater analyses for the Site, the constituents that could be oxidized (and consume oxidant) include arsenic, iron, manganese, and organic carbon. Dosages for $KMnO_4$ for each oxidant demand constituent were estimated based on recommended stoichiometric dosages from several resources, including the USEPA 2006 design manual entitled “Removal of Arsenic from Drinking Water Supplies by Iron Removal Process.” The actual dosages used for the treatability study were calculated to span the range of calculated doses based on literature stoichiometry.

Table A.2 shows the dosage factors for $KMnO_4$ treatment from the literature. The dosage factors in Table A.2 reflect stoichiometry and experience with the oxidant demand constituents identified in site groundwater. Based on these dosage factors, four test samples were set up to achieve the dosage factors shown in Table A.2. The experimental design was intended to adequately span the expected range of treatment stoichiometry.

Table A.2
Dosage Factors for $KMnO_4$

Parameter	Literature Dosage Factors ($mg\ KMnO_4/mg$ species)
Arsenic	1.40
Iron	0.71–1.175
Manganese	1.44–2.40
DOC	4.0–6.25

The projected initial groundwater quality for Well PD-107 (based on previous sampling results), and the minimum dosage factor and minimum calculated $KMnO_4$ dose to address the oxidant demand for each of the potentially oxidizable Site constituents are shown in Table A.3. The total oxidant dose, based on the minimum dosage factor listed in Table A.3, would be the sum of the stoichiometric dosage in the last column of Table A.3 (i.e., 188.8 mg/L). Of the four constituents listed in Table A.2, the inorganics are very likely to be oxidized by $KMnO_4$. Although DOC represents a groundwater constituent that can be oxidized, the specific organic chemicals comprising the DOC are not known; therefore, it is not possible to assess the oxidant demand represented by the DOC. Assuming the DOC is largely caused by tannins and lignins (likely due to the degradation of the wood waste and wetlands vegetation), the DOC would not likely be effectively oxidized and would not likely consume significant amounts of chemical oxidants. As shown by the high minimum concentration of $KMnO_4$ required to address the DOC oxidant demand in Table A.3, the DOC could result in substantial consumption of chemical oxidant (the DOC represents 74 percent of the oxidant dose based on all four oxidant demanding constituents).

Table A.3
Initial Conditions and Minimum $KMnO_4$ Dosage

Parameter	Initial Conditions (mg/L)	Minimum Dosage Factor ($mg\ KMnO_4/mg$ species)	Minimum $KMnO_4$ Dosage (mg/L)
Total Arsenic	4.15	1.40	5.8
Total Iron	48.3	0.71	34.3
Total Manganese	3.26	1.44	4.7
DOC	36	4.00	144

Table A.4 shows the actual dosage that was added for each $KMnO_4$ test run. The minimum and maximum predicted total oxidant demand based on actual published literature values for the inorganic constituents (refer to Table A.2), are 44.8 mg/L and 70.4 mg/L, respectively. The actual dosage range for $KMnO_4$ testing spans the inorganic oxidant demand; however, due to a calculation error, the dosage range used in the study was not adequate to fully oxidize the organics, as represented by DOC. A laboratory stock solution of 0.5N potassium permanganate was used for the Phase 1 tests; the volume of stock solution needed to achieve the dosage for each test solution is also shown in Table A.4.

Table A.4
Actual Dosages Used for $KMnO_4$

Test Number	Actual $KMnO_4$ Dose	
	(mg/L)	(mL $KMnO_4$/L)[1]
1	37.76	2.39
2	47.40	3.00
3	51.09	3.74
4	75.05	4.75

Note:

1 mL and mg of $KMnO_4$ were calculated based on the volume of sample and a concentration of 0.5N or 1.58% (w/v) solution.

Water for the $KMnO_4$ tests was collected on May 12, 2010 from Well PD-107. Four beakers were filled with 1L of groundwater and dosed with $KMnO_4$, at the concentrations shown in Table A.4. The samples were stirred for approximately 2 minutes after the addition of $KMnO_4$ and then allowed to settle for 1 to 2 hours prior to obtaining samples of the supernatant.

Table A.5 shows the initial and final concentrations of arsenic and iron in the groundwater before and after treatment by $KMnO_4$. Field data were collected using a HACH low-range arsenic kit, a HACH DR890 spectrophotometer for total and ferrous iron (Methods #8008 and #8146, respectively), a HORIBA U-22XD multi-parameter instrument, and a HANNA 9025 pH meter.

Table A.5
$KMnO_4$ Testing

Parameter	Initial Conditions		Test 1	Test 2		Test 3		Test 4	
	Field	Lab	Field	Field	Lab	Field	Lab	Field	Lab
Total Arsenic (µg/L)	3,000	4,350	250	250	226	250	183	100	141
Total Iron (mg/L)	57.4	50.6	2.63	2.48		2.63		1.88	
Total Ferrous Iron (mg/L)	36.6		0.03	0.07		0.08		0.02	
Manganese (mg/L)		3.44							
Dissolved Oxygen (mg/L)	>1.2								
pH1			6.60	6.65		6.64		6.62	
Conductivity (µS/cm)	1.73								
ORP (mV)	-52								
Temperature (˚C)	13								

Note:

1 The initial pH conditions were omitted due to instrument error. Field measurements from PD-107 during Landfill groundwater sampling on April 15, 2010 indicate an initial pH of approximately 6 for this groundwater.

The data in Table A.5 show that the $KMnO_4$ dosage was effective in reducing arsenic levels in all four tests, indicating that the dosage range used was sufficient to treat site groundwater. Slightly better removal was achieved for Tests 3 and 4, with the higher $KMnO_4$ doses. These data suggest that the DOC did not represent a significant demand for $KMnO_4$ and did not interfere with treatment chemistry. This is consistent with the low BOD found for the well indicating that the DOC is not readily oxidized biologically or chemically. Table A.6 summarizes the percent removal of total arsenic for each dose based on the collected field and laboratory data. The data in Tables 5 and 6 show that removal was largely independent of $KMnO_4$ dosage for the range of $KMnO_4$ tested, indicating that the inorganic parameters were preferentially oxidized and that DOC did not consume oxidant in the bench scale testing.

Table A.6
Arsenic Removal with $KMnO_4$

Test Number	Percent Removal	
	Field	Lab
1	92%	--
2	92%	95%
3	92%	96%
4	97%	97%

During the oxidation trials with $KMnO_4$, the following observations were made:

- All dosages of $KMnO_4$ showed good settling properties.

- The two test runs with higher dosages showed particulates that had a more reddish/rust color.
- No purplish color remained after treatment, indicating that excess $KMnO_4$ was not present at significant levels.
- As the dosage increased, the supernatant color changed from a clear, slightly brownish-yellow color to a clear yellow color.

3.3 HYDROGEN PEROXIDE

H_2O_2 was selected to be tested as a chemical oxidant as it is a strong oxidant capable of oxidizing organic carbon, arsenic, and iron. The presence of ferrous iron can increase the effectiveness by catalyzing oxidation reactions. In some studies it was noted that H_2O_2 may be more effective at a pH less than 6.0 to 6.5. Therefore, H_2O_2 was tested in a two-stage manner. The first stage tested the effectiveness with four progressive dosages. The second stage used the most effective dosage observed from the first stage in four additional test samples, with each Stage 2 sample adjusted to a pH ranging from 4 to 6.5.

Dosages for H_2O_2 were estimated using published dosage factors from several resources including an on-line calculator available at www.H2O2.com. The stoichiometric dosage factors address each of the oxidant consuming constituents (arsenic, iron, manganese, and DOC). Table A.7 shows the range of literature dosage factors for each oxidizable constituent. The initial constituent concentrations used for calculating the dosage were based on the projected groundwater quality for PD-107, as presented in Table A.3. The predicted minimum and maximum total H_2O_2 dosages based on actual published dosage factors for the inorganic constituents and DOC, shown in Table A.7, are 38.5 mg/L and 74.2 mg/L respectively. Table A.8 shows the actual dosage that was added for Stage 1 H_2O_2 testing. The H_2O_2 doses span the range of literature dosage factors, including oxidant demand for DOC. A stock solution of 3% H_2O_2 was used during the Phase 1 tests.

Table A.7
Dosage Factors for H_2O_2

Parameter	Literature Dosage Factors (mg H_2O_2/mg species)
Total Arsenic	0.3–0.625
Total Iron	0.2–0.5
Total Manganese	0.45–0.75
DOC	0.75–1.25

Table A.8
Actual Dosages Used for H_2O_2

Test Number	Actual H_2O_2 Dose	
	(mg/L)	**(mL H_2O_2)**[1]
1	39.60	1.98
2	46.80	2.34
3	54.60	2.73
4	74.40	3.72
5	86.40	4.32

Note:

[1] mL of H_2O_2 was calculated based on a sample volume of 1.5 L and a 3% solution of H_2O_2.

Water for the H_2O_2 tests was collected on May 13, 2010 from PD-107. For the first stage testing, five beakers were filled with 500 mL of groundwater and ⅓ of the H_2O_2 volume was added followed by mixing and addition of more groundwater and H_2O_2 until the full 1.5 L of groundwater and full dosage was reached. The samples were stirred for approximately 2 minutes between each addition of water and H_2O_2, and after the final addition of H_2O_2. The samples were then allowed to settle for 1 to 2 hours prior to obtaining samples of the supernatant.

Table A.9 shows the initial and final concentrations of arsenic and iron in the groundwater as well as the analyses before and after the treatment with H_2O_2 for the first stage of testing. The consistent DOC concentrations before and after treatment indicate that the organics present in site groundwater were not significantly oxidized, even though H_2O_2 is a more aggressive oxidant than $KMnO_4$. Field data were collected using a HACH low-range arsenic kit, a HACH DR 890 spectrophotometer, a HORIBA U-22XD multi-parameter instrument, and a HANNA 9025 pH meter.

Table A.9
Hydrogen Peroxide Testing—Stage 1

Parameter	Initial Conditions		Test 1	Test 2	Test 3		Test 4		Test 5	
	Field	Lab	Field	Field	Field	Lab	Field	Lab	Field	Lab
Total Arsenic (µg/L)	2,500	5,150								
Diss. Arsenic (µg/L)	2,500	4,500	500	375	300	489	350	415	350	415
Total Iron (mg/L)	55.8	52.4	6.5	5.6	5.14		4.34		3.98	
Diss. Iron (mg/L)		47.9								
Ferrous Iron (mg/L)	32.6		0.09	0.15	0.15		0.18		0.15	
DOC (mg/L)		34.1				34.8		31.2		33.8
pH	6.1		6.60	6.58	6.54		6.58		6.58	
Conductivity (µS/cm)	1.77		1.63	1.62	1.61		1.62		1.61	
ORP (mV)	-58		347	353	354		354		352	
Temperature (˚C)	12.9									

Table A.10 summarizes the percent removal of total arsenic for each dose based on the collected field and laboratory data.

Table A.10
Dissolved Arsenic Removal with H_2O_2—Stage 1

Test Number	Percent Removal	
	Field	Lab
1	80%	--
2	85%	--
3	88%	89%
4	86%	91%
5	86%	91%

The second stage of the H_2O_2 test was to assess oxidation with H_2O_2 at different pH values. This involved selecting a H_2O_2 dosage based on Stage 1 results and evaluating treatment using nitric acid to acidify the groundwater prior to the addition of H_2O_2. From the Stage 1 field tests, Test 4 dosage was selected as the best dosage to use as it provided better treatment than lower doses and was equivalent in effectiveness with the highest H_2O_2 dose.

The same batch of groundwater was used in the second stage as was used in the first stage of H_2O_2 treatment. Four beakers were filled with 1.5 L of groundwater each and dosed with 10% nitric acid to achieve the pH range shown in Table A.11. After the pH was adjusted on all four samples, H_2O_2 was added. Approximately ⅓ of the required H_2O_2 dose was added to each sample and stirred for 1 to 2 minutes followed by repeated addition and mixing until the full dosage was reached. Table A.11 shows the collected field and laboratory data from the second stage H_2O_2 testing. These results show significant DOC reduction at the lower pH range, indicating that DOC would increase oxidant demand for acidified H_2O_2 treatment. The two samples showing the best arsenic removal (i.e., pH Adjust 1 and 2) from the field tests were selected to be analyzed by the laboratory for selected constituents.

Table A.11
Hydrogen Peroxide Testing—Stage 2

Parameter	Initial Conditions		pH Adjust 1		pH Adjust 2		pH Adjust 3	pH Adjust 4
	Field	**Lab**	**Field**	**Lab**	**Field**	**Lab**	**Field**	**Field**
Total Arsenic (µg/L)	2,500	5,150	350		300			
Dissolved Arsenic (µg/L)	2,500	4,500	25	37.9	100	14.3	200	300
Total Iron (mg/L)	55.8	52.4	7.25		12.75		39.6	32.6
Dissolved Iron (mg/L)		47.9	0.35	0.09	0.43	0.40	12.2	13.8
Total Ferrous Iron (mg/L)	32.6		0.2		0.51		1.16	1.29
Manganese (mg/L)								
DOC (mg/L)		34.1		24		16.6		
pH	6.1		5.47		4.97		4.51	4.05
Conductivity (µS/cm)	1.77							
ORP (mV)	-58							
Temperature (˚C)	12.9							

Table A.12 summarizes the percent removal of dissolved and total arsenic for the second stage of H_2O_2 testing, based on the collected field and laboratory data.

Table A.12
Dissolved Arsenic Removal with H_2O_2—Stage 1

pH Adjust	**Dissolved As Removal**	
	Field	**Lab**
1	99%	99.2%
2	96%	99.7%
3	92%	--
4	88%	--

During the oxidation trials with H_2O_2 the following observations were made:

- After the addition of H_2O_2, the sample turned a very dark brown/gray color with dark-colored precipitate.
- Upon settling, the solids remained very dark brown in color and the supernatant appeared clear brown to clear brownish yellow as the dose increased.
- With the addition of nitric acid in the second stage, the groundwater turned very dark brown in color. After the addition of H_2O_2, the color lightened with the lightest color showing in the highest pH and the darkest color showing in the lowest pH.
- The solids ranged from a dark brown to dark blackish brown from highest to lowest pH.
- The supernatant appeared clear brownish yellow to clear brown from highest to lowest pH.

3.4 CO-PRECIPITATION

After the initial oxidation treatments were completed, a second stage of co-precipitation was tested as part of the primary treatment. Sodium hydroxide (NaOH) and calcium hydroxide (lime) were tested to determine if co-precipitation could further enhance the removal of arsenic from groundwater after chemical oxidation treatment to improve the overall treated water quality when compared with oxidation only.

Based on the observed arsenic removals from the field analyses for aeration, $KMnO_4$ treatment and H_2O_2 treatment, it was decided to utilize $KMnO_4$ treatment at the highest dosage tested to assess co-precipitation. The field results indicated that a high percentage of arsenic removal was achievable through $KMnO_4$ treatment without initial pH adjustment; the slightly improved removal achieved with acidified H_2O_2 treatment was not considered justified by the additional pH adjustment step required.

Approximately 15 L of groundwater from PD-107 collected on May 14, 2010 was added to a 5-gallon container. A total of 79.2 mL of 0.5 N $KMnO_4$ solution was added to the groundwater and mixed rapidly for 5 minutes. The treated water was allowed to settle for approximately 1 hour, at which point samples of the supernatant were collected. The mixture was re-suspended to obtain a total suspended solids (TSS) sample, and an additional 10 mg/L of ferric iron (3.70 mL of a 10% ferric chloride [$FeCl_3$] solution) was added to aid with the co-precipitation. The solution was then rapidly mixed for an additional 5 minutes. The solution was then allowed to settle for 1 to 2 hours. After settling, 1.5 L of supernatant was pumped into eight separate beakers for the co-precipitation testing.

NaOH was added to four of the samples while lime was added to the remaining four. The target pH adjustments for the co-precipitation tests with each chemical were 7, 7.5, 8, and 8.5. A stock solution of 50% NaOH was used to create a 5% solution for pH adjustment in the tests. Table A.13 below details the actual pH that was reached with each chemical. Dry, hydrated lime was used for lime treatment. The dry powder was directly added to each test sample as needed to achieve the target pH.

Table A.13
Co-precipitation pH Adjustment

pH Adjust	Final pH	
	NaOH	Lime
1	6.97	7.01
2	7.68	7.75
3	7.98	8.25
4	8.53	8.90

No precipitate was observed in the samples treated with NaOH for pH adjustment; only a small amount of precipitate was observed in the samples treated with lime. An additional 10 mg/L of ferric iron (0.29 mL of 10% $FeCl_3$) was added to each beaker, vigorously stirred, and then added to a settling cone.

Once the samples were placed in the settling cones, a timer was started and the solids collected over a 1-hour time period were recorded. The results of the settling test can be seen in Figures A.5.1 and A.5.2, in Attachment A.5. The sludge volume for lime treatment was 0.4 to 1 percent (volume/volume [v/v]) while the sludge volume for NaOH treatment was less than 0.3 percent (v/v). The sludge volume for lime treatment was generally stable after 15 to 20 minutes.

The field and laboratory analysis as well as the measured field parameters throughout the co-precipitation trial are shown in Tables 14 and 15. These data show that the arsenic removal by $KMnO_4$ was consistent with the initial testing results. The data also show that lime treatment removed 75 to 80 percent of the total arsenic remaining after oxidation, based on field test kit results, resulting in a combined removal greater than 99 percent (Table A.16).

Table A.14
Oxidation Treatment Prior to Co-precipitation

Parameter	Initial Conditions		After Oxidation
	Field	**Lab**	**Field**
Total Arsenic (µg/L)	2,500	4,800	120
Dissolved Arsenic (µg/L)	2,500	4,700	6.0
Total Iron (mg/L)	51.2	56.6	1.1
Dissolved Iron (mg/L)	40.2	52.4	0.05
Total Ferrous Iron (mg/L)	35.8		0.06
DOC (mg/L)		35.1	
Dissolved Oxygen (mg/L)	>1.9		
pH	6.1		
Conductivity (µS/cm)	1.78		
ORP (mV)	-45		
Temperature (˚C)	13.0		

Table A.15
Co-precipitation Laboratory Results

Parameter	NaOH				Lime			
	pH = 6.97	pH = 7.68	pH = 7.98	pH = 8.53	pH = 7.01	pH = 7.75	pH = 8.25	pH = 8.90
Total Arsenic (µg/L)	74	69	54	42	32	25	24	28
Dissolved Arsenic µg/L)			22	29		20	21	
Total Iron (mg/L)	4.96	3.57	2.47	1.21	1.16	0.43	0.44	0.47
Dissolved Iron (mg/L)	0.52	0.05	0.05	0.09	0.05	0.05	0.05	
Manganese (mg/L)								
DOC (mg/L)			33.6	33.4		32.6	31.9	
pH[1]					7.10	7.76	8.1	9.2

Note:

1 Final field reading after 50 to 60 minutes of allowing dissolution of lime powder.

Table A.16
Dissolved Arsenic Removal with Oxidation and Co-precipitation

Test Sample	Dissolved As Removal	
	NaOH	Lime
1	--	--
2	--	99.58%
3	99.54%	99.56%
4	99.39%	--

During the co-precipitation trials, the following observations were made:

- The supernatant used after oxidation in the co-precipitation trials appeared clear with a yellowish color.
- Samples treated with NaOH showed a stable pH reading within minutes of addition; however, samples treated with lime took a longer period of time for the pH to stabilize because the lime powder dissolved in the samples.
- Samples treated with NaOH showed less precipitated solids than the samples treated with lime.
- The precipitate formed with NaOH was not very noticeable at first, but settled out with a dark orange color. The precipitate appeared as large, flocculated particles.
- The supernatant after co-precipitation with NaOH had a yellowish tinge that was most noticeable at a lower pH and almost non-existent in the highest pH samples.
- More solids were generated with the increasing pH for both NaOH and lime.

- Samples treated with lime showed better color removal in the supernatant overall than the samples treated with NaOH. The supernatant appeared very clear with little color.
- Precipitate formed in the samples treated with lime appeared brownish orange to white tinged with orange as the pH increased. The particulates were fine, but settled well.

3.5 PHASE 1 CONCLUSIONS

Both $KMnO_4$ and H_2O_2 exhibited good arsenic removal via oxidation, based on the field analyses that were conducted. It was concluded that $KMnO_4$ would be used as the primary oxidation chemical for the Phase 2 trials based on the following:

- Fewer pH adjustment steps which results in lower capital costs for equipment and lower operating costs for chemicals and instrument maintenance.
- Field and laboratory results, which indicated slightly better arsenic removal for $KMnO_4$ with no initial acidification.
- Visual observations, including better removal of color and better settling properties.
- Reduced chemical hazards associated with transportation, storage, and handling of $KMnO_4$.

Co-precipitation was completed with the use of NaOH and lime, both of which exhibited good removal of iron and arsenic after oxidation. Based on the field analyses and observations, lime showed better removal of color and slightly better removal of arsenic than the NaOH. Therefore, lime would be preferred over NaOH for co-precipitation.

Based on the field results, visual observations and analytical data collected during Phase 1, it was decided to select $KMnO_4$ as the preferred oxidation chemical followed by lime for co-precipitation and settling. This two-step process was selected for the primary treatment to be used for Phase 2 treatability testing. A compilation of all laboratory data from the Phase 1 testing is included in Attachment A.6.

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4.0 Phase 2 Treatability Testing

Phase 2 testing was completed between June 1 and 5, 2010. An aquifer test was being conducted during this time, which provided an opportunity to obtain groundwater samples from beneath the Landfill while the aquifer was being stressed by pumping. Groundwater produced during the aquifer test was expected to be more representative of groundwater that will be recovered during future groundwater recovery operations.

This phase of the bench scale study was used to:

- complete a bench scale test of polishing methods to bring the primary-treated groundwater arsenic concentration below 5 µg/L, and
- determine if groundwater from the surrounding wetlands would be significantly different from landfill groundwater and have any negative impacts on the selected primary treatment.

This section of the report describes the three tests completed during this phase of the field treatability study.

4.1 AQUIFER TEST ANALTYICAL TESTING

On June 1, 2010 the primary aquifer test commenced at approximately 12:02 PM local time. Refer to the Engineering Alternatives Evaluation Attachment C for details and analysis of the aquifer test. PZ-11, located on the north slope of the Landfill, about halfway up the cap, was selected as the control well for the test. As part of the test, PZ-11 was pumped at approximately 12.2 gallons per minute (gpm) for over 24 hours. Samples were collected throughout the aquifer test to determine if there would be any change in composition of the groundwater over time. The first sample of water from PZ-11 was collected at approximately 12:25 PM for laboratory analyses. A second sample was collected the same day at approximately 4:30 PM local time. This sample was collected after a 55-gallon drum was filled will approximately 53 gallons of groundwater to be used for the bench scale testing.

The final aquifer test sample was taken on June 2, 2010 at approximately 10:30 AM. This sample was collected after filling a second 55-gallon drum with 53 gallons of groundwater that was used for the second batch of bench scale testing.

The analyses of the water collected from the aquifer test are shown in Table A.17.

Table A.17
PZ-11 Aquifer Test Lab Results

Parameter	Sample 1	Sample 2	Sample 3
	06/01/10 12:25 PM	**06/01/10 04:30 PM**	**06/02/10 10:30 AM**
Purge Volume (gal)	280	3,270	16,450
Total Arsenic (µg/L)	1,580	1,600	1,630
Dissolved Arsenic (µg/L)	1,540	1,540	1,450
Total Iron (mg/L)	68.8	71.6	71.9
Dissolved Iron (mg/L)	68.0	72.6	71.7
DOC (mg/L)	36.8	38.1	37.1

Based on the above analyses and other analytical data presented in Attachment A.3, it was concluded that no significant variations occurred in the groundwater quality during the aquifer test.

4.2 SECONDARY POLISHING TREATMENT

Field bench testing was conducted to assess alternative secondary treatment technologies. Three sorbents were tested to evaluate secondary removal of arsenic to achieve a final effluent quality less than 5 µg/L. A large sample of water was collected and treated with $KMnO_4$ and lime co-precipitation to simulate the primary treatment process selected above. The primary treated water was then treated by the alternate sorption media.

4.2.1 Sample Preparation

The selected primary treatment was applied to prepare a water sample suitable for secondary treatability testing. In conjunction with the analytical sampling during aquifer testing described above, on June 1, 2010, a groundwater sample was collected from PZ-11 for secondary treatability testing after approximately 3.5 to 4.0 hours of pumping. Fifty-three (53) gallons of groundwater was collected in one 55-gallon drum and then dosed with $KMnO_4$. Due to the large volume of water to be treated, the $KMnO_4$ was added using two different stock solutions. Table A.18 shows the initial conditions used for the calculation of the $KMnO_4$ dose and Table A.19 shows the actual calculated dosage that was added to the drum.

Table A.18
Primary Treatment Initial Conditions for Sample 1 Dose Calculation

Parameter	Initial Conditions (mg/L)	Dosage Factor (mg $KMnO_4$/mg Species)	$KMnO_4$ Dosage (mg/L)
Total Arsenic[1]	1.0	1.40	1.40
Total Iron[1]	69.25	0.71	49.17
Total Manganese[2]	39.5	1.44	56.88
DOC	56.8	4.00	227.2

Notes:

1 Total arsenic and total iron were based on field analyses from Sample 1.

2 Total manganese was estimated to be 4.06 mg/L, but was incorrectly entered into the calculation as 39.5 mg/L, resulting in an actual manganese dosage factor of 14.

Table A.19
Actual Dosages of $KMnO_4$

Dose	Actual Dose (per 200 L of groundwater)		
mg/L $KMnO_4$	g $KMnO_4$	L of 0.5N $KMnO_4$	mL of 10% $KMnO_4$
334.65	66.93	3.850	61

The dosage was based on the lowest literature dosage factor for each groundwater constituent (refer to Table A.2), including DOC. Although the Phase 1 testing indicated that DOC did not interfere with arsenic removal, the dosage was calculated to include DOC as oxidant demand for this trial. The minimum dosage factor was used for the calculated dose due to the strong dependency on DOC (i.e., DOC is present in high concentrations and has the highest literature dosage factor). The calculated dose was 335 mg/L of $KMnO_4$. This dosage is substantially higher than that used in Phase 1 testing.

The $KMnO_4$ was added to the water sample and the water was vigorously stirred with a drill and mixer attachment for approximately 10 minutes. Solids appeared in the sample and the water turned a bright purplish pink color, indicating un-reacted permanganate was present. The solids were allowed to settle for approximately 1 hour and then the supernatant was transferred to a second 55-gallon drum. After transfer, 10 mg/L of iron was added to the groundwater using a 10% solution of $FeCl_3$. Approximately 51.43 mL of $FeCl_3$ was added and the sample re-stirred using the drill and mixer for 5 minutes.

The sample remained very bright, purplish pink after the addition of $FeCl_3$, indicating that the groundwater had been overdosed with $KMnO_4$. The overdose was due to the excessively high manganese concentration used in the dosage calculation and due to inclusion of DOC in the dosage calculation, as noted in Table A.2. This confirmed that the permanganate does not effectively oxidize the DOC. Therefore, the treated sample was discarded.

Prior to preparing the second sample for Phase 2 testing, two jar tests were conducted with 1 L of groundwater each to determine the appropriate $KMnO_4$ dose. The first jar test used the same dosage calculation as was initially used, but with the corrected manganese concentration (4.06 mg/L); the $KMnO_4$ dose for the first jar test was 284 mg/L. The first jar test also resulted in excess permanganate after the reaction, confirming that inclusion of DOC as oxidant demand would have resulted in overdosing of $KMnO_4$. For the second jar test, the calculated total dosage from the first jar test was cut in half (i.e., 142 mg/L). For the second jar test no residual color was present indicating that excess permanganate remained in solution. Based on field testing of the second jar test, this provided a good level of arsenic treatment without overdosing the sample with permanganate.

A second 53-gallon sample of groundwater was collected from PZ-11 on June 2, 2010 and used for Phase 2 bench scale testing. Tables 20 and 21 show the initial conditions utilized for the second trial and the calculated and actual dosages of $KMnO_4$ added to the drum of water.

Table A.20
Primary Treatment Initial Conditions for Sample 2 Dose Calculation

Parameter	Initial Conditions
Total Arsenic[1] (µg/L)	800
Total Iron[1] (mg/L)	80.0
Total Manganese[2] (mg/L)	4.06
DOC (mg/L)	56.8

Notes:
1 Total arsenic and total iron were based on field analyses.
2 Total manganese was based on data collected from PZ-9; refer to Table A.2.1.

Table A.21
$KMnO_4$ Addition for Sample 2

g $KMnO_4$	mL of 0.5N $KMnO_4$	mL of 10% $KMnO_4$
29.1	0	291

The total $KMnO_4$ dosage for the second drum of water was 145.5 mg/L. The $KMnO_4$ was added in four parts and stirred for 2 minutes between each addition. After the final addition of $KMnO_4$, the sample was stirred with the drill and mixer attachment for approximately 5 to10 minutes. The sample was then allowed to settle for approximately 1.5 hours and the supernatant was pumped to an empty 55-gallon drum. The supernatant was analyzed for arsenic and iron in the field to determine if any iron in the form of $FeCl_3$ should be added. The field analyses indicated that approximately 30 µg/L of total arsenic and 5.95 mg/L of total iron remained in the sample; therefore, no additional $FeCl_3$ was added, as adequate iron was present to precipitate upon raising the pH.

The supernatant was then dosed with lime to bring the pH to 8.0. The first phase testing indicated that a pH between 7.75 and 8.10 exhibited the best removal and settling characteristics. The sample was continually mixed as lime was added. After the sample reached a pH of 8.0, it was allowed to settle for approximately 1.5 hours. Samples of the supernatant were collected for field analyses. The supernatant was then transferred into an empty 55-gallon drum.

Based on the literature for arsenic removal, it was expected that sorption would be enhanced at slightly acidic pH values. Therefore, the pH was adjusted to a pH of 6.6 with a 10% solution of hydrochloric acid (HCl); a total of 535 mL of 10% HCl was added to the drum of supernatant to achieve this pH. The treated water was allowed to sit overnight; samples were collected the following day for submission to the laboratory. The results of the laboratory analyses are shown in Table A.22. These data show some DOC removal (about 45 percent) by oxidation and precipitation.

Table A.22
Phase 2 Primary Treatment

Parameter	Initial Conditions		After Oxidation	After Co-precipitation[1]	
	Field	Lab	Field	Field	Lab
Total Arsenic (µg/L)	800	1,580	30	10	13.5
Dissolved Arsenic (µg/L)		1,540	15	5	3.8
Total Iron (mg/L)	80	68.8	5.95	3.08	10
Dissolved Iron (mg/L)		68.0	8.45	0.62	6.98
Total Ferrous Iron (mg/L)			1.98	0.04	
Dissolved Ferrous Iron (mg/L)			6.32	0.02	
DOC (mg/L)		36.8			20.1
pH			6.42	8.0	
ORP (mV)			~15		

Note:
1 Field data were collected on the supernatant after the addition of lime and laboratory data were collected after the sample was pH adjusted with HCl.

4.2.2 Sorption Column Testing

On June 3, 2010, the column trials were started. Three different arsenic removal media were selected for the secondary treatment bench scale test, as described in the GRWP Addendum. The media included Media G2®, a Purolite resin called FerrIX A33E, and activated alumina obtained from Dynamic Adsorbents, Inc.

Approximately 350 mL of each of the selected media, was initially placed in a 1,000 mL graduated cylinder. Deionized water was added to the media and stirred until the media was completely covered with water and no air was left in the column. The total amount of water required to wet all the media was recorded as the pore volume for each media. Table A.23 shows the total pore volume for each medium.

Table A.23
Pore Volumes

Media	Pore Volume (mL)	Porosity
Activated Alumina	200	57%
Purolite Resin	140	40%
Media G2®	140	40%

After the pore volume tests, the media were each placed into glass columns (three columns total) that were approximately 2.5-feet long and had an internal diameter of 1-inch. A plug of glass wool (1 to 2 inches) was placed in the bottom of each column to support the sorbent material. A peristaltic pump was set up to draw primary treated water from the drum and discharge it to the top of each column. The water then flowed by gravity through the column and the effluent was collected in three 5-gallon pails.

A combination of Teflon and C-Flex MasterFlex tubing was used for the pump and on the effluent side of the column. Tubing was placed through a single-hole, number 6 rubber stopper, which was inserted into the bottom of each column. The tubing was then fixed to the side of the column such that the water level in the column would remain over the top of the media though the trials. The outlet of the tubing came down approximately 1-foot lower than the bottom of the columns so that the effluent would flow into the collection pails.

One pump with a tee was used to split the flow between all three columns. Once the columns were started, the tubing height was adjusted such that the influent water maintained a height of 1 to 3 inches over the media and allowed an empty bed contact time (EBCT) close to the manufacturer’s recommendation of 10 minutes.

Once the pump was started, it was noted that water would not flow readily through the Media G2®. It appeared as though the media had been crushed and the particles became very fine and turned more into a sludge consistency once the media was placed in the columns. The hosing was adjusted such that 6 to 8 inches of water was present above the Media G2®; however, this did not improve the flow through the column. Due to the poor flow characteristics, the Media G2® column was taken off-line.

The Purolite resin and activated alumina allowed for better flows than the Media G2®. The Purolite resin particles were very uniform and quite light; therefore, a flooded bed was quite easy to maintain and flow through the column could be maintained at a higher rate. The average flowrate was maintained around 20 mL/min (EBCT equaled 17.5 minutes). The activated alumina required approximately 2.5 inches of water over the media to maintain an effluent flow rate between 10 to 30 mL/minute and an instantaneous average of approximately 19.6 mL/minute (EBCT equaled 17.8 minutes). Field data collected throughout the Phase 2 column testing is shown in Attachment A.7.

The first two pore volumes out of the columns were collected and disposed of prior to the collection of treated effluent for chemical analysis. Approximately 26 L of groundwater were processed through the activated alumina and 30 L of groundwater processed through the Purolite resin. Samples were collected from the following:

- The first 6.84 L of water processed through the activated alumina and the last 8.77 L.
- The first 7.15 L of water processed through the Purolite resin and the last 8.04 L.

Samples were submitted for laboratory analyses. The results of the laboratory analyses are shown in Table A.24.

Table A.24
Sorption Column Treatment Analyses

Parameter	Activated Alumina Initial 6.84L	Activated Alumina Final 8.77L	Purolite Initial 7.15L	Purolite Final 8.07L
Total Arsenic (µg/L)	0.9	0.9	1.2	1.0
Dissolved Arsenic (µg/L)	0.8	0.9	0.9	0.8
Total Iron (mg/L)	0.05	0.05	0.05	0.05
Dissolved Iron (mg/L)	0.05	0.05	0.2	0.05
DOC (mg/L)	87.6	10.6	16.8	7.24

Based on the results shown in Table A.24, it can be seen that both the activated alumina and Purolite resin are capable of polishing the primary treated water to achieve a final effluent quality less than 5 µg/L total arsenic. These results also indicate that dissolved organics eluted from the activated alumina with the initial treatment volume, indicating that column pretreatment or conditioning may be needed for activated alumina.

Observations from the secondary treatment column trials include the following:

- During the trial it was very difficult to maintain an even flow through all three columns with the tee and pinch valves, and in general at least one column would periodically lose flow, requiring frequent adjustments. After removal of the Media G2® column, it was easier to control the flow. However, it was still difficult to maintain an even flow between the two columns.
- Media G2® did not have uniform particle distribution and was quite friable, somewhat like flaked rust. The media tended to crush easily, which created a layer of fines on top of the column and distributed throughout the column which inhibited flow.
- The first couple of liters of effluent from the activated alumina column had a slightly white, cloudy appearance. This was likely due to very fine particulates which were washed out of the column with the initial flow.
- During the trials it appeared as though there may have been some channeling in the Purolite column due to the buoyancy of the resin particles. It may be that an upflow configuration would be preferable with this media.

Field data collected through the trials indicated close to non-detectable levels of arsenic in the effluent from the activated alumina columns; however, there were instances where it appeared as though concentrations between 20 to 30 ppb of arsenic were contained in the effluent of the Purolite column. Refer to Figure A.7.1 in Attachment A.7. The laboratory analyses in Table A.24 did not show any elevated concentrations of arsenic in the Purolite column effluent. Therefore, it was concluded that some sort of interference from the resin was impacting the HACH low-range arsenic field tests.

It should be noted that full scale, commercial adsorption vessels typically provide fewer operating problems than the bench scale columns used for the treatability study. In full scale systems, the column influent is typically filtered to reduce the potential for plugging and blinding of the adsorption media. Centrifugal pumps are also typically used to feed water to the filters and adsorbers, resulting in pressurized influent and more reliable flow control. Due to a very long history of successful operations using adsorption columns for water treatment, it is expected that adsorbers can be reliably operated for treating site groundwater.

4.3 WETLANDS GROUNDWATER PRIMARY TREATMENT TRIALS

A second purpose for the Phase 2 study was to test the selected primary treatment process chemistry on the groundwater taken from the Wetlands area, outside the Landfill. These tests were completed to determine if the water recovered from the Wetlands would be significantly different from that collected on the Landfill and if that groundwater would have any adverse effects on the primary treatment chemistry.

Two tests were conducted with the groundwater collected from the Wetlands, one with wetlands groundwater alone and one with wetlands groundwater mixed with landfill groundwater. Groundwater for these tests was collected on June 4, 2010 from Well D-6A within the Wetlands area.

For the first test, approximately 1 L of groundwater from PZ-11 (landfill groundwater) was added to each of four beakers and 1 L of groundwater from D-6A (wetlands groundwater) was added to each of the same four beakers giving a total volume of 2 L with 50 percent landfill groundwater and 50 percent wetlands groundwater for each sample. All four samples were dosed with $KMnO_4$, with dosage ranging from 80 to 240 mg/L. The initial constituent concentrations used to calculate the dosages as well as the calculated and actual doses are shown in Tables 25 and 26.

Table A.25
Initial Conditions for Mixed Water Trial

Parameter	PZ-11	D-6A
Total Arsenic[1] (µg/L)	1,000	800
Total Iron[1] (mg/L)	75.5	79.0
Total Manganese[2] (mg/L)	4.06	3.30
DOC (mg/L)	56.8	44.6

Notes:
1 Total arsenic and total iron were based on field analyses.
2 Total manganese wasbased on data collected from PZ-9; refer to Table A.2.1.

Table A.26
Actual Dosages for Mixed Water Trial

Test Number	Actual Dose (per L of Sample)	
	mg $KMnO_4$	mL $KMnO_4$
1	80.2	0.80
2	120.18	1.20
3	180.27	1.81
4	240.36	2.41

Based on the color change observed in the samples, it appeared that the first two dosing levels (i.e., Tests 1 and 2) provided good treatment without overdosing. The third and fourth dosages (i.e., Tests 3 and 4) showed a supernatant that had a purple-reddish color, which indicated that these samples had been overdosed with $KMnO_4$. Based on observations and field testing, Test 2 was selected for laboratory analysis. Field data for iron species could not be obtained for the overdosed samples, as the HACH kit relies on a colorimetric reaction to determine analyte concentrations; the residual color from $KMnO_4$ interfered with the HACH analysis.

Table A.27 shows the initial and final concentrations of arsenic and iron in the combined landfill/wetlands groundwater before and after the addition of $KMnO_4$. Field data were collected using a HACH arsenic kit, a HACH spectrophotometer, a HORIBA multi-parameter instrument and a HANNA pH meter. The data of Table A.27 also shows that oxidation removed about 40 percent of the DOC in Test 2.

Table A.27
Analytical Data for Mixed Water Trial

Parameter	Initial Conditions		Test 1	Test 2		Test 3	Test 4
	Field[1]	Lab[2]	Field	Field	Lab	Field	Field
Total Arsenic (µg/L)	900	1,495	70	30	55.4	40	40
Dissolved Arsenic (µg/L)		1,380			8.2		
Total Iron (mg/L)	77.25	66.5	3.16	1.35	1.61	NA	NA
Dissolved Iron (mg/L)		65.85			0.05		
Total Ferrous Iron (mg/L)			0.04	ND		NA	NA
DOC (mg/L)		37.3			21.7		

Notes:

1 Field conditions shown are calculated based on the average of PZ-11 and D-6A concentrations for each parameter analyzed in the field.

2 Lab conditions shown are calculated based on the average of PZ-11 and D-6A concentrations for each parameter from lab data. Laboratory data from June 2nd PZ-11 initial conditions were used in the calculation as it was assumed that these conditions would be relativity constant.

Abbreviations:

NA	Not available due to interference with colorimetric testing by residual $KMnO_4$
ND	Non-detect

Table A.28 summarizes the percent removal of total arsenic for each dose based on the collected field and laboratory data.

Table A.28
Arsenic Removal for Mixed Water Trial

Test Number	Percent Removal	
	Field	**Lab**
1	92%	--
2	97%	96%
3	96%	--
4	96%	--

Based on these trails and the visual observations, it appears that groundwater collected from the Wetlands area did not significantly affect the primary treatment chemistry. It also appeared as though the wetlands groundwater was not significantly different from the groundwater collected from the landfill area.

For the second test, primary oxidation treatment was evaluated on wetlands water only. Approximately 2 L of water collected from D-6A was added to four different beakers. All four samples were then dosed with $KMnO_4$. The initial conditions used to calculate the dosages as well as the actual doses are shown in Tables 28 and 29.

Table A.29
Initial Conditions for Wetlands Water Trial

Parameter	D-6A
Total Arsenic[1] (µg/L)	800
Total Iron[1] (mg/L)	79.0
Total Manganese (mg/L)	3.30
DOC (mg/L)	44.6

Note:

1 Total arsenic and total iron were based on field analyses.

Table A.30
Actual Dosages for Wetlands Water Trial

Test Number	Actual Dose (per L of Sample)	
	mg $KMnO_4$	mL $KMnO_4$
1	80.2	0.80
2	120.18	1.20
3	180.27	1.81
4	240.36	2.41

Based on the color change of the samples, it appeared as though the first two dosages achieved adequate treatment without overdosing. The third dose was added and it appeared as though it would not be overdosed, but then showed a slight color change to red, indicating excess $KMnO_4$. The fourth dose was observed to be clearly overdosed with $KMnO_4$.

Since the third dose appeared to be only slightly overdosed, it was decided to submit this sample for analysis at the laboratory. Field data for iron species could not be obtained for the overdosed samples.

Table A.31 shows the initial and final concentrations of arsenic and iron in the groundwater before and after the addition of $KMnO_4$. Field data was collected using a HACH arsenic kit, a HACH spectrophotometer, a HORIBA multi-parameter instrument, and a HANNA pH meter. DOC removal for this test was 40 percent.

Table A.31
Analytical Data for Wetlands Water Trial

Parameter	Initial Conditions		Dose 1	Dose 2	Dose 3		Dose 4
	Field	Lab	Field	Field	Field	Lab	Field
Total Arsenic (µg/L)	800	1,360	60	30	15	35.1	30
Dissolved Arsenic (µg/L)		1,310				13.1	
Total Iron (mg/L)	79.0	61.1	5.42	1.58	0.14	1.44	NA
Dissolved Iron (mg/L)	67.5	60.0				0.34	
Total Ferrous Iron (mg/L)	35.0		0.04	0.04	ND		NA
DOC (mg/L)		37.5				22.5	

Abbreviations:

NA	Not available due to interference with colorimetric testing by residual $KMnO_4$
ND	Non-detect

Table A.32 summarizes the percent removal of total arsenic for each dose based on the collected field and laboratory data.

Table A.32
Arsenic Removal for Wetlands Water Trial

Dosage	Percent Removal	
	Field	Lab
1	93%	--
2	96%	--
3	98%	97%
4	96%	--

Based on these trials and the visual observations, it again appears that groundwater collected from the Wetlands area was not significantly different from the groundwater collected from the Landfill area, and primary treatment with $KMnO_4$ appeared to be equally effective.

4.4 PHASE 2 CONCLUSIONS

Phase 2 testing included the following tests:

- Primary treatment of groundwater collected from the Wetlands area.
- Primary treatment of groundwater collected from the wetlands and landfill areas mixed together.
- Full primary and secondary treatment of water collected from the landfill area after approximately 22.5 hours of aquifer testing.
- Sampling during aquifer testing over a 22-hour period to determine if changes in water quality from the pumped well occurred over time.
- Oxidation treatment achieved approximately 40 to 45 percent removal of DOC.

The purpose of the primary treatment tests with water collected from the Wetlands area was to determine if this groundwater would be significantly different than water collected from the landfill area groundwater wells, and to determine if the same type of primary treatment would be impacted or be successful with wetlands water. Based on the tests conducted with the groundwater collected from the Wetlands area, it was determined that this water is not significantly different from the groundwater collected from the landfill area and it was treated successfully with using the permanganate-based primary treatment process.

The aquifer test was conducted by pumping groundwater from Well PZ-11. During the test, samples of the groundwater were collected and analyzed to determine if there were significant changes in concentrations over time. From the data collected, no significant changes were observed for the parameters of concern (i.e., arsenic, iron, DOC, and manganese).

After approximately 22.5 hours of pumping, groundwater was collected from PZ-11 and treated using the permanganate-based primary treatment method. The primary treatment included oxidation with $KMnO_4$, followed by co-precipitation with lime and then pH adjustment prior to secondary treatment. The secondary treatment trials were to be conducted using three selected arsenic specific polishing media. However, upon the commencement of the trials, it was noted that one of the media, Media G2®, significantly restricted flow through the test column and was taken off-line and removed from further consideration. It was concluded that this media would have significant operational issues in a full scale system.

The remaining two sorption media that were tested included activated alumina and a Purolite ion-exchange resin. Both these media showed good arsenic removal and achieved the anticipated treated water quality criterion for arsenic of 5 µg/L. It was concluded that either of these media would be operationally sound in a full scale treatment system and a cost comparison would be required to determine which media would be best to utilize for final design.

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5.0 Recommendations

Based on the treatment trials conducted at the Site, it was found that both $KMnO_4$ and H_2O_2 provided good primary treatment via oxidation. However, it was concluded that $KMnO_4$ would be used in the proceeding trials as it is a one-step oxidation as opposed to the H_2O_2 which was found to give better treatment at a pH of 5 and therefore required an initial pH adjustment step prior to oxidation.

Based on the information presented above and the conclusions made throughout the trials, recommendations are as follows:

- Primary treatment should be based on $KMnO_4$ oxidation. This oxidant will support safe operations and provide effective removal of arsenic.
- Co-precipitation with lime should be used as a second step after oxidation. It was found that lime removed more color and created a more stable floc during the trials and that arsenic was further reduced after oxidation by approximately 80 percent.
- Secondary treatment using either Purolite resin or activated alumina can achieve an effluent with less than 5 µg/L of arsenic for site groundwater.
- Preparation of a cost estimate comparing the use of the Purolite resin and the activated alumina and a comparison of media availability in the area to determine which media would best suit the needs of the Site is recommended. Both activated alumina and the Purolite resin were found to work quite well as polishing media in the Phase 2 trials.

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6.0 References

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B&L Woodwaste Site
Pierce County, Washington

Engineering Alternatives Evaluation

Attachment A.1

Landfill Groundwater Sampling Data Validation Memorandum

FINAL

Compliance Screening—Tier 1 Data Validation for B&L Treatability Sampling Rounds 1 and 2

Data Validation of SDG QS91 and QU48

I. INTRODUCTION

A total of 23 groundwater samples were delivered to Analytical Resources, Inc (ARI) (Tukwila, Washington) in two Sample Delivery Groups (SDGs) on April 15, 2010 and April 27, 2010. The following samples were submitted to ARI for analyses and received the associated laboratory batch number:

SDG	Sample ID	Receipt Date	SDG	Sample ID	Receipt Date
QS91	PZ-4B	4/15/2010	QU48	PZ-3B	4/27/2010
QS91	PZ-8B	4/15/2010	QU48	PZ-5B	4/27/2010
QS91	PD-109	4/15/2010	QU48	PZ-6B	4/27/2010
QS91	PZ-9	4/15/2010	QU48	PZ-2B	4/27/2010
QS91	PZ-12	4/15/2010	QU48	PZ-1B	4/27/2010
QS91	PD-107	4/15/2010	QU48	PZ-7B	4/27/2010
QS91	PZ-4B-F	4/15/2010	QU48	PZ-8C	4/27/2010
QS91	PZ-8B-F	4/15/2010	QU48	PZ-4C	4/27/2010
QS91	PD-109-F	4/15/2010	QU48	PZ-10	4/27/2010
QS91	PZ-9-F	4/15/2010	QU48	PZ-11	4/27/2010
QS91	PZ-12-F	4/15/2010	QU48	PZ-13	4/27/2010
QS91	PZ-107-F	4/15/2010			

Samples were submitted for analysis of metals, semivolatile organic compounds (SVOCs), and conventionals. A compliance screening or Tier 1 data quality review was performed on all metal and SVOC results by Chell Black. Holding times, method blank quality, matrix spike/matrix spike duplicate (MS/MSD) recoveries, laboratory control sample (LCS) recoveries, standard reference recoveries, and laboratory replicate relative percent differences (RPDs) were evaluated for all other analyses as appropriate.

The data quality review showed that the results are appropriate for use as reported by the laboraotory without additional qualifiers. Details of the data quality review are presented in the following section. A filled bullet (●) indicates that the data requirements were met, and an empty bullet (○) indicates that the data required further evaluation.

II. METALS ANALYSES—USEPA 200.8

QS91

Samples were analyzed for dissolved and total metals on April 21, 2010. The following requirements were reviewed:

- Sample and quality control analysis frequencies
- Extraction and analysis holding times
- Blank contamination
- LCS recoveries
- Laboratory duplicate RPDs

All analyses were completed within the required holding times. No contamination was detected in the method blanks and the LCS recoveries were within U.S. Environmental Protection Agency (USEPA) guidelines. The RPD could not be calculated as no laboratory duplicate was analyzed. Per USEPA guidelines, if laboratory duplicates are not analyzed, professional judgment is to be used to determine if data should be qualified. Because all other quality control objectives were met, it is with professional judgment that no qualifiers be added to the results.

The data were determined to be of acceptable quality for use; no data qualifiers were added.

QU48

Samples were analyzed for total metals on May 12 and 13, 2010. The following requirements were reviewed:

- Sample and quality control analysis frequencies
- Extraction and analysis holding times
- Blank contamination
- LCS recoveries
- Laboratory duplicate RPDs

All analyses were completed within the required holding times. No contamination was detected in the method blanks and the LCS recoveries were within USEPA guidelines. The RPD could not be calculated as no laboratory duplicate was analyzed. Per USEPA guidelines, if laboratory duplicates are not analyzed, professional judgment is to be used to determine if data should be qualified. Because all other quality control objectives were met, it is with professional judgment that no qualifiers be added to the results.

The data were determined to be of acceptable quality for use; no data qualifiers were added.

III. METALS ANALYSIS—USEPA 6010B

QS91

Samples were analyzed for dissolved and total metals on April 19, 2010. The following requirements were reviewed:

- Sample and quality control analysis frequencies
- Extraction and analysis holding times
- Blank contamination
- LCS recoveries
- Laboratory duplicate RPDs

All analyses were completed within the required holding times. No contamination was detected in the method blanks and the LCS recoveries were within USEPA guidelines. The RPD could not be calculated as no laboratory duplicate was analyzed. Per USEPA guidelines, if laboratory duplicates are not analyzed, professional judgment is to be used to determine if data should be qualified. Because all other quality control objectives were met, it is with professional judgment that no qualifiers be added to the results.

The data were determined to be of acceptable quality for use; no data qualifiers were added.

QU48

Samples were analyzed for total metals on May 4, 2010. The following requirements were reviewed:

- Sample and quality control analysis frequencies
- Extraction and analysis holding times
- Blank contamination
- LCS recoveries
- Laboratory duplicate RPDs

All analyses were completed within the required holding times. No contamination was detected in the method blanks and the LCS recoveries were within USEPA guidelines. The RPD could not be calculated as no laboratory duplicate was analyzed. Per USEPA guidelines, if laboratory duplicates are not analyzed, professional judgment is to be used to determine if data should be qualified. Because all other quality control objectives were met, it is with professional judgment that no qualifiers be added to the results.

The data were determined to be of acceptable quality for use; no data qualifiers were added.

IV. MERCURY ANALYSIS—USEPA 7470A

QS91

Samples were analyzed for dissolved and total mercury on April 19, 2010. The following requirements were reviewed:

- Sample and quality control analysis frequencies
- Extraction and analysis holding times
- Blank contamination
- LCS recoveries
- Laboratory duplicate RPDs

All analyses were completed within the required holding times. No contamination was detected in the method blanks. The LCS recovery for dissolved mercury was within USEPA guidelines. The LCS recovery for total mercury (125 percent) was outside laboratory control limits (80 to 120 percent)—high by 5 percent; however, all results for total mercury were non-detects and per USEPA guidelines do not need to be qualified. The RPD could not be calculated as no laboratory duplicate was analyzed. Per USEPA guidelines, if laboratory duplicates are not analyzed, professional judgment is to be used to determine if data should be qualified. Because all other quality control objectives were met, it is with professional judgment that no qualifiers be added to the results.

The data were determined to be of acceptable quality for use; no data qualifiers were added.

V. pH ANALYSIS—USEPA 150.1

QS91

Samples were analyzed for pH on April 15, 2010. The following requirements were reviewed:

- Sample and quality control analysis frequencies
- Extraction and analysis holding times
- Blank contamination
- LCS recoveries
- Laboratory replicate RPDs

All analyses were completed within the required holding times. No contamination was detected in the method blanks and the LCS recoveries were within laboratory control limits. The RPD for the laboratory replicate was within laboratory control limits.

The data were determined to be of acceptable quality for use; no data qualifiers were added.

VI. CONVENTIONALS—STANDARD METHOD 2320

QS91

Samples were analyzed for select conventionals (alkalinity, carbonate, bicarbonate, and hydroxide) on April 16, 2010. The following requirements were reviewed:

- o Method blank analysis
- Sample and quality control analysis frequencies
- Extraction and analysis holding times
- Standard reference sample recoveries
- Laboratory replicate RPDs

All analyses were completed within the required holding times. The standard reference sample recoveries and laboratory replicated RPDs were within laboratory control limits.

A method blank was not performed; it is assumed a continuing blank was also not performed. However, the alkalinity results are in the range of 400 to 800 mg/L, and the reporting limit (RL) is 1 mg/L. Therefore, any potential method blank contamination would not impact the analytical results and best professional judgment was used to not qualify the data.

The data were determined to be of acceptable quality for use; no data qualifiers were added.

QU48

Samples were analyzed for select conventionals (alkalinity, carbonate, bicarbonate, and hydroxide) on April 30, /2010. The following requirements were reviewed:

- o Method blank analysis
- Sample and quality control analysis frequencies
- Extraction and analysis holding times
- Standard reference sample recoveries
- Laboratory replicate RPDs

All analyses were completed within the required holding times. The standard reference sample recoveries and laboratory replicated RPDs were within laboratory control limits.

A method blank was not performed; it is assumed a continuing blank was also not performed. However, the alkalinity results are in the range of 400 to 800 mg/L, and the reporting limit (RL) is 1 mg/L. Therefore, any potential method blank contamination would not impact the analytical results and best professional judgment was used to not qualify the data.

The data were determined to be of acceptable quality for use; no data qualifiers were added.

VII. CONVENTIONALS—USEPA 300.0

QS91

Samples were analyzed for select conventionals (chloride, fluoride, bromide, N-nitrate, N-nitrite, ortho-phosphorus, and sulfur) between April 14, /2010 and April 16, 2010. The following requirements were reviewed:

- Sample and quality control analysis frequencies
- Extraction and analysis holding times
- Blank contamination
- MS recoveries
- Standard reference sample recoveries
- Laboratory replicate RPDs

All analyses were completed within the required holding times. No contamination was detected in the method blanks and both the MS recoveries and the standard reference sample recoveries were within laboratory control limits. The laboratory replicate RPDs were within laboratory control limits.

The data were determined to be of acceptable quality for use; no data qualifiers were added.

VIII. TOTAL DISSOLVED SOLIDS—USEPA 160.1

QS91

Samples were analyzed for Total Dissolved Solids on April 16, 2010. The following requirements were reviewed:

- Sample and quality control analysis frequencies
- Extraction and analysis holding times
- Blank contamination
- LCS recoveries
- Laboratory replicate RPDs

All analyses were completed within the required holding times. No contamination was detected in the method blanks and the LCS recoveries were within laboratory control limits. The RPD for the laboratory replicate was within laboratory control limits.

The data were determined to be of acceptable quality for use; no data qualifiers were added.

QU48

Samples were analyzed for Total Dissolved Solids on May 3, 2010. The following requirements were reviewed:

- Sample and quality control analysis frequencies
- Extraction and analysis holding times
- Blank contamination
- LCS recoveries
- Laboratory replicate RPDs

All analyses were completed within the required holding times. No contamination was detected in the method blanks and the LCS recoveries were within laboratory control limits. The RPD for the laboratory replicate was within laboratory control limits.

The data were determined to be of acceptable quality for use; no data qualifiers were added.

IX. SULFIDE—USEPA 376.2

QS91

Samples were analyzed for sulfide on April 19, 2010. The following requirements were reviewed:

- Sample and quality control analysis frequencies
- Extraction and analysis holding times
- Blank contamination
- LCS recoveries
- Laboratory replicate RPDs

All analyses were completed within the required holding times. No contamination was detected in the method blanks and the LCS recoveries were within laboratory control limits. The RPD for the laboratory replicate was within laboratory control limits.

The data were determined to be of acceptable quality for use; no data qualifiers were added.

X. BIOLOGICAL OXYGEN DEMAND—USEPA 405.1

QS91

Samples were analyzed for Biological Oxygen Demand on April 15, 2010. The following requirements were reviewed:

- Sample and quality control analysis frequencies
- Extraction and analysis holding times
- Blank contamination
- LCS recoveries

All analyses were completed within the required holding times. No contamination was detected in the method blanks and the LCS recoveries were within laboratory control limits.

The data were determined to be of acceptable quality for use; no data qualifiers were added.

XI. TOTAL AND DISSOLVED ORGANIC CARBON—USEPA 415.1

QS91

Samples were analyzed for total and dissolved organic carbon on April 20, 2010. The following requirements were reviewed:

- Sample and quality control analysis frequencies
- Extraction and analysis holding times
- Blank contamination
- Standard reference sample recoveries
- Laboratory replicate RPDs

All analyses were completed within the required holding times. No contamination was detected in the method blanks and the standard reference sample recoveries were within laboratory control limits. The RPD for the laboratory replicate was within laboratory control limits.

The data were determined to be of acceptable quality for use; no data qualifiers were added.

XII. SVOCS—SW 8270

QS91

Samples were analyzed for selected SVOCs (2,4-dimethlyphenol, 4-methlyphenol, 2-methylphenol, and phenol) on April 19, 2010. The following requirements were reviewed:

- Sample and quality control analysis frequencies
- Extraction and analysis holding times
- Blank contamination
- Surrogate recoveries
- LCS recoveries
- o MS/MSD recoveries
- o MS/MSD RPD

All analyses were completed within the required holding times. No contamination was detected in the method blank. The sample surrogate, LCS recoveries, and standard reference sample recoveries were within laboratory control limits. There were no MS or MSD results provided and per USEPA guidelines, data should not be qualified based on MS/MSD data alone; therefore, it is with professional judgment that no qualifiers were added to the data based on the lack of

MS/MSD results as all other quality assurance/quality control objectives for this analysis have been met.

The data were determined to be of acceptable quality for use; no data qualifiers were added.

XIII. QUALIFIER SUMMARY

No qualifiers were added to the data.

XIV. REFERENCES

U.S. Environmental Protection Agency (USEPA), 1999. *USEPA Contract Laboratory Program National Functional Guidelines for Organic Data Review, OSWER 9240.1-05 A-P.* EPA540/R-99/008. October.

U.S. Environmental Protection Agency (USEPA). 2004. *USEPA National Contract Laboratory Program National Functional Guidelines for Inorganic Data Review, OSWER 9240.1-45, EPA 540-R-04-004.* Office of Superfund Remediation and Technology Innovation (OSRTI), Washington, D.C. October.

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B&L Woodwaste Site
Pierce County, Washington

Engineering Alternatives Evaluation

Attachment A.2

Landfill Groundwater Sampling Results

FINAL

Table A.2.1
Round 1 Landfill Sampling Results

	Location	PZ-4B	PZ-8B	PD-109	PZ-9	PZ-12	PD-107
	Sample Date	4/15/2010	4/15/2010	4/15/2010	4/15/2010	4/15/2010	4/15/2010
Parameter	**Units**						
Anions[1]							
Chloride	mg/L	5.7	7.8	17.2	20.6	60.3	11.3
Bromide	mg/L	0.1 U	0.1 U	0.9	0.1	1	0.1 U
Nitrogen as nitrate	mg-N/L	0.1 U	0.1 U	0.1 U	0.1 U	0.1	0.2
Nitrogen as nitrite	mg-N/L	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	1 U
Ortho-phosphorus[1]	mg/L	0.1 U	0.3	0.1 U	0.1 U	0.1 U	0.1 U
Sulfate	mg/L	2.4	3.1	0.1 U	0.1 U	0.4	0.1 U
Fluoride	mg/L	0.3	0.3	1 U	0.1 U	1 U	1.6
Metals[2]							
Antimony	µg/L	50 U	50 U	50 U	50 U	50 U	50 U
Antimony (dissolved)	µg/L	50 U	50 U	50 U	50 U	50 U	50 U
Arsenic[3]	µg/L	2	18.1	190	1,920	1,550	4,150
Arsenic (dissolved)[3]	µg/L	2.2	16.8	190	1,710	1,360	4,260
Arsenic III (dissolved)[4]	µg/L	1.54	11.7	146	1,460	662	2,960
Arsenic V (dissolved)[4]	µg/L	0.71	4.33	60	777	884	1,750
Dimethylarsinic acid/DMAs (dissolved)[4]	µg/L	0.35 U	0.35 U	6.9 U	6.9 U	6.9 U	6.9 U
Monomethylarsonic acid/MMAs (dissolved)[4]	µg/L	0.35 U	0.35 U	6.9 U	6.9 U	6.9 U	6.9 U
Barium	µg/L	28	25	168	128	80	146
Barium (dissolved)	µg/L	24	9	164	109	72	129
Beryllium	µg/L	1 U	1 U	1 U	1 U	1 U	1 U
Beryllium (dissolved)	µg/L	1 U	1 U	1 U	1 U	1 U	1 U
Cadmium	µg/L	2 U	2 U	2 U	2 U	2 U	2 U
Cadmium (dissolved)	µg/L	2 U	2 U	2 U	2 U	2 U	2 U
Calcium (dissolved)	µg/L	17,600	14,200	59,000	116,000	691,00	130,000
Chromium	µg/L	5 U	7	5 U	5 U	5 U	5 U
Chromium (dissolved)	µg/L	5 U	5 U	5 U	5 U	5 U	5 U
Copper	µg/L	2 U	5	2 U	7	5	10
Copper (dissolved)	µg/L	2 U	2 U	2 U	2 U	2 U	2 U
Iron	µg/L	8,550	2,720	69,600	77,900	24,400	48,300
Iron (dissolved)	µg/L	7,990	530	69,500	76,100	23,000	46,700
Lead[3]	µg/L	1 U	1 U	1 U	3	1	7
Lead (dissolved)[3]	µg/L	1 U	1 U	1 U	1 U	1 U	1 U
Magnesium (dissolved)	µg/L	9,300	13,000	39,600	66,100	41,600	103,000
Manganese	µg/L	271	879	2,160	4,060	4,380	3,260
Manganese (dissolved)	µg/L	271	850	2,160	3,950	4,480	3,320
Mercury	µg/L	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U
Mercury (dissolved)	µg/L	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U
Nickel	µg/L	10 U	10	10	10 U	20	30
Nickel (dissolved)	µg/L	10 U	10 U	10 U	10 U	20	20
Potassium (dissolved)	µg/L	4,680	3,280	63,600	12,200	11,900	20,600
Selenium[3]	µg/L	0.5 U	0.5 U	2 U	2 U	2 U	2 U
Selenium (dissolved)[3]	µg/L	0.5 U	0.5 U	2 U	2 U	2 U	2 U
Silicon (dissolved)	µg/L	21,100	19,700	28,000	30,600	24,200	37,500
Silver	µg/L	3 U	3 U	3 U	3 U	3 U	3 U
Silver (dissolved)	µg/L	3 U	3 U	3 U	3 U	3 U	3 U
Sodium (dissolved)	µg/L	21,400	19,500	29,300	68,000	86,300	37,500
Metals[2] (continued)							
Thallium[3]	µg/L	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U
Thallium (dissolved)[3]	µg/L	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U
Zinc	µg/L	10 U	10 U	10 U	20	20	80
Zinc (dissolved)	µg/L	10 U	10 U	10 U	10 U	10	40
Phenols[5]							
Phenol	µg/L	--	--	1 U	1 U	1 U	1 U
2-Methylphenol	µg/L	--	--	1 U	1 U	1 U	1 U
4-Methylphenol	µg/L	--	--	1 U	42	360	1 U
2,4-Dimethylphenol	µg/L	--	--	1 U	1.8	1 U	1 U
General Chemistry							
Total Alkalinity (as $CaCO_3$)[6]	mg/L	135	138	464	812	499	875
Bicarbonate[6]	mg/L	135	138	464	812	499	875
Carbonate[6]	mg/L	1 U	1 U	1 U	1 U	1 U	1 U
Hydroxide[6]	mg/L	1 U	1 U	1 U	1 U	1 U	1 U
Sulfide[7]	mg/L	0.05 U	0.05 U	0.05 U	0.05 U	0.05 U	0.05 U
Biological Oxygen Demand (BOD)[8]	mg/L	--	--	14.9	18.4	9.5	18
Total Organic Carbon (TOC)[9]	mg/L	4.27	1.7	24	57.6	42.8	36.4
Dissolved Organic Carbon (DOC)	mg/L	--	--	23.4	56.8	46.8	36
pH	pH units	6.66	7.13	6.51	6.46	6.42	6.44
Total Dissolved Solids (TDS)	g/L	0.206	0.201	0.532	0.909	0.686	0.889
Field Parameters							
pH	pH units	7.01	7.28	6.52	6.12	6.27	5.97
Specific Conductivity	mS/cm	0.305	0.280	1.040	1.778	1.044	1.494
Temperature	°C	11.5	11.4	11.8	13.0	12.7	12.7
Oxidation-reduction Potential (ORP)	mV	-129	-53	-130	-232	-92	-106

Notes:

-- Dashes indicate no analysis was scheduled.
1 Analyzed by USEPA Method 300.0.
2 Analyzed by USEPA Method 6010B.
3 Analyzed by USEPA Method 200.8.
4 Analyzed by ion chromatography inductively coupled plasma dynamic reaction cell msass spectrometry (IC-ICP-DRC-MS) at Applied Speciation and Consulting, LLC. Samples were collected under CO_2 atmosphere, laboratory filtered, and analyzed the same day. Observed matrix spike recoveries suggest that the sample matrix induces partial oxidation of arsenite to arsenate.
5 Analyzed by USEPA Method 8270D.
6 Analyzed by USEPA Method 2320.
7 Analyzed by USEPA Method 376.2.
8 Analyzed by USEPA Method 405.1.
9 Anaylzed by USEPA Method 415.1.

Abbreviations:

°C	DegreesCelsius
$CaCO_3$	Calcium carbonate
USEPA	U.S. Environmental Protection Agency
mS/cm	Millisiemens/centimeter
mV	Millivolt

Qualifter:

U Result was less than detection limit

Table A.2.2
Round 2 Landfill Sampling Results

Location		PZ-1B	PZ-2B	PZ-3B	PZ-4C	PZ-5B	PZ-6B	PZ-7B	PZ-8C	PZ-10	PZ-11	PZ-13
Sample Date		4/27/2010	4/27/2010	4/27/2010	4/27/2010	4/27/2010	4/27/2010	4/27/2010	4/27/2010	4/27/2010	4/27/2010	4/27/2010
Parameter	**Units**											
Cations[1]												
Calcium	mg/L	745	102	109	15.8	18.6	85.5	75.1	14.6	119	96.4	139
Magnesium	mg/L	494	549	581	8.72	9.63	51.3	39.7	15.7	108	705	479
Metals[2]												
Arsenic	µg/L	1,610	172	1,130	1.2	262	9.7	78.9	13.7	1,860	1,880	273
Copper	µg/L	0.8	1.1	1	0.5 U	1.1	0.9	0.7	0.7	1.4	0.7	47
Iron[1]	µg/L	88,500	58,600	60,600	7,590	2,060	22,000	21,500	130	62,300	44,700	55,000
Lead	µg/L	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	12
Manganese[1]	µg/L	2,610	5,740	5,470	307	1,310	4,550	4,350	188	2,680	2,900	4,100
Zinc	µg/L	4 U	15	5	4 U	4 U	4 U	4 U	4 U	4 U	4 U	59
General Chemistry[3]												
Total Alkalinity (as $CaCO_3$)	mg/L	545	627	688	129	157	538	525	144	923	660	567
Bicarbonate	mg/L	545	627	688	129	157	538	525	144	923	660	567
Carbonate	mg/L	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
Hydroxide	mg/L	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
Total Dissolved Solids (TDS)[4]	mg/L	549	925	737	164	228	630	553	163	937	649	633
Field Parameters												
pH	pH units	6.29	6.1	6.23	6.82	5.7	6.14	6.1	7.0	6.09	6.25	6.04
Specific Conductivity	mS/cm	1.2	1.38	1.5	0.260	0.364	1.3	1.15	0.297	1.599	1.177	1.328
Temperature	°C	12.6	12	12.3	12.28	11.9	11.7	11.6	12.1	13	12.95	12.86
Oxidation-reduction Potential	mV	-114	-28	-101	-151	28	-69	-17	26	-145.7	-160	-110

Notes:

1 Analyzed by USEPA Method 6010B.
2 Analyzed by USEPA Method 200.8.
3 Analyzed by USEPA Method 2320.
4 Analyzed by USEPA Method 160.1.

Abbreviations:

°C	DegreesCelsius
$CaCO_3$	Calcium carbonate
USEPA	U.S. Environmental Protection Agency
mS/cm	Millisiemens/centimeter
mV	Millivolt

Qualifier:

U Result was less than detection limit

B&L Woodwaste Site
Pierce County, Washington

Engineering Alternatives Evaluation

Attachment A.3

Landfill Groundwater Sampling Laboratory Analytical Reports

FINAL

METHOD BLANK RESULTS-CONVENTIONALS
QS91-Floyd-Snider

ANALYTICAL RESOURCES INCORPORATED

Matrix: Water
Data Release Authorized:
Reported: 04/22/10

Project: B&L Woodwaste 1412.2
Event: B&L RIM T.1412.2
Date Sampled: NA
Date Received: NA

Analyte	Method	Date	Units	Blank	ID
Total Dissolved Solids	EPA 160.1	04/16/10	mg/L	< 5.0 U	
Chloride	EPA 300.0	04/15/10	mg/L	< 0.1 U	
		04/19/10		< 0.1 U	
Fluoride	EPA 300.0	04/15/10	mg/L	< 0.1 U	
		04/16/10		< 0.1 U	
Bromide	EPA 300.0	04/16/10	mg/L	< 0.1 U	
N-Nitrate	EPA 300.0	04/16/10	mg-N/L	< 0.1 U	
N-Nitrite	EPA 300.0	04/16/10	mg-N/L	< 0.1 U	
Ortho-Phosphorous	EPA 300.0	04/16/10	mg-P/L	< 0.1 U	
Sulfate	EPA 300.0	04/14/10	mg/L	< 0.1 U	
		04/16/10		< 0.1 U	
Sulfide	EPA 376.2	04/19/10	mg/L	< 0.050 U	
		04/19/10		< 0.050 U	
Biological Oxygen Demand	EPA 405.1	04/15/10	mg/L	< 1.0 U	
Total Organic Carbon	EPA 415.1	04/20/10	mg/L	< 1.50 U	
Dissolved Organic Carbon	EPA 415.1	04/20/10	mg/L	< 1.50 U	

SAMPLE RESULTS-CONVENTIONALS
QS91-Floyd-Snider

Matrix: Water
Data Release Authorized:
Reported: 04/22/10

Project: B&L Woodwaste 1412.2
Event: B&L RIM T.1412.2
Date Sampled: 04/15/10
Date Received: 04/15/10

Client ID: PZ-4B
ARI ID: 10-9686 QS91A

Analyte	Date Batch	Method	Units	RL	Sample
pH	04/15/10 041510#1	EPA 150.1	std units	0.01	6.66
Alkalinity	04/16/10 041610#1	SM 2320	mg/L CaCO3	1.0	135
Carbonate	04/16/10	SM 2320	mg/L CaCO3	1.0	< 1.0 U
Bicarbonate	04/16/10	SM 2320	mg/L CaCO3	1.0	135
Hydroxide	04/16/10	SM 2320	mg/L CaCO3	1.0	< 1.0 U
Total Dissolved Solids	04/16/10 041610#1	EPA 160.1	mg/L	5.0	206
Sulfide	04/19/10 041910#1	EPA 376.2	mg/L	0.050	< 0.050 U
Total Organic Carbon	04/20/10 042010#1	EPA 415.1	mg/L	1.50	4.27

RL Analytical reporting limit
U Undetected at reported detection limit

SAMPLE RESULTS-CONVENTIONALS
QS91-Floyd-Snider

ANALYTICAL RESOURCES INCORPORATED

Matrix: Water
Data Release Authorized:
Reported: 04/22/10

Project: B&L Woodwaste 1412.2
Event: B&L RIM T.1412.2
Date Sampled: 04/15/10
Date Received: 04/15/10

Client ID: PZ-8B
ARI ID: 10-9687 QS91B

Analyte	Date Batch	Method	Units	RL	Sample
pH	04/15/10 041510#1	EPA 150.1	std units	0.01	7.13
Alkalinity	04/16/10 041610#1	SM 2320	mg/L CaCO3	1.0	138
Carbonate	04/16/10	SM 2320	mg/L CaCO3	1.0	< 1.0 U
Bicarbonate	04/16/10	SM 2320	mg/L CaCO3	1.0	138
Hydroxide	04/16/10	SM 2320	mg/L CaCO3	1.0	< 1.0 U
Total Dissolved Solids	04/16/10 041610#1	EPA 160.1	mg/L	5.0	201
Sulfide	04/19/10 041910#1	EPA 376.2	mg/L	0.050	< 0.050 U
Total Organic Carbon	04/20/10 042010#1	EPA 415.1	mg/L	1.50	1.70

RL Analytical reporting limit
U Undetected at reported detection limit

SAMPLE RESULTS-CONVENTIONALS
QS91-Floyd-Snider

Matrix: Water
Data Release Authorized:
Reported: 04/22/10

Project: B&L Woodwaste 1412.2
Event: B&L RIM T.1412.2
Date Sampled: 04/15/10
Date Received: 04/15/10

Client ID: PD-109
ARI ID: 10-9688 QS91C

Analyte	Date Batch	Method	Units	RL	Sample
pH	04/15/10 041510#1	EPA 150.1	std units	0.01	6.51
Alkalinity	04/16/10 041610#1	SM 2320	mg/L CaCO3	1.0	464
Carbonate	04/16/10	SM 2320	mg/L CaCO3	1.0	< 1.0 U
Bicarbonate	04/16/10	SM 2320	mg/L CaCO3	1.0	464
Hydroxide	04/16/10	SM 2320	mg/L CaCO3	1.0	< 1.0 U
Total Dissolved Solids	04/16/10 041610#1	EPA 160.1	mg/L	10.0	532
Sulfide	04/19/10 041910#1	EPA 376.2	mg/L	0.050	< 0.050 U
Biological Oxygen Demand	04/15/10 041510#1	EPA 405.1	mg/L	3.0	14.9
Total Organic Carbon	04/20/10 042010#1	EPA 415.1	mg/L	1.50	24.0

RL	Analytical reporting limit
U	Undetected at reported detection limit

SAMPLE RESULTS-CONVENTIONALS
QS91-Floyd-Snider

Matrix: Water
Data Release Authorized:
Reported: 04/22/10

Project: B&L Woodwaste 1412.2
Event: B&L RIM T.1412.2
Date Sampled: 04/15/10
Date Received: 04/15/10

Client ID: PZ-9
ARI ID: 10-9689 QS91D

Analyte	Date Batch	Method	Units	RL	Sample
pH	04/15/10 041510#1	EPA 150.1	std units	0.01	6.46
Alkalinity	04/16/10 041610#1	SM 2320	mg/L CaCO3	1.0	812
Carbonate	04/16/10	SM 2320	mg/L CaCO3	1.0	< 1.0 U
Bicarbonate	04/16/10	SM 2320	mg/L CaCO3	1.0	812
Hydroxide	04/16/10	SM 2320	mg/L CaCO3	1.0	< 1.0 U
Total Dissolved Solids	04/16/10 041610#1	EPA 160.1	mg/L	13.3	909
Sulfide	04/19/10 041910#1	EPA 376.2	mg/L	0.050	< 0.050 U
Biological Oxygen Demand	04/15/10 041510#1	EPA 405.1	mg/L	6.0	18.4
Total Organic Carbon	04/20/10 042010#1	EPA 415.1	mg/L	6.00	57.6

RL	Analytical reporting limit
U	Undetected at reported detection limit

SAMPLE RESULTS-CONVENTIONALS
QS91-Floyd-Snider

ANALYTICAL RESOURCES INCORPORATED

Matrix: Water
Data Release Authorized:
Reported: 04/22/10

Project: B&L Woodwaste 1412.2
Event: B&L RIM T.1412.2
Date Sampled: 04/15/10
Date Received: 04/15/10

Client ID: PZ-12
ARI ID: 10-9690 QS91E

Analyte	Date Batch	Method	Units	RL	Sample
pH	04/15/10 041510#1	EPA 150.1	std units	0.01	6.42
Alkalinity	04/16/10 041610#1	SM 2320	mg/L CaCO3	1.0	499
Carbonate	04/16/10	SM 2320	mg/L CaCO3	1.0	< 1.0 U
Bicarbonate	04/16/10	SM 2320	mg/L CaCO3	1.0	499
Hydroxide	04/16/10	SM 2320	mg/L CaCO3	1.0	< 1.0 U
Total Dissolved Solids	04/16/10 041610#1	EPA 160.1	mg/L	10.0	686
Sulfide	04/19/10 041910#1	EPA 376.2	mg/L	0.050	< 0.050 U
Biological Oxygen Demand	04/15/10 041510#1	EPA 405.1	mg/L	6.0	9.5
Total Organic Carbon	04/20/10 042010#1	EPA 415.1	mg/L	3.00	42.8

RL Analytical reporting limit
U Undetected at reported detection limit

SAMPLE RESULTS-CONVENTIONALS
QS91-Floyd-Snider

Matrix: Water
Data Release Authorized:
Reported: 04/22/10

Project: B&L Woodwaste 1412.2
Event: B&L RIM T.1412.2
Date Sampled: 04/15/10
Date Received: 04/15/10

Client ID: PD-107
ARI ID: 10-9691 QS91F

Analyte	Date Batch	Method	Units	RL	Sample
pH	04/15/10 041510#1	EPA 150.1	std units	0.01	6.44
Alkalinity	04/16/10 041610#1	SM 2320	mg/L CaCO3	1.0	875
Carbonate	04/16/10	SM 2320	mg/L CaCO3	1.0	< 1.0 U
Bicarbonate	04/16/10	SM 2320	mg/L CaCO3	1.0	875
Hydroxide	04/16/10	SM 2320	mg/L CaCO3	1.0	< 1.0 U
Total Dissolved Solids	04/16/10 041610#1	EPA 160.1	mg/L	13.3	889
Sulfide	04/19/10 041910#1	EPA 376.2	mg/L	0.050	< 0.050 U
Biological Oxygen Demand	04/15/10 041510#1	EPA 405.1	mg/L	6.0	18.0
Total Organic Carbon	04/20/10 042010#1	EPA 415.1	mg/L	1.50	36.4

RL	Analytical reporting limit
U	Undetected at reported detection limit

SAMPLE RESULTS-CONVENTIONALS
QS91-Floyd-Snider

Matrix: Water
Data Release Authorized:
Reported: 04/22/10

Project: B&L Woodwaste 1412.2
Event: B&L RIM T.1412.2
Date Sampled: 04/15/10
Date Received: 04/15/10

Client ID: PZ-4B-F
ARI ID: 10-9692 QS91G

Analyte	Date Batch	Method	Units	RL	Sample
Chloride	04/15/10 041510#1	EPA 300.0	mg/L	1.0	5.7
Fluoride	04/16/10 041610#1	EPA 300.0	mg/L	0.1	0.3
Bromide	04/16/10 041610#1	EPA 300.0	mg/L	0.1	< 0.1 U
N-Nitrate	04/16/10 041610#1	EPA 300.0	mg-N/L	0.1	< 0.1 U
N-Nitrite	04/16/10 041610#1	EPA 300.0	mg-N/L	0.1	< 0.1 U
Ortho-Phosphorous	04/16/10 041610#1	EPA 300.0	mg-P/L	0.1	< 0.1 U
Sulfate	04/14/10 041410#1	EPA 300.0	mg/L	1.0	2.4

RL	Analytical reporting limit
U	Undetected at reported detection limit

SAMPLE RESULTS-CONVENTIONALS
QS91-Floyd-Snider

Matrix: Water
Data Release Authorized:
Reported: 04/22/10

Project: B&L Woodwaste 1412.2
Event: B&L RIM T.1412.2
Date Sampled: 04/15/10
Date Received: 04/15/10

Client ID: PZ-8B-F
ARI ID: 10-9693 QS91H

Analyte	Date Batch	Method	Units	RL	Sample
Chloride	04/15/10 041510#1	EPA 300.0	mg/L	1.0	7.8
Fluoride	04/16/10 041610#1	EPA 300.0	mg/L	0.1	0.3
Bromide	04/16/10 041610#1	EPA 300.0	mg/L	0.1	< 0.1 U
N-Nitrate	04/16/10 041610#1	EPA 300.0	mg-N/L	0.1	< 0.1 U
N-Nitrite	04/16/10 041610#1	EPA 300.0	mg-N/L	0.1	< 0.1 U
Ortho-Phosphorous	04/16/10 041610#1	EPA 300.0	mg-P/L	0.1	0.3
Sulfate	04/14/10 041410#1	EPA 300.0	mg/L	1.0	3.1

RL	Analytical reporting limit
U	Undetected at reported detection limit

SAMPLE RESULTS-CONVENTIONALS
QS91-Floyd-Snider

ANALYTICAL RESOURCES INCORPORATED

Matrix: Water
Data Release Authorized:
Reported: 04/22/10

Project: B&L Woodwaste 1412.2
Event: B&L RIM T.1412.2
Date Sampled: 04/15/10
Date Received: 04/15/10

Client ID: PD-109-F
ARI ID: 10-9694 QS91I

Analyte	**Date Batch**	**Method**	**Units**	**RL**	**Sample**
Chloride	04/15/10 041510#1	EPA 300.0	mg/L	1.0	17.2
Fluoride	04/15/10 041510#1	EPA 300.0	mg/L	1.0	< 1.0 U
Bromide	04/16/10 041610#1	EPA 300.0	mg/L	0.1	0.9
N-Nitrate	04/16/10 041610#1	EPA 300.0	mg-N/L	0.1	< 0.1 U
N-Nitrite	04/16/10 041610#1	EPA 300.0	mg-N/L	0.1	< 0.1 U
Ortho-Phosphorous	04/16/10 041610#1	EPA 300.0	mg-P/L	0.1	< 0.1 U
Sulfate	04/16/10 041610#1	EPA 300.0	mg/L	0.1	< 0.1 U
Dissolved Organic Carbon	04/20/10	EPA 415.1	mg/L	1.50	23.4

RL	Analytical reporting limit
U	Undetected at reported detection limit

SAMPLE RESULTS-CONVENTIONALS
QS91-Floyd-Snider

Matrix: Water
Data Release Authorized:
Reported: 04/22/10

Project: B&L Woodwaste 1412.2
Event: B&L RIM T.1412.2
Date Sampled: 04/15/10
Date Received: 04/15/10

Client ID: PZ-9-F
ARI ID: 10-9695 QS91J

Analyte	**Date Batch**	**Method**	**Units**	**RL**	**Sample**
Chloride	04/15/10 041510#1	EPA 300.0	mg/L	1.0	20.6
Fluoride	04/16/10 041610#1	EPA 300.0	mg/L	0.1	< 0.1 U
Bromide	04/16/10 041610#1	EPA 300.0	mg/L	0.1	0.1
N-Nitrate	04/16/10 041610#1	EPA 300.0	mg-N/L	0.1	< 0.1 U
N-Nitrite	04/16/10 041610#1	EPA 300.0	mg-N/L	0.1	< 0.1 U
Ortho-Phosphorous	04/16/10 041610#1	EPA 300.0	mg-P/L	0.1	< 0.1 U
Sulfate	04/16/10 041610#1	EPA 300.0	mg/L	0.1	< 0.1 U
Dissolved Organic Carbon	04/20/10	EPA 415.1	mg/L	1.50	56.8

RL	Analytical reporting limit
U	Undetected at reported detection limit

SAMPLE RESULTS-CONVENTIONALS
QS91-Floyd-Snider

Matrix: Water
Data Release Authorized:
Reported: 04/22/10

Project: B&L Woodwaste 1412.2
Event: B&L RIM T.1412.2
Date Sampled: 04/15/10
Date Received: 04/15/10

Client ID: PZ-12-F
ARI ID: 10-9696 QS91K

Analyte	**Date** **Batch**	**Method**	**Units**	**RL**	**Sample**
Chloride	04/19/10 041910#1	EPA 300.0	mg/L	2.0	60.3
Fluoride	04/15/10 041510#1	EPA 300.0	mg/L	1.0	< 1.0 U
Bromide	04/16/10 041610#1	EPA 300.0	mg/L	0.1	1.0
N-Nitrate	04/16/10 041610#1	EPA 300.0	mg-N/L	0.1	0.1
N-Nitrite	04/16/10 041610#1	EPA 300.0	mg-N/L	0.1	< 0.1 U
Ortho-Phosphorous	04/16/10 041610#1	EPA 300.0	mg-P/L	0.1	< 0.1 U
Sulfate	04/16/10 041610#1	EPA 300.0	mg/L	0.1	0.4
Dissolved Organic Carbon	04/20/10	EPA 415.1	mg/L	1.50	46.8

RL Analytical reporting limit
U Undetected at reported detection limit

SAMPLE RESULTS-CONVENTIONALS
QS91-Floyd-Snider

Matrix: Water
Data Release Authorized:
Reported: 04/22/10

Project: B&L Woodwaste 1412.2
Event: B&L RIM T.1412.2
Date Sampled: 04/15/10
Date Received: 04/15/10

Client ID: PD-107F
ARI ID: 10-9697 QS91L

Analyte	**Date Batch**	**Method**	**Units**	**RL**	**Sample**
Chloride	04/15/10 041510#1	EPA 300.0	mg/L	1.0	11.3
Fluoride	04/15/10 041510#1	EPA 300.0	mg/L	1.0	1.6
Bromide	04/16/10 041610#1	EPA 300.0	mg/L	0.1	< 0.1 U
N-Nitrate	04/16/10 041610#1	EPA 300.0	mg-N/L	0.1	0.2
N-Nitrite	04/14/10 041410#1	EPA 300.0	mg-N/L	1.0	< 1.0 U
Ortho-Phosphorous	04/16/10 041610#1	EPA 300.0	mg-P/L	0.1	< 0.1 U
Sulfate	04/16/10 041610#1	EPA 300.0	mg/L	0.1	< 0.1 U
Dissolved Organic Carbon	04/20/10	EPA 415.1	mg/L	1.50	36.0

RL Analytical reporting limit
U Undetected at reported detection limit

LAB CONTROL RESULTS-CONVENTIONALS
QS91-Floyd-Snider

Matrix: Water
Data Release Authorized:
Reported: 04/22/10

Project: B&L Woodwaste 1412.2
Event: B&L RIM T.1412.2
Date Sampled: NA
Date Received: NA

Analyte/Method	**QC ID**	**Date**	**Units**	**LCS**	**Spike Added**	**Recovery**
pH EPA 150.1	ICVL	04/15/10	std units	7.01	7.00	0.01
Total Dissolved Solids EPA 160.1	ICVL	04/16/10	mg/L	493	500	98.6%
Sulfide	ICVL	04/19/10	mg/L	0.461	0.501	92.0%
EPA 376.2	PREP	04/19/10		6.96	6.56	106.1%
Biological Oxygen Demand EPA 405.1	ICVL	04/15/10	mg/L	137	198	69.2%

pH is evaluated as the Absolute Difference between the values rather than Percent Recovery.

STANDARD REFERENCE RESULTS-CONVENTIONALS
QS91-Floyd-Snider

Matrix: Water
Data Release Authorized:
Reported: 04/22/10

Project: B&L Woodwaste 1412.2
Event: B&L RIM T.1412.2
Date Sampled: NA
Date Received: NA

Analyte/SRM ID	Method	Date	Units	SRM	True Value	Recovery
Alkalinity ERA #P114506	SM 2320	04/16/10	mg/L CaCO3	34.1	35.0	97.4%
Chloride ERA #230109	EPA 300.0	04/15/10	mg/L	3.0	3.0	100.0%
		04/19/10		2.8	3.0	93.3%
Fluoride ERA #02098	EPA 300.0	04/15/10	mg/L	3.0	3.0	100.0%
		04/16/10		2.9	3.0	96.7%
Bromide ERA #05078	EPA 300.0	04/16/10	mg/L	2.9	3.0	96.7%
N-Nitrate ERA #09127	EPA 300.0	04/16/10	mg-N/L	2.8	3.0	93.3%
N-Nitrite	EPA 300.0	04/16/10	mg-N/L	3.0	3.0	100.0%
Ortho-Phosphorous EAR #210109	EPA 300.0	04/16/10	mg-P/L	2.9	3.0	96.7%
Sulfate ERA #220109	EPA 300.0	04/14/10	mg/L	2.9	3.0	96.7%
		04/16/10		3.1	3.0	103.3%
Total Organic Carbon ERA 0506-09-01	EPA 415.1	04/20/10	mg/L	19.7	20.0	98.5%
Dissolved Organic Carbon ERA 0506-09-01	EPA 415.1	04/20/10	mg/L	19.7	20.0	98.5%

REPLICATE RESULTS-CONVENTIONALS
QS91-Floyd-Snider

ANALYTICAL RESOURCES INCORPORATED

Matrix: Water
Data Release Authorized
Reported: 04/22/10

Project: B&L Woodwaste 1412.2
Event: B&L RIM T.1412.2
Date Sampled: 04/15/10
Date Received: 04/15/10

Analyte	Method	Date	Units	Sample	Replicate(s)	RPD/RSD
ARI ID: QS91A Client ID: PZ-4B						
pH	EPA 150.1	04/15/10	std units	6.66	6.67	0.01
Alkalinity	SM 2320	04/16/10	mg/L CaCO3	135	134	0.7%
Carbonate	SM 2320	04/16/10	mg/L CaCO3	< 1.0	< 1.0	NA
Bicarbonate	SM 2320	04/16/10	mg/L CaCO3	135	134	0.7%
Hydroxide	SM 2320	04/16/10	mg/L CaCO3	< 1.0	< 1.0	NA
Sulfide	EPA 376.2	04/19/10	mg/L	< 0.050	< 0.050	NA
Total Organic Carbon	EPA 415.1	04/20/10	mg/L	4.27	3.92	8.5%
ARI ID: QS91E Client ID: PZ-12						
Total Dissolved Solids	EPA 160.1	04/16/10	mg/L	686	682	0.6%
ARI ID: QS91G Client ID: PZ-4B-F						
Chloride	EPA 300.0	04/15/10	mg/L	5.7	5.5	3.6%
Fluoride	EPA 300.0	04/16/10	mg/L	0.3	0.3	0.0%
Bromide	EPA 300.0	04/16/10	mg/L	< 0.1	< 0.1	NA
N-Nitrate	EPA 300.0	04/16/10	mg-N/L	< 0.1	< 0.1	NA
N-Nitrite	EPA 300.0	04/16/10	mg-N/L	< 0.1	< 0.1	NA
Ortho-Phosphorous	EPA 300.0	04/16/10	mg-P/L	< 0.1	< 0.1	NA
Sulfate	EPA 300.0	04/14/10	mg/L	2.4	2.4	0.0%
ARI ID: QS91I Client ID: PD-109-F						
Dissolved Organic Carbo	EPA 415.1	04/20/10	mg/L	23.4	24.6	5.0%

pH is evaluated as the Absolute Difference between the values rather than Relative Percent Difference

MS/MSD RESULTS-CONVENTIONALS
QS91-Floyd-Snider

Matrix: Water
Data Release Authorized:
Reported: 04/22/10

Project: B&L Woodwaste 1412.2
Event: B&L RIM T.1412.2
Date Sampled: 04/15/10
Date Received: 04/15/10

Analyte	**Method**	**Date**	**Units**	**Sample**	**Spike**	**Spike Added**	**Recovery**
ARI ID: QS91A Client ID: PZ-4B							
Sulfide	EPA 376.2	04/19/10	mg/L	< 0.050	6.04	6.56	92.1%
Total Organic Carbon	EPA 415.1	04/20/10	mg/L	4.27	23.2	20.0	94.6%
ARI ID: QS91G Client ID: PZ-4B-F							
Chloride	EPA 300.0	04/15/10	mg/L	5.7	24.2	20.0	92.5%
Fluoride	EPA 300.0	04/16/10	mg/L	0.3	2.1	2.0	90.0%
Bromide	EPA 300.0	04/16/10	mg/L	< 0.1	2.1	2.0	105.0%
N-Nitrate	EPA 300.0	04/16/10	mg-N/L	< 0.1	1.9	2.0	95.0%
N-Nitrite	EPA 300.0	04/16/10	mg-N/L	< 0.1	2.0	2.0	100.0%
Ortho-Phosphorous	EPA 300.0	04/16/10	mg-P/L	< 0.1	1.9	2.0	95.0%
Sulfate	EPA 300.0	04/14/10	mg/L	2.4	20.8	20.0	92.0%
ARI ID: QS91I Client ID: PD-109-F							
Dissolved Organic Carbon	EPA 415.1	04/20/10	mg/L	23.4	42.5	20.0	95.5%

SW8270 SEMIVOLATILES WATER SURROGATE RECOVERY SUMMARY

Matrix: Water

QC Report No: QS91-Floyd-Snider
Project: B&L Woodwaste 1412.2
B&L RIM T.1412.2

Client ID	PHL	2FP	TBP	2CP	TOT OUT
MB-041610	71.5%	77.3%	102%	76.8%	0
LCS-041610	80.3%	81.1%	102%	83.2%	0
PD-109	66.1%	73.9%	108%	77.9%	0
PZ-9	58.4%	60.3%	106%	66.4%	0
PZ-12	58.4%	58.7%	104%	65.1%	0
PZ-12 DL	57.5%	57.6%	87.1%	65.9%	0
PD-107	62.1%	64.5%	106%	67.2%	0

	LCS/MB LIMITS	QC LIMITS
(PHL) = d5-Phenol	(50-100)	(41-100)
(2FP) = 2-Fluorophenol	(46-100)	(38-100)
(TBP) = 2,4,6-Tribromophenol	(52-123)	(48-118)
(2CP) = d4-2-Chlorophenol	(53-100)	(44-100)

Prep Method: SW3520C
Log Number Range: 10-9688 to 10-9691

ANALYTICAL
RESOURCES
INCORPORATED

ORGANICS ANALYSIS DATA SHEET
Semivolatiles by SW8270D GC/MS
Page 1 of 1

Sample ID: PD-109
SAMPLE

Lab Sample ID: QS91C
LIMS ID: 10-9688
Matrix: Water
Data Release Authorized:
Reported: 04/19/10

QC Report No: QS91-Floyd-Snider
Project: B&L Woodwaste 1412.2
B&L RIM T.1412.2
Date Sampled: 04/15/10
Date Received: 04/15/10

Date Extracted: 04/16/10
Date Analyzed: 04/19/10 13:24
Instrument/Analyst: NT6/JZ

Sample Amount: 500 mL
Final Extract Volume: 0.50 mL
Dilution Factor: 1.00

CAS Number	Analyte	RL	Result
108-95-2	Phenol	1.0	< 1.0 U
95-48-7	2-Methylphenol	1.0	< 1.0 U
106-44-5	4-Methylphenol	1.0	< 1.0 U
105-67-9	2,4-Dimethylphenol	1.0	< 1.0 U

Reported in µg/L (ppb)

Semivolatile Surrogate Recovery

d5-Phenol	66.1%
2-Fluorophenol	73.9%
2,4,6-Tribromophenol	108%
d4-2-Chlorophenol	77.9%

ORGANICS ANALYSIS DATA SHEET
Semivolatiles by SW8270D GC/MS
Page 1 of 1

Sample ID: PZ-9
SAMPLE

Lab Sample ID: QS91D
LIMS ID: 10-9689
Matrix: Water
Data Release Authorized:
Reported: 04/19/10

QC Report No: QS91-Floyd-Snider
Project: B&L Woodwaste 1412.2
B&L RIM T.1412.2
Date Sampled: 04/15/10
Date Received: 04/15/10

Date Extracted: 04/16/10
Date Analyzed: 04/19/10 13:57
Instrument/Analyst: NT6/JZ

Sample Amount: 500 mL
Final Extract Volume: 0.50 mL
Dilution Factor: 1.00

CAS Number	Analyte	RL	Result
108-95-2	Phenol	1.0	< 1.0 U
95-48-7	2-Methylphenol	1.0	< 1.0 U
106-44-5	**4-Methylphenol**	**1.0**	**42**
105-67-9	**2,4-Dimethylphenol**	**1.0**	**1.8**

Reported in µg/L (ppb)

Semivolatile Surrogate Recovery	
d5-Phenol	58.4%
2-Fluorophenol	60.3%
2,4,6-Tribromophenol	106%
d4-2-Chlorophenol	66.4%

ORGANICS ANALYSIS DATA SHEET
Semivolatiles by SW8270D GC/MS
Page 1 of 1

Sample ID: PZ-12
SAMPLE

Lab Sample ID: QS91E
LIMS ID: 10-9690
Matrix: Water
Data Release Authorized:
Reported: 04/19/10

QC Report No: QS91-Floyd-Snider
Project: B&L Woodwaste 1412.2
B&L RIM T.1412.2
Date Sampled: 04/15/10
Date Received: 04/15/10

Date Extracted: 04/16/10
Date Analyzed: 04/19/10 14:29
Instrument/Analyst: NT6/JZ

Sample Amount: 500 mL
Final Extract Volume: 0.50 mL
Dilution Factor: 1.00

CAS Number	Analyte	RL	Result
108-95-2	Phenol	1.0	< 1.0 U
95-48-7	2-Methylphenol	1.0	< 1.0 U
106-44-5	**4-Methylphenol**	**1.0**	**310 ES**
105-67-9	2,4-Dimethylphenol	1.0	< 1.0 U

Reported in µg/L (ppb)

Semivolatile Surrogate Recovery	
d5-Phenol	58.4%
2-Fluorophenol	58.7%
2,4,6-Tribromophenol	104%
d4-2-Chlorophenol	65.1%

ORGANICS ANALYSIS DATA SHEET
Semivolatiles by SW8270D GC/MS
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Sample ID: PZ-12
DILUTION

Lab Sample ID: QS91E
LIMS ID: 10-9690
Matrix: Water
Data Release Authorized:
Reported: 04/19/10

QC Report No: QS91-Floyd-Snider
Project: B&L Woodwaste 1412.2
B&L RIM T.1412.2
Date Sampled: 04/15/10
Date Received: 04/15/10

Date Extracted: 04/16/10
Date Analyzed: 04/19/10 15:37
Instrument/Analyst: NT6/JZ

Sample Amount: 500 mL
Final Extract Volume: 0.50 mL
Dilution Factor: 5.00

CAS Number	Analyte	RL	Result
108-95-2	Phenol	5.0	< 5.0 U
95-48-7	2-Methylphenol	5.0	< 5.0 U
106-44-5	**4-Methylphenol**	**5.0**	**360**
105-67-9	2,4-Dimethylphenol	5.0	< 5.0 U

Reported in µg/L (ppb)

Semivolatile Surrogate Recovery	
d5-Phenol	57.5%
2-Fluorophenol	57.6%
2,4,6-Tribromophenol	87.1%
d4-2-Chlorophenol	65.9%

ORGANICS ANALYSIS DATA SHEET
Semivolatiles by SW8270D GC/MS
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Sample ID: PD-107
SAMPLE

Lab Sample ID: QS91F
LIMS ID: 10-9691
Matrix: Water
Data Release Authorized:
Reported: 04/19/10

QC Report No: QS91-Floyd-Snider
Project: B&L Woodwaste 1412.2
B&L RIM T.1412.2
Date Sampled: 04/15/10
Date Received: 04/15/10

Date Extracted: 04/16/10
Date Analyzed: 04/19/10 15:02
Instrument/Analyst: NT6/JZ

Sample Amount: 500 mL
Final Extract Volume: 0.50 mL
Dilution Factor: 1.00

CAS Number	Analyte	RL	Result
108-95-2	Phenol	1.0	< 1.0 U
95-48-7	2-Methylphenol	1.0	< 1.0 U
106-44-5	4-Methylphenol	1.0	< 1.0 U
105-67-9	2,4-Dimethylphenol	1.0	< 1.0 U

Reported in µg/L (ppb)

Semivolatile Surrogate Recovery	
d5-Phenol	62.1%
2-Fluorophenol	64.5%
2,4,6-Tribromophenol	106%
d4-2-Chlorophenol	67.2%

ORGANICS ANALYSIS DATA SHEET
Semivolatiles by SW8270D GC/MS
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Sample ID: MB-041610
METHOD BLANK

Lab Sample ID: MB-041610
LIMS ID: 10-9688
Matrix: Water
Data Release Authorized:
Reported: 04/19/10

QC Report No: QS91-Floyd-Snider
Project: B&L Woodwaste 1412.2
B&L RIM T.1412.2
Date Sampled: NA
Date Received: NA

Date Extracted: 04/16/10
Date Analyzed: 04/19/10 12:19
Instrument/Analyst: NT6/JZ

Sample Amount: 500 mL
Final Extract Volume: 0.50 mL
Dilution Factor: 1.00

CAS Number	**Analyte**	**RL**	**Result**
108-95-2	Phenol	1.0	< 1.0 U
95-48-7	2-Methylphenol	1.0	< 1.0 U
106-44-5	4-Methylphenol	1.0	< 1.0 U
105-67-9	2,4-Dimethylphenol	1.0	< 1.0 U

Reported in µg/L (ppb)

Semivolatile Surrogate Recovery	
d5-Phenol	71.5%
2-Fluorophenol	77.3%
2,4,6-Tribromophenol	102%
d4-2-Chlorophenol	76.8%

ORGANICS ANALYSIS DATA SHEET
Semivolatiles by SW8270D GC/MS
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Sample ID: LCS-041610
LAB CONTROL

Lab Sample ID: LCS-041610
LIMS ID: 10-9688
Matrix: Water
Data Release Authorized:
Reported: 04/19/10

QC Report No: QS91-Floyd-Snider
Project: B&L Woodwaste 1412.2
B&L RIM T.1412.2
Date Sampled: 04/15/10
Date Received: 04/15/10

Date Extracted: 04/16/10
Date Analyzed: 04/19/10 12:51
Instrument/Analyst: NT6/JZ
GPC Cleanup: NO

Sample Amount: 500 mL
Final Extract Volume: 0.50 mL
Dilution Factor: 1.00

Analyte	**Lab Control**	**Spike Added**	**Recovery**
Phenol	16.3	25.0	65.2%
2-Methylphenol	17.4	25.0	69.6%
4-Methylphenol	35.3	50.0	70.6%
2,4-Dimethylphenol	14.2	25.0	56.8%

Semivolatile Surrogate Recovery	
d5-Phenol	80.3%
2-Fluorophenol	81.1%
2,4,6-Tribromophenol	102%
d4-2-Chlorophenol	83.2%

Results reported in µg/L

INORGANICS ANALYSIS DATA SHEET
TOTAL METALS
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Sample ID: PZ-4B
SAMPLE

Lab Sample ID: QS91A
LIMS ID: 10-9686
Matrix: Water
Data Release Authorized:
Reported: 04/22/10

QC Report No: QS91-Floyd-Snider
Project: B&L Woodwaste 1412.2
B&L RIM T.1412.2
Date Sampled: 04/15/10
Date Received: 04/15/10

Prep Meth	Prep Date	Analysis Method	Analysis Date	CAS Number	Analyte	RL	µg/L	Q
3010A	04/16/10	6010B	04/19/10	7440-36-0	Antimony	50	50	U
200.8	04/16/10	200.8	04/21/10	**7440-38-2**	**Arsenic**	0.2	**2.0**	
3010A	04/16/10	6010B	04/19/10	**7440-39-3**	**Barium**	3	**28**	
3010A	04/16/10	6010B	04/19/10	7440-41-7	Beryllium	1	1	U
3010A	04/16/10	6010B	04/19/10	7440-43-9	Cadmium	2	2	U
3010A	04/16/10	6010B	04/19/10	7440-47-3	Chromium	5	5	U
3010A	04/16/10	6010B	04/19/10	7440-50-8	Copper	2	2	U
3010A	04/16/10	6010B	04/19/10	**7439-89-6**	**Iron**	50	**8,550**	
200.8	04/16/10	200.8	04/21/10	7439-92-1	Lead	1	1	U
3010A	04/16/10	6010B	04/19/10	**7439-96-5**	**Manganese**	1	**271**	
7470A	04/16/10	7470A	04/19/10	7439-97-6	Mercury	0.1	0.1	U
3010A	04/16/10	6010B	04/19/10	7440-02-0	Nickel	10	10	U
200.8	04/16/10	200.8	04/21/10	7782-49-2	Selenium	0.5	0.5	U
3010A	04/16/10	6010B	04/19/10	7440-22-4	Silver	3	3	U
200.8	04/16/10	200.8	04/21/10	7440-28-0	Thallium	0.2	0.2	U
3010A	04/16/10	6010B	04/19/10	7440-66-6	Zinc	10	10	U

U-Analyte undetected at given RL
RL-Reporting Limit

ANALYTICAL
RESOURCES
INCORPORATED

INORGANICS ANALYSIS DATA SHEET
TOTAL METALS
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Sample ID: PZ-8B
SAMPLE

Lab Sample ID: QS91B
LIMS ID: 10-9687
Matrix: Water
Data Release Authorized:
Reported: 04/22/10

QC Report No: QS91-Floyd-Snider
Project: B&L Woodwaste 1412.2
B&L RIM T.1412.2
Date Sampled: 04/15/10
Date Received: 04/15/10

Prep Meth	Prep Date	Analysis Method	Analysis Date	CAS Number	Analyte	RL	µg/L	Q
3010A	04/16/10	6010B	04/19/10	7440-36-0	Antimony	50	50	U
200.8	04/16/10	200.8	04/21/10	**7440-38-2**	**Arsenic**	0.2	**18.1**	
3010A	04/16/10	6010B	04/19/10	**7440-39-3**	**Barium**	3	**25**	
3010A	04/16/10	6010B	04/19/10	7440-41-7	Beryllium	1	1	U
3010A	04/16/10	6010B	04/19/10	7440-43-9	Cadmium	2	2	U
3010A	04/16/10	6010B	04/19/10	**7440-47-3**	**Chromium**	5	**7**	
3010A	04/16/10	6010B	04/19/10	**7440-50-8**	**Copper**	2	**5**	
3010A	04/16/10	6010B	04/19/10	**7439-89-6**	**Iron**	50	**2,720**	
200.8	04/16/10	200.8	04/21/10	7439-92-1	Lead	1	1	U
3010A	04/16/10	6010B	04/19/10	**7439-96-5**	**Manganese**	1	**879**	
7470A	04/16/10	7470A	04/19/10	7439-97-6	Mercury	0.1	0.1	U
3010A	04/16/10	6010B	04/19/10	**7440-02-0**	**Nickel**	10	**10**	
200.8	04/16/10	200.8	04/21/10	7782-49-2	Selenium	0.5	0.5	U
3010A	04/16/10	6010B	04/19/10	7440-22-4	Silver	3	3	U
200.8	04/16/10	200.8	04/21/10	7440-28-0	Thallium	0.2	0.2	U
3010A	04/16/10	6010B	04/19/10	7440-66-6	Zinc	10	10	U

U-Analyte undetected at given RL
RL-Reporting Limit

INORGANICS ANALYSIS DATA SHEET
TOTAL METALS
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Sample ID: PD-109
SAMPLE

Lab Sample ID: QS91C
LIMS ID: 10-9688
Matrix: Water
Data Release Authorized:
Reported: 04/22/10

QC Report No: QS91-Floyd-Snider
Project: B&L Woodwaste 1412.2
B&L RIM T.1412.2
Date Sampled: 04/15/10
Date Received: 04/15/10

Prep Meth	Prep Date	Analysis Method	Analysis Date	CAS Number	Analyte	RL	µg/L	Q
3010A	04/16/10	6010B	04/19/10	7440-36-0	Antimony	50	50	U
200.8	04/16/10	200.8	04/21/10	**7440-38-2**	**Arsenic**	0.5	**190**	
3010A	04/16/10	6010B	04/19/10	**7440-39-3**	**Barium**	3	**168**	
3010A	04/16/10	6010B	04/19/10	7440-41-7	Beryllium	1	1	U
3010A	04/16/10	6010B	04/19/10	7440-43-9	Cadmium	2	2	U
3010A	04/16/10	6010B	04/19/10	7440-47-3	Chromium	5	5	U
3010A	04/16/10	6010B	04/19/10	7440-50-8	Copper	2	2	U
3010A	04/16/10	6010B	04/19/10	**7439-89-6**	**Iron**	50	**69,600**	
200.8	04/16/10	200.8	04/21/10	7439-92-1	Lead	1	1	U
3010A	04/16/10	6010B	04/19/10	**7439-96-5**	**Manganese**	1	**2,160**	
7470A	04/16/10	7470A	04/19/10	7439-97-6	Mercury	0.1	0.1	U
3010A	04/16/10	6010B	04/19/10	**7440-02-0**	**Nickel**	10	**10**	
200.8	04/16/10	200.8	04/21/10	7782-49-2	Selenium	2	2	U
3010A	04/16/10	6010B	04/19/10	7440-22-4	Silver	3	3	U
200.8	04/16/10	200.8	04/21/10	7440-28-0	Thallium	0.2	0.2	U
3010A	04/16/10	6010B	04/19/10	7440-66-6	Zinc	10	10	U

U-Analyte undetected at given RL
RL-Reporting Limit

INORGANICS ANALYSIS DATA SHEET
TOTAL METALS
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Sample ID: PZ-9
SAMPLE

Lab Sample ID: QS91D
LIMS ID: 10-9689
Matrix: Water
Data Release Authorized:
Reported: 04/22/10

QC Report No: QS91-Floyd-Snider
Project: B&L Woodwaste 1412.2
B&L RIM T.1412.2
Date Sampled: 04/15/10
Date Received: 04/15/10

Prep Meth	Prep Date	Analysis Method	Analysis Date	CAS Number	Analyte	RL	µg/L	Q
3010A	04/16/10	6010B	04/19/10	7440-36-0	Antimony	50	50	U
200.8	04/16/10	200.8	04/21/10	**7440-38-2**	**Arsenic**	2	**1,920**	
3010A	04/16/10	6010B	04/19/10	**7440-39-3**	**Barium**	3	**128**	
3010A	04/16/10	6010B	04/19/10	7440-41-7	Beryllium	1	1	U
3010A	04/16/10	6010B	04/19/10	7440-43-9	Cadmium	2	2	U
3010A	04/16/10	6010B	04/19/10	7440-47-3	Chromium	5	5	U
3010A	04/16/10	6010B	04/19/10	**7440-50-8**	**Copper**	2	**7**	
3010A	04/16/10	6010B	04/19/10	**7439-89-6**	**Iron**	50	**77,900**	
200.8	04/16/10	200.8	04/21/10	**7439-92-1**	**Lead**	1	**3**	
3010A	04/16/10	6010B	04/19/10	**7439-96-5**	**Manganese**	1	**4,060**	
7470A	04/16/10	7470A	04/19/10	7439-97-6	Mercury	0.1	0.1	U
3010A	04/16/10	6010B	04/19/10	7440-02-0	Nickel	10	10	U
200.8	04/16/10	200.8	04/21/10	7782-49-2	Selenium	2	2	U
3010A	04/16/10	6010B	04/19/10	7440-22-4	Silver	3	3	U
200.8	04/16/10	200.8	04/21/10	7440-28-0	Thallium	0.2	0.2	U
3010A	04/16/10	6010B	04/19/10	**7440-66-6**	**Zinc**	10	**20**	

U-Analyte undetected at given RL
RL-Reporting Limit

INORGANICS ANALYSIS DATA SHEET
TOTAL METALS
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Sample ID: PZ-12
SAMPLE

Lab Sample ID: QS91E
LIMS ID: 10-9690
Matrix: Water
Data Release Authorized:
Reported: 04/22/10

QC Report No: QS91-Floyd-Snider
Project: B&L Woodwaste 1412.2
B&L RIM T.1412.2
Date Sampled: 04/15/10
Date Received: 04/15/10

Prep Meth	Prep Date	Analysis Method	Analysis Date	CAS Number	Analyte	RL	µg/L	Q
3010A	04/16/10	6010B	04/19/10	7440-36-0	Antimony	50	50	U
200.8	04/16/10	200.8	04/21/10	**7440-38-2**	**Arsenic**	2	**1,550**	
3010A	04/16/10	6010B	04/19/10	**7440-39-3**	**Barium**	3	**80**	
3010A	04/16/10	6010B	04/19/10	7440-41-7	Beryllium	1	1	U
3010A	04/16/10	6010B	04/19/10	7440-43-9	Cadmium	2	2	U
3010A	04/16/10	6010B	04/19/10	7440-47-3	Chromium	5	5	U
3010A	04/16/10	6010B	04/19/10	**7440-50-8**	**Copper**	2	**5**	
3010A	04/16/10	6010B	04/19/10	**7439-89-6**	**Iron**	50	**24,400**	
200.8	04/16/10	200.8	04/21/10	**7439-92-1**	**Lead**	1	**1**	
3010A	04/16/10	6010B	04/19/10	**7439-96-5**	**Manganese**	1	**4,380**	
7470A	04/16/10	7470A	04/19/10	7439-97-6	Mercury	0.1	0.1	U
3010A	04/16/10	6010B	04/19/10	**7440-02-0**	**Nickel**	10	**20**	
200.8	04/16/10	200.8	04/21/10	7782-49-2	Selenium	2	2	U
3010A	04/16/10	6010B	04/19/10	7440-22-4	Silver	3	3	U
200.8	04/16/10	200.8	04/21/10	7440-28-0	Thallium	0.2	0.2	U
3010A	04/16/10	6010B	04/19/10	**7440-66-6**	**Zinc**	10	**20**	

U-Analyte undetected at given RL
RL-Reporting Limit

INORGANICS ANALYSIS DATA SHEET
TOTAL METALS
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Sample ID: PD-107
SAMPLE

Lab Sample ID: QS91F
LIMS ID: 10-9691
Matrix: Water
Data Release Authorized:
Reported: 04/22/10

QC Report No: QS91-Floyd-Snider
Project: B&L Woodwaste 1412.2
B&L RIM T.1412.2
Date Sampled: 04/15/10
Date Received: 04/15/10

Prep Meth	Prep Date	Analysis Method	Analysis Date	CAS Number	Analyte	RL	µg/L	Q
3010A	04/16/10	6010B	04/19/10	7440-36-0	Antimony	50	50	U
200.8	04/16/10	200.8	04/21/10	**7440-38-2**	**Arsenic**	10	**4,150**	
3010A	04/16/10	6010B	04/19/10	**7440-39-3**	**Barium**	3	**146**	
3010A	04/16/10	6010B	04/19/10	7440-41-7	Beryllium	1	1	U
3010A	04/16/10	6010B	04/19/10	7440-43-9	Cadmium	2	2	U
3010A	04/16/10	6010B	04/19/10	7440-47-3	Chromium	5	5	U
3010A	04/16/10	6010B	04/19/10	**7440-50-8**	**Copper**	2	**10**	
3010A	04/16/10	6010B	04/19/10	**7439-89-6**	**Iron**	50	**48,300**	
200.8	04/16/10	200.8	04/21/10	**7439-92-1**	**Lead**	1	**7**	
3010A	04/16/10	6010B	04/19/10	**7439-96-5**	**Manganese**	1	**3,260**	
7470A	04/16/10	7470A	04/19/10	7439-97-6	Mercury	0.1	0.1	U
3010A	04/16/10	6010B	04/19/10	**7440-02-0**	**Nickel**	10	**30**	
200.8	04/16/10	200.8	04/21/10	7782-49-2	Selenium	2	2	U
3010A	04/16/10	6010B	04/19/10	7440-22-4	Silver	3	3	U
200.8	04/16/10	200.8	04/21/10	7440-28-0	Thallium	0.2	0.2	U
3010A	04/16/10	6010B	04/19/10	**7440-66-6**	**Zinc**	10	**80**	

U-Analyte undetected at given RL
RL-Reporting Limit

INORGANICS ANALYSIS DATA SHEET
TOTAL METALS
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Sample ID: METHOD BLANK

Lab Sample ID: QS91MB
LIMS ID: 10-9686
Matrix: Water
Data Release Authorized:
Reported: 04/22/10

QC Report No: QS91-Floyd-Snider
Project: B&L Woodwaste 1412.2
B&L RIM T.1412.2
Date Sampled: NA
Date Received: NA

Prep Meth	Prep Date	Analysis Method	Analysis Date	CAS Number	Analyte	RL	µg/L	Q
3010A	04/16/10	6010B	04/19/10	7440-36-0	Antimony	50	50	U
200.8	04/16/10	200.8	04/21/10	7440-38-2	Arsenic	0.2	0.2	U
3010A	04/16/10	6010B	04/19/10	7440-39-3	Barium	3	3	U
3010A	04/16/10	6010B	04/19/10	7440-41-7	Beryllium	1	1	U
3010A	04/16/10	6010B	04/19/10	7440-43-9	Cadmium	2	2	U
3010A	04/16/10	6010B	04/19/10	7440-47-3	Chromium	5	5	U
3010A	04/16/10	6010B	04/19/10	7440-50-8	Copper	2	2	U
3010A	04/16/10	6010B	04/19/10	7439-89-6	Iron	50	50	U
200.8	04/16/10	200.8	04/21/10	7439-92-1	Lead	1	1	U
3010A	04/16/10	6010B	04/19/10	7439-96-5	Manganese	1	1	U
7470A	04/16/10	7470A	04/19/10	7439-97-6	Mercury	0.1	0.1	U
3010A	04/16/10	6010B	04/19/10	7440-02-0	Nickel	10	10	U
200.8	04/16/10	200.8	04/21/10	7782-49-2	Selenium	0.5	0.5	U
3010A	04/16/10	6010B	04/19/10	7440-22-4	Silver	3	3	U
200.8	04/16/10	200.8	04/21/10	7440-28-0	Thallium	0.2	0.2	U
3010A	04/16/10	6010B	04/19/10	7440-66-6	Zinc	10	10	U

U-Analyte undetected at given RL
RL-Reporting Limit

INORGANICS ANALYSIS DATA SHEET
TOTAL METALS
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Sample ID: LAB CONTROL

Lab Sample ID: QS91LCS
LIMS ID: 10-9686
Matrix: Water
Data Release Authorized:
Reported: 04/22/10

QC Report No: QS91-Floyd-Snider
Project: B&L Woodwaste 1412.2
B&L RIM T.1412.2
Date Sampled: NA
Date Received: NA

BLANK SPIKE QUALITY CONTROL REPORT

Analyte	Analysis Method	Spike Found	Spike Added	% Recovery	Q
Antimony	6010B	2080	2000	104%	
Arsenic	200.8	26.0	25.0	104%	
Barium	6010B	2050	2000	102%	
Beryllium	6010B	501	500	100%	
Cadmium	6010B	528	500	106%	
Chromium	6010B	511	500	102%	
Copper	6010B	512	500	102%	
Iron	6010B	2050	2000	102%	
Lead	200.8	26	25	104%	
Manganese	6010B	489	500	97.8%	
Mercury	7470A	2.5	2.0	125%	N
Nickel	6010B	520	500	104%	
Selenium	200.8	79.8	80.0	99.8%	
Silver	6010B	542	500	108%	
Thallium	200.8	25.8	25.0	103%	
Zinc	6010B	510	500	102%	

Reported in µg/L

N-Control limit not met
Control Limits: 80-120%

INORGANICS ANALYSIS DATA SHEET
DISSOLVED METALS
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Sample ID: PZ-4B-F
SAMPLE

Lab Sample ID: QS91G
LIMS ID: 10-9692
Matrix: Water
Data Release Authorized:
Reported: 04/22/10

QC Report No: QS91-Floyd-Snider
Project: B&L Woodwaste 1412.2
B&L RIM T.1412.2
Date Sampled: 04/15/10
Date Received: 04/15/10

Prep Meth	Prep Date	Analysis Method	Analysis Date	CAS Number	Analyte	RL	µg/L	Q
6010B	04/16/10	6010B	04/19/10	7440-36-0	Antimony	50	50	U
200.8	04/16/10	200.8	04/21/10	**7440-38-2**	**Arsenic**	0.2	**2.2**	
6010B	04/16/10	6010B	04/19/10	**7440-39-3**	**Barium**	3	**24**	
6010B	04/16/10	6010B	04/19/10	7440-41-7	Beryllium	1	1	U
6010B	04/16/10	6010B	04/19/10	7440-43-9	Cadmium	2	2	U
6010B	04/16/10	6010B	04/19/10	**7440-70-2**	**Calcium**	50	**17,600**	
6010B	04/16/10	6010B	04/19/10	7440-47-3	Chromium	5	5	U
6010B	04/16/10	6010B	04/19/10	7440-50-8	Copper	2	2	U
6010B	04/16/10	6010B	04/19/10	**7439-89-6**	**Iron**	50	**7,990**	
200.8	04/16/10	200.8	04/21/10	7439-92-1	Lead	1	1	U
6010B	04/16/10	6010B	04/19/10	**7439-95-4**	**Magnesium**	50	**9,300**	
6010B	04/16/10	6010B	04/19/10	**7439-96-5**	**Manganese**	1	**271**	
7470A	04/16/10	7470A	04/19/10	7439-97-6	Mercury	0.1	0.1	U
6010B	04/16/10	6010B	04/19/10	7440-02-0	Nickel	10	10	U
6010B	04/16/10	6010B	04/19/10	**7440-09-7**	**Potassium**	500	**4,680**	
200.8	04/16/10	200.8	04/21/10	7782-49-2	Selenium	0.5	0.5	U
6010B	04/16/10	6010B	04/19/10	**7440-21-3**	**Silicon**	60	**21,100**	
6010B	04/16/10	6010B	04/19/10	7440-22-4	Silver	3	3	U
6010B	04/16/10	6010B	04/19/10	**7440-23-5**	**Sodium**	500	**21,400**	
200.8	04/16/10	200.8	04/21/10	7440-28-0	Thallium	0.2	0.2	U
6010B	04/16/10	6010B	04/19/10	7440-66-6	Zinc	10	10	U

U-Analyte undetected at given RL
RL-Reporting Limit

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DISSOLVED METALS
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Sample ID: PZ-8B-F
SAMPLE

Lab Sample ID: QS91H
LIMS ID: 10-9693
Matrix: Water
Data Release Authorized:
Reported: 04/22/10

QC Report No: QS91-Floyd-Snider
Project: B&L Woodwaste 1412.2
B&L RIM T.1412.2
Date Sampled: 04/15/10
Date Received: 04/15/10

Prep Meth	Prep Date	Analysis Method	Analysis Date	CAS Number	Analyte	RL	µg/L	Q
6010B	04/16/10	6010B	04/19/10	7440-36-0	Antimony	50	50	U
200.8	04/16/10	200.8	04/21/10	**7440-38-2**	**Arsenic**	0.2	**16.8**	
6010B	04/16/10	6010B	04/19/10	**7440-39-3**	**Barium**	3	**9**	
6010B	04/16/10	6010B	04/19/10	7440-41-7	Beryllium	1	1	U
6010B	04/16/10	6010B	04/19/10	7440-43-9	Cadmium	2	2	U
6010B	04/16/10	6010B	04/19/10	**7440-70-2**	**Calcium**	50	**14,200**	
6010B	04/16/10	6010B	04/19/10	7440-47-3	Chromium	5	5	U
6010B	04/16/10	6010B	04/19/10	7440-50-8	Copper	2	2	U
6010B	04/16/10	6010B	04/19/10	**7439-89-6**	**Iron**	50	**530**	
200.8	04/16/10	200.8	04/21/10	7439-92-1	Lead	1	1	U
6010B	04/16/10	6010B	04/19/10	**7439-95-4**	**Magnesium**	50	**13,000**	
6010B	04/16/10	6010B	04/19/10	**7439-96-5**	**Manganese**	1	**850**	
7470A	04/16/10	7470A	04/19/10	7439-97-6	Mercury	0.1	0.1	U
6010B	04/16/10	6010B	04/19/10	7440-02-0	Nickel	10	10	U
6010B	04/16/10	6010B	04/19/10	**7440-09-7**	**Potassium**	500	**3,280**	
200.8	04/16/10	200.8	04/21/10	7782-49-2	Selenium	0.5	0.5	U
6010B	04/16/10	6010B	04/19/10	**7440-21-3**	**Silicon**	60	**19,700**	
6010B	04/16/10	6010B	04/19/10	7440-22-4	Silver	3	3	U
6010B	04/16/10	6010B	04/19/10	**7440-23-5**	**Sodium**	500	**19,500**	
200.8	04/16/10	200.8	04/21/10	7440-28-0	Thallium	0.2	0.2	U
6010B	04/16/10	6010B	04/19/10	7440-66-6	Zinc	10	10	U

U-Analyte undetected at given RL
RL-Reporting Limit

INORGANICS ANALYSIS DATA SHEET
DISSOLVED METALS
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Sample ID: PD-109-F
SAMPLE

Lab Sample ID: QS91I
LIMS ID: 10-9694
Matrix: Water
Data Release Authorized:
Reported: 04/22/10

QC Report No: QS91-Floyd-Snider
Project: B&L Woodwaste 1412.2
B&L RIM T.1412.2
Date Sampled: 04/15/10
Date Received: 04/15/10

Prep Meth	Prep Date	Analysis Method	Analysis Date	CAS Number	Analyte	RL	µg/L	Q
6010B	04/16/10	6010B	04/19/10	7440-36-0	Antimony	50	50	U
200.8	04/16/10	200.8	04/21/10	**7440-38-2**	**Arsenic**	0.5	**190**	
6010B	04/16/10	6010B	04/19/10	**7440-39-3**	**Barium**	3	**164**	
6010B	04/16/10	6010B	04/19/10	7440-41-7	Beryllium	1	1	U
6010B	04/16/10	6010B	04/19/10	7440-43-9	Cadmium	2	2	U
6010B	04/16/10	6010B	04/19/10	**7440-70-2**	**Calcium**	50	**59,000**	
6010B	04/16/10	6010B	04/19/10	7440-47-3	Chromium	5	5	U
6010B	04/16/10	6010B	04/19/10	7440-50-8	Copper	2	2	U
6010B	04/16/10	6010B	04/19/10	**7439-89-6**	**Iron**	50	**69,500**	
200.8	04/16/10	200.8	04/21/10	7439-92-1	Lead	1	1	U
6010B	04/16/10	6010B	04/19/10	**7439-95-4**	**Magnesium**	50	**39,600**	
6010B	04/16/10	6010B	04/19/10	**7439-96-5**	**Manganese**	1	**2,160**	
7470A	04/16/10	7470A	04/19/10	7439-97-6	Mercury	0.1	0.1	U
6010B	04/16/10	6010B	04/19/10	7440-02-0	Nickel	10	10	U
6010B	04/16/10	6010B	04/19/10	**7440-09-7**	**Potassium**	500	**6,360**	
200.8	04/16/10	200.8	04/21/10	7782-49-2	Selenium	2	2	U
6010B	04/16/10	6010B	04/19/10	**7440-21-3**	**Silicon**	60	**28,000**	
6010B	04/16/10	6010B	04/19/10	7440-22-4	Silver	3	3	U
6010B	04/16/10	6010B	04/19/10	**7440-23-5**	**Sodium**	500	**29,300**	
200.8	04/16/10	200.8	04/21/10	7440-28-0	Thallium	0.2	0.2	U
6010B	04/16/10	6010B	04/19/10	7440-66-6	Zinc	10	10	U

U-Analyte undetected at given RL
RL-Reporting Limit

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DISSOLVED METALS
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Sample ID: PZ-9-F
SAMPLE

Lab Sample ID: QS91J
LIMS ID: 10-9695
Matrix: Water
Data Release Authorized:
Reported: 04/22/10

QC Report No: QS91-Floyd-Snider
Project: B&L Woodwaste 1412.2
B&L RIM T.1412.2
Date Sampled: 04/15/10
Date Received: 04/15/10

Prep Meth	Prep Date	Analysis Method	Analysis Date	CAS Number	Analyte	RL	µg/L	Q
6010B	04/16/10	6010B	04/19/10	7440-36-0	Antimony	50	50	U
200.8	04/16/10	200.8	04/21/10	**7440-38-2**	**Arsenic**	2	**1,710**	
6010B	04/16/10	6010B	04/19/10	**7440-39-3**	**Barium**	3	**109**	
6010B	04/16/10	6010B	04/19/10	7440-41-7	Beryllium	1	1	U
6010B	04/16/10	6010B	04/19/10	7440-43-9	Cadmium	2	2	U
6010B	04/16/10	6010B	04/19/10	**7440-70-2**	**Calcium**	50	**116,000**	
6010B	04/16/10	6010B	04/19/10	7440-47-3	Chromium	5	5	U
6010B	04/16/10	6010B	04/19/10	7440-50-8	Copper	2	2	U
6010B	04/16/10	6010B	04/19/10	**7439-89-6**	**Iron**	50	**76,100**	
200.8	04/16/10	200.8	04/21/10	7439-92-1	Lead	1	1	U
6010B	04/16/10	6010B	04/19/10	**7439-95-4**	**Magnesium**	50	**66,100**	
6010B	04/16/10	6010B	04/19/10	**7439-96-5**	**Manganese**	1	**3,950**	
7470A	04/16/10	7470A	04/19/10	7439-97-6	Mercury	0.1	0.1	U
6010B	04/16/10	6010B	04/19/10	7440-02-0	Nickel	10	10	U
6010B	04/16/10	6010B	04/19/10	**7440-09-7**	**Potassium**	500	**12,200**	
200.8	04/16/10	200.8	04/21/10	7782-49-2	Selenium	2	2	U
6010B	04/16/10	6010B	04/19/10	**7440-21-3**	**Silicon**	60	**30,600**	
6010B	04/16/10	6010B	04/19/10	7440-22-4	Silver	3	3	U
6010B	04/16/10	6010B	04/19/10	**7440-23-5**	**Sodium**	500	**68,000**	
200.8	04/16/10	200.8	04/21/10	7440-28-0	Thallium	0.2	0.2	U
6010B	04/16/10	6010B	04/19/10	7440-66-6	Zinc	10	10	U

U-Analyte undetected at given RL
RL-Reporting Limit

ANALYTICAL RESOURCES INCORPORATED

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Sample ID: PZ-12-F
SAMPLE

Lab Sample ID: QS91K
LIMS ID: 10-9696
Matrix: Water
Data Release Authorized:
Reported: 04/22/10

QC Report No: QS91-Floyd-Snider
Project: B&L Woodwaste 1412.2
B&L RIM T.1412.2
Date Sampled: 04/15/10
Date Received: 04/15/10

Prep Meth	Prep Date	Analysis Method	Analysis Date	CAS Number	Analyte	RL	µg/L	Q
6010B	04/16/10	6010B	04/19/10	7440-36-0	Antimony	50	50	U
200.8	04/16/10	200.8	04/21/10	**7440-38-2**	**Arsenic**	2	**1,360**	
6010B	04/16/10	6010B	04/19/10	**7440-39-3**	**Barium**	3	**72**	
6010B	04/16/10	6010B	04/19/10	7440-41-7	Beryllium	1	1	U
6010B	04/16/10	6010B	04/19/10	7440-43-9	Cadmium	2	2	U
6010B	04/16/10	6010B	04/19/10	**7440-70-2**	**Calcium**	50	**69,100**	
6010B	04/16/10	6010B	04/19/10	7440-47-3	Chromium	5	5	U
6010B	04/16/10	6010B	04/19/10	7440-50-8	Copper	2	2	U
6010B	04/16/10	6010B	04/19/10	**7439-89-6**	**Iron**	50	**23,000**	
200.8	04/16/10	200.8	04/21/10	7439-92-1	Lead	1	1	U
6010B	04/16/10	6010B	04/19/10	**7439-95-4**	**Magnesium**	50	**41,600**	
6010B	04/16/10	6010B	04/19/10	**7439-96-5**	**Manganese**	1	**4,480**	
7470A	04/16/10	7470A	04/19/10	7439-97-6	Mercury	0.1	0.1	U
6010B	04/16/10	6010B	04/19/10	**7440-02-0**	**Nickel**	10	**20**	
6010B	04/16/10	6010B	04/19/10	**7440-09-7**	**Potassium**	500	**11,900**	
200.8	04/16/10	200.8	04/21/10	7782-49-2	Selenium	2	2	U
6010B	04/16/10	6010B	04/19/10	**7440-21-3**	**Silicon**	60	**24,200**	
6010B	04/16/10	6010B	04/19/10	7440-22-4	Silver	3	3	U
6010B	04/16/10	6010B	04/19/10	**7440-23-5**	**Sodium**	500	**86,300**	
200.8	04/16/10	200.8	04/21/10	7440-28-0	Thallium	0.2	0.2	U
6010B	04/16/10	6010B	04/19/10	**7440-66-6**	**Zinc**	10	**10**	

U-Analyte undetected at given RL
RL-Reporting Limit

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Sample ID: PD-107F
SAMPLE

Lab Sample ID: QS91L
LIMS ID: 10-9697
Matrix: Water
Data Release Authorized:
Reported: 04/22/10

QC Report No: QS91-Floyd-Snider
Project: B&L Woodwaste 1412.2
B&L RIM T.1412.2
Date Sampled: 04/15/10
Date Received: 04/15/10

Prep Meth	Prep Date	Analysis Method	Analysis Date	CAS Number	Analyte	RL	µg/L	Q
6010B	04/16/10	6010B	04/19/10	7440-36-0	Antimony	50	50	U
200.8	04/16/10	200.8	04/21/10	**7440-38-2**	**Arsenic**	10	**4,260**	
6010B	04/16/10	6010B	04/19/10	**7440-39-3**	**Barium**	3	**129**	
6010B	04/16/10	6010B	04/19/10	7440-41-7	Beryllium	1	1	U
6010B	04/16/10	6010B	04/19/10	7440-43-9	Cadmium	2	2	U
6010B	04/16/10	6010B	04/19/10	**7440-70-2**	**Calcium**	50	**130,000**	
6010B	04/16/10	6010B	04/19/10	7440-47-3	Chromium	5	5	U
6010B	04/16/10	6010B	04/19/10	7440-50-8	Copper	2	2	U
6010B	04/16/10	6010B	04/19/10	**7439-89-6**	**Iron**	50	**46,700**	
200.8	04/16/10	200.8	04/21/10	7439-92-1	Lead	1	1	U
6010B	04/16/10	6010B	04/19/10	**7439-95-4**	**Magnesium**	50	**103,000**	
6010B	04/16/10	6010B	04/19/10	**7439-96-5**	**Manganese**	1	**3,320**	
7470A	04/16/10	7470A	04/19/10	7439-97-6	Mercury	0.1	0.1	U
6010B	04/16/10	6010B	04/19/10	**7440-02-0**	**Nickel**	10	**20**	
6010B	04/16/10	6010B	04/19/10	**7440-09-7**	**Potassium**	500	**20,600**	
200.8	04/16/10	200.8	04/21/10	7782-49-2	Selenium	2	2	U
6010B	04/16/10	6010B	04/19/10	**7440-21-3**	**Silicon**	60	**37,500**	
6010B	04/16/10	6010B	04/19/10	7440-22-4	Silver	3	3	U
6010B	04/16/10	6010B	04/19/10	**7440-23-5**	**Sodium**	500	**37,500**	
200.8	04/16/10	200.8	04/21/10	7440-28-0	Thallium	0.2	0.2	U
6010B	04/16/10	6010B	04/19/10	**7440-66-6**	**Zinc**	10	**40**	

U-Analyte undetected at given RL
RL-Reporting Limit

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Sample ID: METHOD BLANK

Lab Sample ID: QS91MB
LIMS ID: 10-9692
Matrix: Water
Data Release Authorized:
Reported: 04/22/10

QC Report No: QS91-Floyd-Snider
Project: B&L Woodwaste 1412.2
B&L RIM T.1412.2
Date Sampled: NA
Date Received: NA

Prep Meth	Prep Date	Analysis Method	Analysis Date	CAS Number	Analyte	RL	µg/L	Q
6010B	04/16/10	6010B	04/19/10	7440-36-0	Antimony	50	50	U
200.8	04/16/10	200.8	04/21/10	7440-38-2	Arsenic	0.2	0.2	U
6010B	04/16/10	6010B	04/19/10	7440-39-3	Barium	3	3	U
6010B	04/16/10	6010B	04/19/10	7440-41-7	Beryllium	1	1	U
6010B	04/16/10	6010B	04/19/10	7440-43-9	Cadmium	2	2	U
6010B	04/16/10	6010B	04/19/10	7440-70-2	Calcium	50	50	U
6010B	04/16/10	6010B	04/19/10	7440-47-3	Chromium	5	5	U
6010B	04/16/10	6010B	04/19/10	7440-50-8	Copper	2	2	U
6010B	04/16/10	6010B	04/19/10	7439-89-6	Iron	50	50	U
200.8	04/16/10	200.8	04/21/10	7439-92-1	Lead	1	1	U
6010B	04/16/10	6010B	04/19/10	7439-95-4	Magnesium	50	50	U
6010B	04/16/10	6010B	04/19/10	7439-96-5	Manganese	1	1	U
7470A	04/16/10	7470A	04/19/10	7439-97-6	Mercury	0.1	0.1	U
6010B	04/16/10	6010B	04/19/10	7440-02-0	Nickel	10	10	U
6010B	04/16/10	6010B	04/19/10	7440-09-7	Potassium	500	500	U
200.8	04/16/10	200.8	04/21/10	7782-49-2	Selenium	0.5	0.5	U
6010B	04/16/10	6010B	04/19/10	7440-21-3	Silicon	60	60	U
6010B	04/16/10	6010B	04/19/10	7440-22-4	Silver	3	3	U
6010B	04/16/10	6010B	04/19/10	7440-23-5	Sodium	500	500	U
200.8	04/16/10	200.8	04/21/10	7440-28-0	Thallium	0.2	0.2	U
6010B	04/16/10	6010B	04/19/10	7440-66-6	Zinc	10	10	U

U-Analyte undetected at given RL
RL-Reporting Limit

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Sample ID: LAB CONTROL

Lab Sample ID: QS91LCS
LIMS ID: 10-9692
Matrix: Water
Data Release Authorized:
Reported: 04/22/10

QC Report No: QS91-Floyd-Snider
Project: B&L Woodwaste 1412.2
B&L RIM T.1412.2
Date Sampled: NA
Date Received: NA

BLANK SPIKE QUALITY CONTROL REPORT

Analyte	Analysis Method	Spike Found	Spike Added	% Recovery	Q
Antimony	6010B	2130	2000	106%	
Arsenic	200.8	26.2	25.0	105%	
Barium	6010B	1800	2000	90.0%	
Beryllium	6010B	453	500	90.6%	
Cadmium	6010B	518	500	104%	
Calcium	6010B	9300	10000	93.0%	
Chromium	6010B	456	500	91.2%	
Copper	6010B	458	500	91.6%	
Iron	6010B	1930	2000	96.5%	
Lead	200.8	26	25	104%	
Magnesium	6010B	9470	10000	94.7%	
Manganese	6010B	430	500	86.0%	
Mercury	7470A	2.4	2.0	120%	
Nickel	6010B	470	500	94.0%	
Potassium	6010B	9760	10000	97.6%	
Selenium	200.8	80.4	80.0	100%	
Silicon	6010B	9240	10000	92.4%	
Silver	6010B	501	500	100%	
Sodium	6010B	9370	10000	93.7%	
Thallium	200.8	25.9	25.0	104%	
Zinc	6010B	480	500	96.0%	

Reported in µg/L

N-Control limit not met
Control Limits: 80-120%

SAMPLE RESULTS-CONVENTIONALS
QU48-Floyd-Snider

Matrix: Groundwater
Data Release Authorized:
Reported: 05/13/10

Project: B&L RIM
Event: B&L-RIM T.1313.1
Date Sampled: 04/27/10
Date Received: 04/27/10

Client ID: PZ-3B
ARI ID: 10-10452 QU48A

Analyte	Date Batch	Method	Units	RL	Sample
Alkalinity	04/30/10 043010#1	SM 2320	mg/L CaCO3	1.0	688
Carbonate	04/30/10	SM 2320	mg/L CaCO3	1.0	< 1.0 U
Bicarbonate	04/30/10	SM 2320	mg/L CaCO3	1.0	688
Hydroxide	04/30/10	SM 2320	mg/L CaCO3	1.0	< 1.0 U
Total Dissolved Solids	05/03/10 050310#1	EPA 160.1	mg/L	13.3	737

RL	Analytical reporting limit
U	Undetected at reported detection limit

SAMPLE RESULTS-CONVENTIONALS
QU48-Floyd-Snider

Matrix: Groundwater
Data Release Authorized:
Reported: 05/13/10

Project: B&L RIM
Event: B&L-RIM T.1313.1
Date Sampled: 04/27/10
Date Received: 04/27/10

Client ID: PZ-5B
ARI ID: 10-10453 QU48B

Analyte	**Date Batch**	**Method**	**Units**	**RL**	**Sample**
Alkalinity	04/30/10 043010#1	SM 2320	mg/L CaCO3	1.0	157
Carbonate	04/30/10	SM 2320	mg/L CaCO3	1.0	< 1.0 U
Bicarbonate	04/30/10	SM 2320	mg/L CaCO3	1.0	157
Hydroxide	04/30/10	SM 2320	mg/L CaCO3	1.0	< 1.0 U
Total Dissolved Solids	05/03/10 050310#1	EPA 160.1	mg/L	5.0	228

RL	Analytical reporting limit
U	Undetected at reported detection limit

SAMPLE RESULTS-CONVENTIONALS
QU48-Floyd-Snider

Matrix: Groundwater
Data Release Authorized:
Reported: 05/13/10

Project: B&L RIM
Event: B&L-RIM T.1313.1
Date Sampled: 04/27/10
Date Received: 04/27/10

Client ID: PZ-6B
ARI ID: 10-10454 QU48C

Analyte	**Date Batch**	**Method**	**Units**	**RL**	**Sample**
Alkalinity	04/30/10 043010#1	SM 2320	mg/L CaCO3	1.0	538
Carbonate	04/30/10	SM 2320	mg/L CaCO3	1.0	< 1.0 U
Bicarbonate	04/30/10	SM 2320	mg/L CaCO3	1.0	538
Hydroxide	04/30/10	SM 2320	mg/L CaCO3	1.0	< 1.0 U
Total Dissolved Solids	05/03/10 050310#1	EPA 160.1	mg/L	10.0	630

RL = Analytical reporting limit
U = Undetected at reported detection limit

SAMPLE RESULTS-CONVENTIONALS
QU48-Floyd-Snider

ANALYTICAL
RESOURCES
INCORPORATED

Matrix: Groundwater
Data Release Authorized:
Reported: 05/13/10

Project: B&L RIM
Event: B&L-RIM T.1313.1
Date Sampled: 04/27/10
Date Received: 04/27/10

Client ID: PZ-2B
ARI ID: 10-10455 QU48D

Analyte	Date Batch	Method	Units	RL	Sample
Alkalinity	04/30/10 043010#1	SM 2320	mg/L CaCO3	1.0	627
Carbonate	04/30/10	SM 2320	mg/L CaCO3	1.0	< 1.0 U
Bicarbonate	04/30/10	SM 2320	mg/L CaCO3	1.0	627
Hydroxide	04/30/10	SM 2320	mg/L CaCO3	1.0	< 1.0 U
Total Dissolved Solids	05/03/10 050310#1	EPA 160.1	mg/L	13.3	925

RL	Analytical reporting limit
U	Undetected at reported detection limit

SAMPLE RESULTS-CONVENTIONALS
QU48-Floyd-Snider

Matrix: Groundwater
Data Release Authorized:
Reported: 05/13/10

Project: B&L RIM
Event: B&L-RIM T.1313.1
Date Sampled: 04/27/10
Date Received: 04/27/10

Client ID: PZ-1B
ARI ID: 10-10456 QU48E

Analyte	**Date Batch**	**Method**	**Units**	**RL**	**Sample**
Alkalinity	04/30/10 043010#1	SM 2320	mg/L CaCO3	1.0	545
Carbonate	04/30/10	SM 2320	mg/L CaCO3	1.0	< 1.0 U
Bicarbonate	04/30/10	SM 2320	mg/L CaCO3	1.0	545
Hydroxide	04/30/10	SM 2320	mg/L CaCO3	1.0	< 1.0 U
Total Dissolved Solids	05/03/10 050310#1	EPA 160.1	mg/L	10.0	549

RL	Analytical reporting limit
U	Undetected at reported detection limit

SAMPLE RESULTS-CONVENTIONALS
QU48-Floyd-Snider

ANALYTICAL RESOURCES INCORPORATED

Matrix: Groundwater
Data Release Authorized:
Reported: 05/13/10

Project: B&L RIM
Event: B&L-RIM T.1313.1
Date Sampled: 04/27/10
Date Received: 04/27/10

Client ID: PZ-7B
ARI ID: 10-10457 QU48F

Analyte	Date Batch	Method	Units	RL	Sample
Alkalinity	04/30/10 043010#1	SM 2320	mg/L CaCO3	1.0	525
Carbonate	04/30/10	SM 2320	mg/L CaCO3	1.0	< 1.0 U
Bicarbonate	04/30/10	SM 2320	mg/L CaCO3	1.0	525
Hydroxide	04/30/10	SM 2320	mg/L CaCO3	1.0	< 1.0 U
Total Dissolved Solids	05/03/10 050310#1	EPA 160.1	mg/L	10.0	553

RL	Analytical reporting limit
U	Undetected at reported detection limit

SAMPLE RESULTS-CONVENTIONALS
QU48-Floyd-Snider

Matrix: Groundwater
Data Release Authorized:
Reported: 05/13/10

Project: B&L RIM
Event: B&L-RIM T.1313.1
Date Sampled: 04/27/10
Date Received: 04/27/10

Client ID: PZ-8C
ARI ID: 10-10458 QU48G

Analyte	**Date Batch**	**Method**	**Units**	**RL**	**Sample**
Alkalinity	04/30/10 043010#1	SM 2320	mg/L CaCO3	1.0	144
Carbonate	04/30/10	SM 2320	mg/L CaCO3	1.0	< 1.0 U
Bicarbonate	04/30/10	SM 2320	mg/L CaCO3	1.0	144
Hydroxide	04/30/10	SM 2320	mg/L CaCO3	1.0	< 1.0 U
Total Dissolved Solids	05/03/10 050310#1	EPA 160.1	mg/L	5.0	163

RL	Analytical reporting limit
U	Undetected at reported detection limit

SAMPLE RESULTS-CONVENTIONALS
QU48-Floyd-Snider

Matrix: Groundwater
Data Release Authorized:
Reported: 05/13/10

Project: B&L RIM
Event: B&L-RIM T.1313.1
Date Sampled: 04/27/10
Date Received: 04/27/10

Client ID: PZ-4C
ARI ID: 10-10459 QU48H

Analyte	**Date Batch**	**Method**	**Units**	**RL**	**Sample**
Alkalinity	04/30/10 043010#1	SM 2320	mg/L CaCO3	1.0	129
Carbonate	04/30/10	SM 2320	mg/L CaCO3	1.0	< 1.0 U
Bicarbonate	04/30/10	SM 2320	mg/L CaCO3	1.0	129
Hydroxide	04/30/10	SM 2320	mg/L CaCO3	1.0	< 1.0 U
Total Dissolved Solids	05/03/10 050310#1	EPA 160.1	mg/L	5.0	164

RL	Analytical reporting limit
U	Undetected at reported detection limit

SAMPLE RESULTS-CONVENTIONALS
QU48-Floyd-Snider

Matrix: Groundwater
Data Release Authorized:
Reported: 05/13/10

Project: B&L RIM
Event: B&L-RIM T.1313.1
Date Sampled: 04/27/10
Date Received: 04/27/10

Client ID: PZ-10
ARI ID: 10-10460 QU48I

Analyte	Date Batch	Method	Units	RL	Sample
Alkalinity	04/30/10 043010#1	SM 2320	mg/L CaCO3	1.0	923
Carbonate	04/30/10	SM 2320	mg/L CaCO3	1.0	< 1.0 U
Bicarbonate	04/30/10	SM 2320	mg/L CaCO3	1.0	923
Hydroxide	04/30/10	SM 2320	mg/L CaCO3	1.0	< 1.0 U
Total Dissolved Solids	05/03/10 050310#1	EPA 160.1	mg/L	13.3	937

RL	Analytical reporting limit
U	Undetected at reported detection limit

SAMPLE RESULTS-CONVENTIONALS
QU48-Floyd-Snider

ANALYTICAL RESOURCES INCORPORATED

Matrix: Groundwater
Data Release Authorized:
Reported: 05/13/10

Project: B&L RIM
Event: B&L-RIM T.1313.1
Date Sampled: 04/27/10
Date Received: 04/27/10

Client ID: PZ-11
ARI ID: 10-10461 QU48J

Analyte	**Date Batch**	**Method**	**Units**	**RL**	**Sample**
Alkalinity	04/30/10 043010#1	SM 2320	mg/L CaCO3	1.0	660
Carbonate	04/30/10	SM 2320	mg/L CaCO3	1.0	< 1.0 U
Bicarbonate	04/30/10	SM 2320	mg/L CaCO3	1.0	660
Hydroxide	04/30/10	SM 2320	mg/L CaCO3	1.0	< 1.0 U
Total Dissolved Solids	05/03/10 050310#1	EPA 160.1	mg/L	13.3	649

RL	Analytical reporting limit
U	Undetected at reported detection limit

SAMPLE RESULTS-CONVENTIONALS
QU48-Floyd-Snider

ANALYTICAL RESOURCES INCORPORATED

Matrix: Groundwater
Data Release Authorized:
Reported: 05/13/10

Project: B&L RIM
Event: B&L-RIM T.1313.1
Date Sampled: 04/27/10
Date Received: 04/27/10

Client ID: PZ-13
ARI ID: 10-10462 QU48K

Analyte	**Date Batch**	**Method**	**Units**	**RL**	**Sample**
Alkalinity	04/30/10 043010#1	SM 2320	mg/L CaCO3	1.0	567
Carbonate	04/30/10	SM 2320	mg/L CaCO3	1.0	< 1.0 U
Bicarbonate	04/30/10	SM 2320	mg/L CaCO3	1.0	567
Hydroxide	04/30/10	SM 2320	mg/L CaCO3	1.0	< 1.0 U
Total Dissolved Solids	05/03/10 050310#1	EPA 160.1	mg/L	10.0	633

RL	Analytical reporting limit
U	Undetected at reported detection limit

METHOD BLANK RESULTS-CONVENTIONALS
QU48-Floyd-Snider

ANALYTICAL RESOURCES INCORPORATED

Matrix: Groundwater
Data Release Authorized:
Reported: 05/13/10

Project: B&L RIM
Event: B&L-RIM T.1313.1
Date Sampled: NA
Date Received: NA

Analyte	Method	Date	Units	Blank	ID
Total Dissolved Solids	EPA 160.1	05/03/10	mg/L	< 5.0 U	

LAB CONTROL RESULTS-CONVENTIONALS
QU48-Floyd-Snider

ANALYTICAL RESOURCES INCORPORATED

Matrix: Groundwater
Data Release Authorized:
Reported: 05/13/10

Project: B&L RIM
Event: B&L-RIM T.1313.1
Date Sampled: NA
Date Received: NA

Analyte/Method	QC ID	Date	Units	LCS	Spike Added	Recovery
Total Dissolved Solids EPA 160.1	ICVL	05/03/10	mg/L	427 15	500	85.4%

STANDARD REFERENCE RESULTS-CONVENTIONALS
QU48-Floyd-Snider

Matrix: Groundwater
Data Release Authorized:
Reported: 05/13/10

Project: B&L RIM
Event: B&L-RIM T.1313.1
Date Sampled: NA
Date Received: NA

Analyte/SRM ID	**Method**	**Date**	**Units**	**SRM**	**True Value**	**Recovery**
Alkalinity ERA #P114506	SM 2320	04/30/10	mg/L CaCO3	34.1	35.0	97.4%

REPLICATE RESULTS-CONVENTIONALS
QU48-Floyd-Snider

Matrix: Groundwater
Data Release Authorized:
Reported: 05/13/10

Project: B&L RIM
Event: B&L-RIM T.1313.1
Date Sampled: 04/27/10
Date Received: 04/27/10

Analyte	Method	Date	Units	Sample	Replicate(s)	RPD/RSD
ARI ID: QU48A Client ID: PZ-3B						
Alkalinity	SM 2320	04/30/10	mg/L CaCO3	688	687	0.1%
Carbonate	SM 2320	04/30/10	mg/L CaCO3	< 1.0	< 1.0	NA
Bicarbonate	SM 2320	04/30/10	mg/L CaCO3	688	687	0.1%
Hydroxide	SM 2320	04/30/10	mg/L CaCO3	< 1.0	< 1.0	NA
Total Dissolved Solids	EPA 160.1	05/03/10	mg/L	737	759	2.9%

Preliminary Inorganics
Analysis Data Sheet

CLIENTID	LIMSID	MATRIX	JOB	SAMPLE	METH	EL	VALUE	UNITS	C
PZ-3B	10-10452TC	Water	QU48	A	PMS	AS		mg/L	
PZ-3B	10-10452TC	Water	QU48	A	ICP	CA	109.15329	mg/L	
PZ-3B	10-10452TC	Water	QU48	A	PMS	CU		mg/L	
PZ-3B	10-10452TC	Water	QU48	A	ICP	FE	60.58015	mg/L	
PZ-3B	10-10452TC	Water	QU48	A	ICP	MG	58.14458	mg/L	
PZ-3B	10-10452TC	Water	QU48	A	ICP	MN	5.46858	mg/L	
PZ-3B	10-10452TC	Water	QU48	A	PMS	PB		mg/L	
PZ-3B	10-10452TC	Water	QU48	A	PMS	ZN		mg/L	
PZ-5B	10-10453TC	Water	QU48	B	PMS	AS		mg/L	
PZ-5B	10-10453TC	Water	QU48	B	ICP	CA	18.57951	mg/L	
PZ-5B	10-10453TC	Water	QU48	B	PMS	CU		mg/L	
PZ-5B	10-10453TC	Water	QU48	B	ICP	FE	2.06448	mg/L	
PZ-5B	10-10453TC	Water	QU48	B	ICP	MG	9.63135	mg/L	
PZ-5B	10-10453TC	Water	QU48	B	ICP	MN	1.31453	mg/L	
PZ-5B	10-10453TC	Water	QU48	B	PMS	PB		mg/L	
PZ-5B	10-10453TC	Water	QU48	B	PMS	ZN		mg/L	
PZ-6B	10-10454TC	Water	QU48	C	PMS	AS		mg/L	
PZ-6B	10-10454TC	Water	QU48	C	ICP	CA	85.49930	mg/L	
PZ-6B	10-10454TC	Water	QU48	C	PMS	CU		mg/L	
PZ-6B	10-10454TC	Water	QU48	C	ICP	FE	21.97037	mg/L	
PZ-6B	10-10454TC	Water	QU48	C	ICP	MG	51.29717	mg/L	
PZ-6B	10-10454TC	Water	QU48	C	ICP	MN	4.55156	mg/L	
PZ-6B	10-10454TC	Water	QU48	C	PMS	PB		mg/L	
PZ-6B	10-10454TC	Water	QU48	C	PMS	ZN		mg/L	
PZ-2B	10-10455TC	Water	QU48	D	PMS	AS		mg/L	
PZ-2B	10-10455TC	Water	QU48	D	ICP	CA	102.03016	mg/L	
PZ-2B	10-10455TC	Water	QU48	D	PMS	CU		mg/L	
PZ-2B	10-10455TC	Water	QU48	D	ICP	FE	58.56759	mg/L	
PZ-2B	10-10455TC	Water	QU48	D	ICP	MG	54.88788	mg/L	
PZ-2B	10-10455TC	Water	QU48	D	ICP	MN	5.74424	mg/L	
PZ-2B	10-10455TC	Water	QU48	D	PMS	PB		mg/L	
PZ-2B	10-10455TC	Water	QU48	D	PMS	ZN		mg/L	
PZ-1B	10-10456TC	Water	QU48	E	PMS	AS		mg/L	
PZ-1B	10-10456TC	Water	QU48	E	ICP	CA	74.54358	mg/L	
PZ-1B	10-10456TC	Water	QU48	E	PMS	CU		mg/L	
PZ-1B	10-10456TC	Water	QU48	E	ICP	FE	88.49567	mg/L	
PZ-1B	10-10456TC	Water	QU48	E	ICP	MG	49.38497	mg/L	
PZ-1B	10-10456TC	Water	QU48	E	ICP	MN	2.60573	mg/L	
PZ-1B	10-10456TC	Water	QU48	E	PMS	PB		mg/L	
PZ-1B	10-10456TC	Water	QU48	E	PMS	ZN		mg/L	
PZ-7B	10-10457TC	Water	QU48	F	PMS	AS		mg/L	
PZ-7B	10-10457TC	Water	QU48	F	ICP	CA	75.10627	mg/L	
PZ-7B	10-10457TC	Water	QU48	F	PMS	CU		mg/L	
PZ-7B	10-10457TC	Water	QU48	F	ICP	FE	21.50343	mg/L	
PZ-7B	10-10457TC	Water	QU48	F	ICP	MG	39.70014	mg/L	
PZ-7B	10-10457TC	Water	QU48	F	ICP	MN	4.34963	mg/L	
PZ-7B	10-10457TC	Water	QU48	F	PMS	PB		mg/L	

METH	Analysis Method
EL	Analyte (Element)
C	Concentration Qualifier
U	Analyte undetected at RL (printed as 'VALUE')

Preliminary Inorganics
Analysis Data Sheet

CLIENTID	LIMSID	MATRIX	JOB	SAMPLE	METH	EL	VALUE	UNITS	C
PZ-7B	10-10457TC	Water	QU48	F	PMS	ZN		mg/L	
PZ-8C	10-10458TC	Water	QU48	G	PMS	AS		mg/L	
PZ-8C	10-10458TC	Water	QU48	G	ICP	CA	14.58855	mg/L	
PZ-8C	10-10458TC	Water	QU48	G	PMS	CU		mg/L	
PZ-8C	10-10458TC	Water	QU48	G	ICP	FE	0.13250	mg/L	
PZ-8C	10-10458TC	Water	QU48	G	ICP	MG	15.73600	mg/L	
PZ-8C	10-10458TC	Water	QU48	G	ICP	MN	0.18821	mg/L	
PZ-8C	10-10458TC	Water	QU48	G	PMS	PB		mg/L	
PZ-8C	10-10458TC	Water	QU48	G	PMS	ZN		mg/L	
PZ-4C	10-10459TC	Water	QU48	H	PMS	AS		mg/L	
PZ-4C	10-10459TC	Water	QU48	H	ICP	CA	15.79717	mg/L	
PZ-4C	10-10459TC	Water	QU48	H	PMS	CU		mg/L	
PZ-4C	10-10459TC	Water	QU48	H	ICP	FE	7.58532	mg/L	
PZ-4C	10-10459TC	Water	QU48	H	ICP	MG	8.72212	mg/L	
PZ-4C	10-10459TC	Water	QU48	H	ICP	MN	0.30651	mg/L	
PZ-4C	10-10459TC	Water	QU48	H	PMS	PB		mg/L	
PZ-4C	10-10459TC	Water	QU48	H	PMS	ZN		mg/L	
PZ-10	10-10460TC	Water	QU48	I	PMS	AS		mg/L	
PZ-10	10-10460TC	Water	QU48	I	ICP	CA	119.31317	mg/L	
PZ-10	10-10460TC	Water	QU48	I	PMS	CU		mg/L	
PZ-10	10-10460TC	Water	QU48	I	ICP	FE	62.33148	mg/L	
PZ-10	10-10460TC	Water	QU48	I	ICP	MG	108.41588	mg/L	
PZ-10	10-10460TC	Water	QU48	I	ICP	MN	2.67858	mg/L	
PZ-10	10-10460TC	Water	QU48	I	PMS	PB		mg/L	
PZ-10	10-10460TC	Water	QU48	I	PMS	ZN		mg/L	
PZ-11	10-10461TC	Water	QU48	J	PMS	AS		mg/L	
PZ-11	10-10461TC	Water	QU48	J	ICP	CA	96.40534	mg/L	
PZ-11	10-10461TC	Water	QU48	J	PMS	CU		mg/L	
PZ-11	10-10461TC	Water	QU48	J	ICP	FE	44.70114	mg/L	
PZ-11	10-10461TC	Water	QU48	J	ICP	MG	70.46399	mg/L	
PZ-11	10-10461TC	Water	QU48	J	ICP	MN	2.90104	mg/L	
PZ-11	10-10461TC	Water	QU48	J	PMS	PB		mg/L	
PZ-11	10-10461TC	Water	QU48	J	PMS	ZN		mg/L	
PZ-13	10-10462TC	Water	QU48	K	PMS	AS		mg/L	
PZ-13	10-10462TC	Water	QU48	K	ICP	CA	138.66367	mg/L	
PZ-13	10-10462TC	Water	QU48	K	PMS	CU		mg/L	
PZ-13	10-10462TC	Water	QU48	K	ICP	FE	54.95403	mg/L	
PZ-13	10-10462TC	Water	QU48	K	ICP	MG	47.89766	mg/L	
PZ-13	10-10462TC	Water	QU48	K	ICP	MN	4.10186	mg/L	
PZ-13	10-10462TC	Water	QU48	K	PMS	PB		mg/L	
PZ-13	10-10462TC	Water	QU48	K	PMS	ZN		mg/L	

METH	Analysis Method
EL	Analyte (Element)
C	Concentration Qualifier
U	Analyte undetected at RL (printed as 'VALUE')

INORGANICS ANALYSIS DATA SHEET
TOTAL METALS
Page 1 of 1

Sample ID: PZ-3B
SAMPLE

Lab Sample ID: QU48A
LIMS ID: 10-10452
Matrix: Groundwater
Data Release Authorized:
Reported: 05/14/10

QC Report No: QU48-Floyd-Snider
Project: B&L RIM
B&L-RIM T.1313.1
Date Sampled: 04/27/10
Date Received: 04/27/10

Prep Meth	Prep Date	Analysis Method	Analysis Date	CAS Number	Analyte	RL	µg/L	Q
200.8	04/29/10	200.8	05/13/10	**7440-38-2**	**Arsenic**	2	**1,130**	
3010A	04/28/10	6010B	05/04/10	**7440-70-2**	**Calcium**	50	**109,000**	
200.8	04/29/10	200.8	05/12/10	**7440-50-8**	**Copper**	0.5	**1.0**	
3010A	04/28/10	6010B	05/04/10	**7439-89-6**	**Iron**	50	**60,600**	
200.8	04/29/10	200.8	05/12/10	7439-92-1	Lead	1	1	U
3010A	04/28/10	6010B	05/04/10	**7439-95-4**	**Magnesium**	50	**58,100**	
3010A	04/28/10	6010B	05/04/10	**7439-96-5**	**Manganese**	1	**5,470**	
200.8	04/29/10	200.8	05/12/10	**7440-66-6**	**Zinc**	4	**5**	

U-Analyte undetected at given RL
RL-Reporting Limit

INORGANICS ANALYSIS DATA SHEET
TOTAL METALS
Page 1 of 1

Sample ID: PZ-5B
SAMPLE

Lab Sample ID: QU48B
LIMS ID: 10-10453
Matrix: Groundwater
Data Release Authorized:
Reported: 05/14/10

QC Report No: QU48-Floyd-Snider
Project: B&L RIM
B&L-RIM T.1313.1
Date Sampled: 04/27/10
Date Received: 04/27/10

Prep Meth	Prep Date	Analysis Method	Analysis Date	CAS Number	Analyte	RL	µg/L	Q
200.8	04/29/10	200.8	05/12/10	**7440-38-2**	**Arsenic**	0.2	**262**	
3010A	04/28/10	6010B	05/04/10	**7440-70-2**	**Calcium**	50	**18,600**	
200.8	04/29/10	200.8	05/12/10	**7440-50-8**	**Copper**	0.5	**1.1**	
3010A	04/28/10	6010B	05/04/10	**7439-89-6**	**Iron**	50	**2,060**	
200.8	04/29/10	200.8	05/12/10	7439-92-1	Lead	1	1	U
3010A	04/28/10	6010B	05/04/10	**7439-95-4**	**Magnesium**	50	**9,630**	
3010A	04/28/10	6010B	05/04/10	**7439-96-5**	**Manganese**	1	**1,310**	
200.8	04/29/10	200.8	05/12/10	7440-66-6	Zinc	4	4	U

U-Analyte undetected at given RL
RL-Reporting Limit

INORGANICS ANALYSIS DATA SHEET
TOTAL METALS
Page 1 of 1

Sample ID: PZ-6B
SAMPLE

Lab Sample ID: QU48C
LIMS ID: 10-10454
Matrix: Groundwater
Data Release Authorized:
Reported: 05/14/10

QC Report No: QU48-Floyd-Snider
Project: B&L RIM
B&L-RIM T.1313.1
Date Sampled: 04/27/10
Date Received: 04/27/10

Prep Meth	Prep Date	Analysis Method	Analysis Date	CAS Number	Analyte	RL	µg/L	Q
200.8	04/29/10	200.8	05/12/10	**7440-38-2**	**Arsenic**	0.2	**9.7**	
3010A	04/28/10	6010B	05/04/10	**7440-70-2**	**Calcium**	50	**85,500**	
200.8	04/29/10	200.8	05/12/10	**7440-50-8**	**Copper**	0.5	**0.9**	
3010A	04/28/10	6010B	05/04/10	**7439-89-6**	**Iron**	50	**22,000**	
200.8	04/29/10	200.8	05/12/10	7439-92-1	Lead	1	1	U
3010A	04/28/10	6010B	05/04/10	**7439-95-4**	**Magnesium**	50	**51,300**	
3010A	04/28/10	6010B	05/04/10	**7439-96-5**	**Manganese**	1	**4,550**	
200.8	04/29/10	200.8	05/12/10	7440-66-6	Zinc	4	4	U

U-Analyte undetected at given RL
RL-Reporting Limit

INORGANICS ANALYSIS DATA SHEET
TOTAL METALS
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Sample ID: PZ-2B
SAMPLE

Lab Sample ID: QU48D
LIMS ID: 10-10455
Matrix: Groundwater
Data Release Authorized:
Reported: 05/14/10

QC Report No: QU48-Floyd-Snider
Project: B&L RIM
B&L-RIM T.1313.1
Date Sampled: 04/27/10
Date Received: 04/27/10

Prep Meth	Prep Date	Analysis Method	Analysis Date	CAS Number	Analyte	RL	µg/L	Q
200.8	04/29/10	200.8	05/13/10	**7440-38-2**	**Arsenic**	0.5	**172**	
3010A	04/28/10	6010B	05/04/10	**7440-70-2**	**Calcium**	50	**102,000**	
200.8	04/29/10	200.8	05/12/10	**7440-50-8**	**Copper**	0.5	**1.1**	
3010A	04/28/10	6010B	05/04/10	**7439-89-6**	**Iron**	50	**58,600**	
200.8	04/29/10	200.8	05/12/10	7439-92-1	Lead	1	1	U
3010A	04/28/10	6010B	05/04/10	**7439-95-4**	**Magnesium**	50	**54,900**	
3010A	04/28/10	6010B	05/04/10	**7439-96-5**	**Manganese**	1	**5,740**	
200.8	04/29/10	200.8	05/12/10	**7440-66-6**	**Zinc**	4	**15**	

U-Analyte undetected at given RL
RL-Reporting Limit

INORGANICS ANALYSIS DATA SHEET
TOTAL METALS
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Sample ID: PZ-1B
SAMPLE

Lab Sample ID: QU48E
LIMS ID: 10-10456
Matrix: Groundwater
Data Release Authorized:
Reported: 05/14/10

QC Report No: QU48-Floyd-Snider
Project: B&L RIM
B&L-RIM T.1313.1
Date Sampled: 04/27/10
Date Received: 04/27/10

Prep Meth	Prep Date	Analysis Method	Analysis Date	CAS Number	Analyte	RL	µg/L	Q
200.8	04/29/10	200.8	05/13/10	**7440-38-2**	**Arsenic**	2	**1,610**	
3010A	04/28/10	6010B	05/04/10	**7440-70-2**	**Calcium**	50	**74,500**	
200.8	04/29/10	200.8	05/12/10	**7440-50-8**	**Copper**	0.5	**0.8**	
3010A	04/28/10	6010B	05/04/10	**7439-89-6**	**Iron**	50	**88,500**	
200.8	04/29/10	200.8	05/12/10	7439-92-1	Lead	1	1	U
3010A	04/28/10	6010B	05/04/10	**7439-95-4**	**Magnesium**	50	**49,400**	
3010A	04/28/10	6010B	05/04/10	**7439-96-5**	**Manganese**	1	**2,610**	
200.8	04/29/10	200.8	05/12/10	7440-66-6	Zinc	4	4	U

U-Analyte undetected at given RL
RL-Reporting Limit

INORGANICS ANALYSIS DATA SHEET
TOTAL METALS
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Sample ID: PZ-7B
SAMPLE

Lab Sample ID: QU48F
LIMS ID: 10-10457
Matrix: Groundwater
Data Release Authorized:
Reported: 05/14/10

QC Report No: QU48-Floyd-Snider
Project: B&L RIM
B&L-RIM T.1313.1
Date Sampled: 04/27/10
Date Received: 04/27/10

Prep Meth	Prep Date	Analysis Method	Analysis Date	CAS Number	Analyte	RL	µg/L	Q
200.8	04/29/10	200.8	05/12/10	**7440-38-2**	**Arsenic**	0.2	**78.9**	
3010A	04/28/10	6010B	05/04/10	**7440-70-2**	**Calcium**	50	**75,100**	
200.8	04/29/10	200.8	05/12/10	**7440-50-8**	**Copper**	0.5	**0.7**	
3010A	04/28/10	6010B	05/04/10	**7439-89-6**	**Iron**	50	**21,500**	
200.8	04/29/10	200.8	05/12/10	7439-92-1	Lead	1	1	U
3010A	04/28/10	6010B	05/04/10	**7439-95-4**	**Magnesium**	50	**39,700**	
3010A	04/28/10	6010B	05/04/10	**7439-96-5**	**Manganese**	1	**4,350**	
200.8	04/29/10	200.8	05/12/10	7440-66-6	Zinc	4	4	U

U-Analyte undetected at given RL
RL-Reporting Limit

INORGANICS ANALYSIS DATA SHEET
TOTAL METALS
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Sample ID: PZ-8C
SAMPLE

Lab Sample ID: QU48G
LIMS ID: 10-10458
Matrix: Groundwater
Data Release Authorized:
Reported: 05/14/10

QC Report No: QU48-Floyd-Snider
Project: B&L RIM
B&L-RIM T.1313.1
Date Sampled: 04/27/10
Date Received: 04/27/10

Prep Meth	Prep Date	Analysis Method	Analysis Date	CAS Number	Analyte	RL	µg/L	Q
200.8	04/29/10	200.8	05/12/10	**7440-38-2**	**Arsenic**	0.2	**13.7**	
3010A	04/28/10	6010B	05/04/10	**7440-70-2**	**Calcium**	50	**14,600**	
200.8	04/29/10	200.8	05/12/10	**7440-50-8**	**Copper**	0.5	**0.7**	
3010A	04/28/10	6010B	05/04/10	**7439-89-6**	**Iron**	50	**130**	
200.8	04/29/10	200.8	05/12/10	7439-92-1	Lead	1	1	U
3010A	04/28/10	6010B	05/04/10	**7439-95-4**	**Magnesium**	50	**15,700**	
3010A	04/28/10	6010B	05/04/10	**7439-96-5**	**Manganese**	1	**188**	
200.8	04/29/10	200.8	05/12/10	7440-66-6	Zinc	4	4	U

U-Analyte undetected at given RL
RL-Reporting Limit

INORGANICS ANALYSIS DATA SHEET
TOTAL METALS

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Sample ID: PZ-4C
SAMPLE

Lab Sample ID: QU48H
LIMS ID: 10-10459
Matrix: Groundwater
Data Release Authorized:
Reported: 05/14/10

QC Report No: QU48-Floyd-Snider
Project: B&L RIM
B&L-RIM T.1313.1
Date Sampled: 04/27/10
Date Received: 04/27/10

Prep Meth	Prep Date	Analysis Method	Analysis Date	CAS Number	Analyte	RL	µg/L	Q
200.8	04/29/10	200.8	05/12/10	**7440-38-2**	**Arsenic**	0.2	**1.2**	
3010A	04/28/10	6010B	05/04/10	**7440-70-2**	**Calcium**	50	**15,800**	
200.8	04/29/10	200.8	05/12/10	7440-50-8	Copper	0.5	0.5	U
3010A	04/28/10	6010B	05/04/10	**7439-89-6**	**Iron**	50	**7,590**	
200.8	04/29/10	200.8	05/12/10	7439-92-1	Lead	1	1	U
3010A	04/28/10	6010B	05/04/10	**7439-95-4**	**Magnesium**	50	**8,720**	
3010A	04/28/10	6010B	05/04/10	**7439-96-5**	**Manganese**	1	**307**	
200.8	04/29/10	200.8	05/12/10	7440-66-6	Zinc	4	4	U

U-Analyte undetected at given RL
RL-Reporting Limit

INORGANICS ANALYSIS DATA SHEET
TOTAL METALS
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Sample ID: PZ-10
SAMPLE

Lab Sample ID: QU48I
LIMS ID: 10-10460
Matrix: Groundwater
Data Release Authorized:
Reported: 05/14/10

QC Report No: QU48-Floyd-Snider
Project: B&L RIM
B&L-RIM T.1313.1
Date Sampled: 04/27/10
Date Received: 04/27/10

Prep Meth	Prep Date	Analysis Method	Analysis Date	CAS Number	Analyte	RL	µg/L	Q
200.8	04/29/10	200.8	05/13/10	**7440-38-2**	**Arsenic**	2	**1,860**	
3010A	04/28/10	6010B	05/04/10	**7440-70-2**	**Calcium**	50	**119,000**	
200.8	04/29/10	200.8	05/12/10	**7440-50-8**	**Copper**	0.5	**1.4**	
3010A	04/28/10	6010B	05/04/10	**7439-89-6**	**Iron**	50	**62,300**	
200.8	04/29/10	200.8	05/12/10	7439-92-1	Lead	1	1	U
3010A	04/28/10	6010B	05/04/10	**7439-95-4**	**Magnesium**	50	**108,000**	
3010A	04/28/10	6010B	05/04/10	**7439-96-5**	**Manganese**	1	**2,680**	
200.8	04/29/10	200.8	05/12/10	7440-66-6	Zinc	4	4	U

U-Analyte undetected at given RL
RL-Reporting Limit

INORGANICS ANALYSIS DATA SHEET
TOTAL METALS
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Sample ID: PZ-11
SAMPLE

Lab Sample ID: QU48J
LIMS ID: 10-10461
Matrix: Groundwater
Data Release Authorized:
Reported: 05/14/10

QC Report No: QU48-Floyd-Snider
Project: B&L RIM
B&L-RIM T.1313.1
Date Sampled: 04/27/10
Date Received: 04/27/10

Prep Meth	Prep Date	Analysis Method	Analysis Date	CAS Number	Analyte	RL	µg/L	Q
200.8	04/29/10	200.8	05/13/10	**7440-38-2**	**Arsenic**	2	**1,880**	
3010A	04/28/10	6010B	05/04/10	**7440-70-2**	**Calcium**	50	**96,400**	
200.8	04/29/10	200.8	05/12/10	**7440-50-8**	**Copper**	0.5	**0.7**	
3010A	04/28/10	6010B	05/04/10	**7439-89-6**	**Iron**	50	**44,700**	
200.8	04/29/10	200.8	05/12/10	7439-92-1	Lead	1	1	U
3010A	04/28/10	6010B	05/04/10	**7439-95-4**	**Magnesium**	50	**70,500**	
3010A	04/28/10	6010B	05/04/10	**7439-96-5**	**Manganese**	1	**2,900**	
200.8	04/29/10	200.8	05/12/10	7440-66-6	Zinc	4	4	U

U-Analyte undetected at given RL
RL-Reporting Limit

INORGANICS ANALYSIS DATA SHEET
TOTAL METALS
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Sample ID: PZ-13
SAMPLE

Lab Sample ID: QU48K
LIMS ID: 10-10462
Matrix: Groundwater
Data Release Authorized:
Reported: 05/14/10

QC Report No: QU48-Floyd-Snider
Project: B&L RIM
B&L-RIM T.1313.1
Date Sampled: 04/27/10
Date Received: 04/27/10

Prep Meth	Prep Date	Analysis Method	Analysis Date	CAS Number	Analyte	RL	µg/L	Q
200.8	04/29/10	200.8	05/12/10	**7440-38-2**	**Arsenic**	0.2	**273**	
3010A	04/28/10	6010B	05/04/10	**7440-70-2**	**Calcium**	50	**139,000**	
200.8	04/29/10	200.8	05/12/10	**7440-50-8**	**Copper**	0.5	**47.0**	
3010A	04/28/10	6010B	05/04/10	**7439-89-6**	**Iron**	50	**55,000**	
200.8	04/29/10	200.8	05/12/10	**7439-92-1**	**Lead**	1	**12**	
3010A	04/28/10	6010B	05/04/10	**7439-95-4**	**Magnesium**	50	**47,900**	
3010A	04/28/10	6010B	05/04/10	**7439-96-5**	**Manganese**	1	**4,100**	
200.8	04/29/10	200.8	05/12/10	**7440-66-6**	**Zinc**	4	**59**	

U-Analyte undetected at given RL
RL-Reporting Limit

INORGANICS ANALYSIS DATA SHEET
TOTAL METALS
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Sample ID: METHOD BLANK

Lab Sample ID: QU48MB
LIMS ID: 10-10452
Matrix: Groundwater
Data Release Authorized:
Reported: 05/14/10

QC Report No: QU48-Floyd-Snider
Project: B&L RIM
B&L-RIM T.1313.1
Date Sampled: NA
Date Received: NA

Prep Meth	Prep Date	Analysis Method	Analysis Date	CAS Number	Analyte	RL	µg/L	Q
200.8	04/29/10	200.8	05/12/10	7440-38-2	Arsenic	0.2	0.2	U
3010A	04/28/10	6010B	05/04/10	7440-70-2	Calcium	50	50	U
200.8	04/29/10	200.8	05/12/10	7440-50-8	Copper	0.5	0.5	U
3010A	04/28/10	6010B	05/04/10	7439-89-6	Iron	50	50	U
200.8	04/29/10	200.8	05/12/10	7439-92-1	Lead	1	1	U
3010A	04/28/10	6010B	05/04/10	7439-95-4	Magnesium	50	50	U
3010A	04/28/10	6010B	05/04/10	7439-96-5	Manganese	1	1	U
200.8	04/29/10	200.8	05/12/10	7440-66-6	Zinc	4	4	U

U-Analyte undetected at given RL
RL-Reporting Limit

INORGANICS ANALYSIS DATA SHEET
TOTAL METALS
Page 1 of 1

Sample ID: LAB CONTROL

Lab Sample ID: QU48LCS
LIMS ID: 10-10452
Matrix: Groundwater
Data Release Authorized:
Reported: 05/14/10

QC Report No: QU48-Floyd-Snider
Project: B&L RIM
B&L-RIM T.1313.1
Date Sampled: NA
Date Received: NA

BLANK SPIKE QUALITY CONTROL REPORT

Analyte	Analysis Method	Spike Found	Spike Added	% Recovery	Q
Arsenic	200.8	26.8	25.0	107%	
Calcium	6010B	9900	10000	99.0%	
Copper	200.8	27.2	25.0	109%	
Iron	6010B	2080	2000	104%	
Lead	200.8	26	25	104%	
Magnesium	6010B	10100	10000	101%	
Manganese	6010B	498	500	99.6%	
Zinc	200.8	81	80	101%	

Reported in µg/L

N-Control limit not met
Control Limits: 80-120%

APPLIED SPECIATION AND CONSULTING, LLC

18804 Northcreek Parkway Bothell, WA, 98011
Tel: (425) 483-3300 Fax: (425) 483-9818
www.appliedspeciation.com

May 4, 2010

Brett Beaulieu
Floyd Snider
601 Union St., Suite 600
Seattle, WA 98101
(206) 292-2078

Re: Project B+L RIM 1412.2

Dear Mr. Beaulieu,

Attached is the report associated with eight (8) groundwater samples submitted for arsenic speciation analyses on April 15, 2010. All samples were received on April 15, 2010 in a sealed container at 0.5°C. Arsenic speciation analysis was performed by ion chromatography inductively coupled plasma dynamic reaction cell mass spectrometry (IC-ICP-DRC-MS). Any issues associated with the analysis are addressed in the following report.

If you have any questions, please feel free to contact me at your convenience.

Sincerely,

Ben Wozniak

Ben Wozniak
Project Manager
Applied Speciation and Consulting, LLC

Applied Speciation and Consulting, LLC

Report Prepared for:

Brett Beaulieu
Floyd Snider
601 Union St., Suite 600
Seattle, WA 98101

May 4, 2010

1. Sample Reception

Eight (8) groundwater samples were submitted for arsenic speciation analyses on April 15, 2010. All samples were received in acceptable condition on April 15, 2010 in a sealed cooler at 0.5°C.

All samples were received in a laminar flow clean hood void of trace metals contamination and ultra-violet radiation. An aliquot of each sample submitted in a 125mL HDPE bottle (provided by Applied Speciation and Consulting) was filtered using a 0.45µm syringe filter, and all filtrates were then prepared for analysis via ion chromatography inductively coupled plasma dynamic reaction cell mass spectrometry (IC-ICP-DRC-MS).

2. Sample Preparation

All sample preparation is performed in laminar flow clean hoods known to be free from trace metals contamination. All applied water for dilutions and sample preservatives are also monitored for contamination to account for any biases associated with the sample results.

Arsenic Speciation Analysis by IC-ICP-DRC-MS Prior to analysis, all aqueous samples submitted in a 125mL HDPE bottle were filtered with a syringe filter (0.45µm) and injected directly into sealed autosampler vials. No further sample preparation was performed as the sample bottles provided by Applied Speciation and Consulting contained hydrochloric acid preservative designed to stabilize arsenite and arsenate in solution.

3. Sample Analysis

All samples analysis is precluded by a minimum of a five-point calibration curve spanning the entire concentration range of interest. Calibration curves are performed at the beginning of each analytical day. All calibration curves, associated with each species of interest, are standardized by linear regression resulting in a response factor. All sample results are **instrument blank corrected** to account for any operational biases.

Prior to sample analysis, all calibration curves are verified using second source standards which are identified as initial calibration verification standards (ICV).

Ongoing instrument performance is identified by the analysis of continuing calibration verification standards (CCV) and continuing calibration blanks (CCB) at a minimal interval of every ten analytical runs.

Arsenic Speciation Analysis by IC-ICP-DRC-MS All samples for arsenic speciation analysis were analyzed by ion chromatography inductively coupled plasma dynamic reaction cell mass spectrometry (IC-ICP-DRC-MS) on April 15, 2010. Aliquots of each sample extract are injected onto an anion exchange column and mobilized by an acidic (pH < 7) gradient. The eluting arsenic species are then introduced into a radio frequency (RF) plasma where energy-transfer processes cause desolvation, atomization, and ionization. The ions are extracted from the plasma through a differentially-pumped vacuum interface and travel through a pressurized chamber (DRC) containing a specific reactive gas which preferentially reacts with arsenic, producing an entirely different mass to charge ratio (m/z) which can then be differentiated from the initial isobaric interferences. A solid-state detector detects ions transmitted through the mass analyzer on the basis of their mass-to-charge ratio (m/z), and the resulting current is processed by a data handling system.

Retention times for each eluting species are compared to known standards for species identification.

4. Analytical Issues

The overall analyses went well and no significant analytical issues were encountered. All quality control parameters associated with these samples were within acceptance limits, with the following exceptions:

Although the recoveries of the arsenite and arsenate matrix spikes performed on the sample identified as PD-109 were within the established control limits of 75-125%, the recoveries of arsenite (76.9% and 78.4%) were biased low while those of arsenate (121.6% and 123.2%) were elevated. The recoveries of the CCVs surrounding these samples, which were spiked with both arsenite and arsenate, did not show evidence of species conversion. Therefore the observed matrix spike recoveries suggest that the sample matrix associated with PD-109 induces partial oxidation of arsenite to arsenate.

Applied Speciation and Consulting (ASC) provided separate field spikes for arsenite and arsenate to monitor for any species conversion between the time of sample collection and analysis. The field spikes, designated as PZ-9 AsIII and PZ-9 As V, were analyzed on the date of sample receipt along with the rest of the submitted samples. Upon analysis it was determined that the arsenite field spike, prepared at an expected concentration of 8000µg/L arsenite, recovered approximately 74% as arsenite and 5% as arsenate. The recovery of the arsenate field spike, prepared at an expected concentration of 8000µg/L arsenate, recovered approximately 28% as arsenate. The arsenite concentration of the arsenate field spike (459µg/L) was also curiously lower than that of the native sample matrix (1460µg/L).

Upon discovery of the low recovery of the arsenate field spike, the pH of all the submitted samples was checked to verify that they had been properly preserved in the field. For those samples identified as PZ-4B, PZ-8B, PZ-12, and PD-109, the pH of each was ≤2 as expected. However, the pH for each of the samples identified as PD-107, PZ-9, PZ-9 As III, and PZ-9 As V was discovered to be approximately 6, which suggests that these were not collected properly in the field. The 125mL HDPE bottles submitted for these latter four samples were also found to contain a significant quantity of brownish-black colored solid. Since the field spikes do not appear to have been properly collected in the field, no definitive conclusions may be made regarding the observed spike recoveries. ASC also strongly recommends that the apparent improper collection of PD-107 and PZ-9 be considered when interpreting the obtained results.

The estimated method detection limits (eMDLs) for arsenite and arsenate are generated from replicate analyses of the lowest standard in the calibration curve. Not all arsenic species are present in preparation blanks; therefore, eMDL calculations based on preparation blanks may be artificially biased low. The eMDLs for MMAs and DMAs are calculated from the average eMDL of arsenite and arsenate. The calibration does not contain MMAs or DMAs due to impurities in these standards which would bias the results for other arsenic species.

If you have any questions or concerns regarding this report, please feel free to contact me.

Sincerely,

Ben Wozniak

Ben Wozniak
Project Manager
Applied Speciation and Consulting, LLC

Arsenic Speciation Results for Floyd Snider
Project Name: B&L RIM 1412.2
Contact: Brett Beaulieu

Date: May 4, 2010
Report Generated by: Ben Wozniak
Applied Speciation and Consulting, LLC

__Sample Results__

Sample ID	**Dilution**	**As(III)**	**As(V)**	**DMAs**	**MMAs**
PZ-4B	50	1.54	0.71	ND (<0.35)	ND (<0.35)
PZ-8B	50	11.7	4.33	ND (<0.35)	ND (<0.35)
PD-109	1000	146	60	ND (<6.9)	ND (<6.9)
PD-107	1000	2960	1750	ND (<6.9)	ND (<6.9)
PZ-9 As III	1000	7400	1190	ND (<6.9)	ND (<6.9)
PZ-12	1000	662	884	ND (<6.9)	ND (<6.9)
PZ-9 As V	1000	459	3060	ND (<6.9)	ND (<6.9)
PZ-9	1000	1460	777	ND (<6.9)	ND (<6.9)

All results reflect the applied dilution and are reported in µg/L

ND = Not detected at the applied dilution

As(III) = Arsenite

As(V) = Arsenate

DMAs = Dimethylarsinic acid

MMAs = Monomethylarsonic acid

Arsenic Speciation Results for Floyd Snider
Project Name: B&L RIM 1412.2
Contact: Brett Beaulieu

Date: May 4, 2010
Report Generated by: Ben Wozniak
Applied Speciation and Consulting, LLC

Quality Control Summary - Preparation Blank Summary

Analyte (µg/L)	**PBW1**	**PBW2**	**PBW3**	**PBW4**	**Mean**	**StdDev**	**eMDL***	**eMDL at 50x**	**eMDL at 1000x**
As(III)	0.000	0.000	0.000	0.000	0.000	0.000	0.001	0.071	1.4
As(V)	0.004	0.000	-0.002	-0.002	0.000	0.003	0.012	0.62	12
DMAs	0.000	0.000	0.000	0.000	0.000	0.000	0.007	0.35	6.9
MMAs	0.000	0.000	0.000	0.000	0.000	0.000	0.007	0.35	6.9

eMDL = Estimated Method Detection Limit
*Please see narrative regarding eMDL calculations

Quality Control Summary - Certified Reference Materials

Analyte (µg/L)	**CRM**	**True Value**	**Result**	**Recovery**
As(III)	ICV	5.000	4.533	90.7
As(V)	ICV	5.000	4.112	82.2
DMAs	ICV	5.245	4.913	93.7
MMAs	ICV	5.235	4.568	87.3

Arsenic Speciation Results for Floyd Snider
Project Name: B&L RIM 1412.2
Contact: Brett Beaulieu

Date: May 4, 2010
Report Generated by: Ben Wozniak
Applied Speciation and Consulting, LLC

Quality Control Summary - Matrix Duplicates

Analyte (µg/L)	**Sample ID**	**Rep 1**	**Rep 2**	**Mean**	**RPD**
As(III)	PD-109	146.4	155.5	150.9	6.0
As(V)	PD-109	60	57	59	6.2
DMAs	PD-109	ND (<6.9)	ND (<6.9)	NC	NC
MMAs	PD-109	ND (<6.9)	ND (<6.9)	NC	NC

NC = Not calculated due to one or more concentrations below the eMDL.
ND = Not detected at the applied dilution.

Quality Control Summary - Matrix Spike/ Matrix Spike Duplicate

Analyte (µg/L)	**Sample ID**	**Spike Conc**	**MS Result**	**Recovery**	**Spike Conc**	**MSD Result**	**Recovery**	**RPD**
As(III)	PD-109	2000	1689	76.9	2000	1720	78.4	1.8
As(V)	PD-109	2000	2491	121.6	2000	2523	123.2	1.3

APPLIED SPECIATION AND CONSULTING, LLC

18804 Northcreek Parkway
Bothell, WA 98011

Phone (425) 483-3300
Fax (425) 483-9818

Company Name: Floyd Snider
Contact Person: Brett Beaulieu
Address: 601 Union St, Ste 600, Seattle, WA 98101
Phone Number: 206-292-2078
Fax Number: 206-682-7807
Email Address: Brett.beaulieu@floydsnider.com
Project Name: B+L RIM 1412.2
Project Number:
PO Number:

ASC Project Manager:

By submitting of samples the client agrees to all terms and conditions set forth in the quotation provided by the ASC project manager. If you are not familiar with the term and conditions associated with your project, please contact your ASC representative as soon as possible (425) 483-3300.

Requested Turn Around Time: STD
Method of Sample Delivery:
Currier Tracking Number:
Confirmation of Sample Reception: ☐ Yes ☐ No

Sample ID	Bottle ID	Date and Time	Matrix*	Volume	Preservative	Initials	Requested Analytes and Methods	Comments
PZ-4B		4/15 0950	GW	250 mL	HCl		Arsenic As speciation	
PZ-8B		4/15 0840						
PD-109		4/15 1100						
PD-107		4/15 1155						
PZ-9 As III		4/15 0900						
PZ-12		4/15 1050						
PZ-9 As V		4/15 0900						
PZ-9		4/15 0900						

Relinquished by: (sign) (print) Kristin Anderson Date/Time 4/15 1325
Received by: (sign) (print) Matthew Sullivan Date/Time: 4/15/10 1341

Comments:
Temp: 0.5°C

Relinquished by: (sign)________ (print)________ Date/Time:________
Received by: (sign)________ (print)________ Date/Time:________

Comments:
Temp:

Please account for each sample bottle as a seperate line item for verification purposes.

*Matrix: Air, Freshwater (FW), seawater (SW), groundwater (GW), wastewater (WW), soil (SL), sediment (SD), tissue (TS), product (P), other (O)

B&L Woodwaste Site
Pierce County, Washington

Engineering Alternatives Evaluation

Attachment A.4

Aeration Tests Field Data

FINAL

Figure A.4.1
Dissolved Oxgyen During Aeration for 30 Minutes

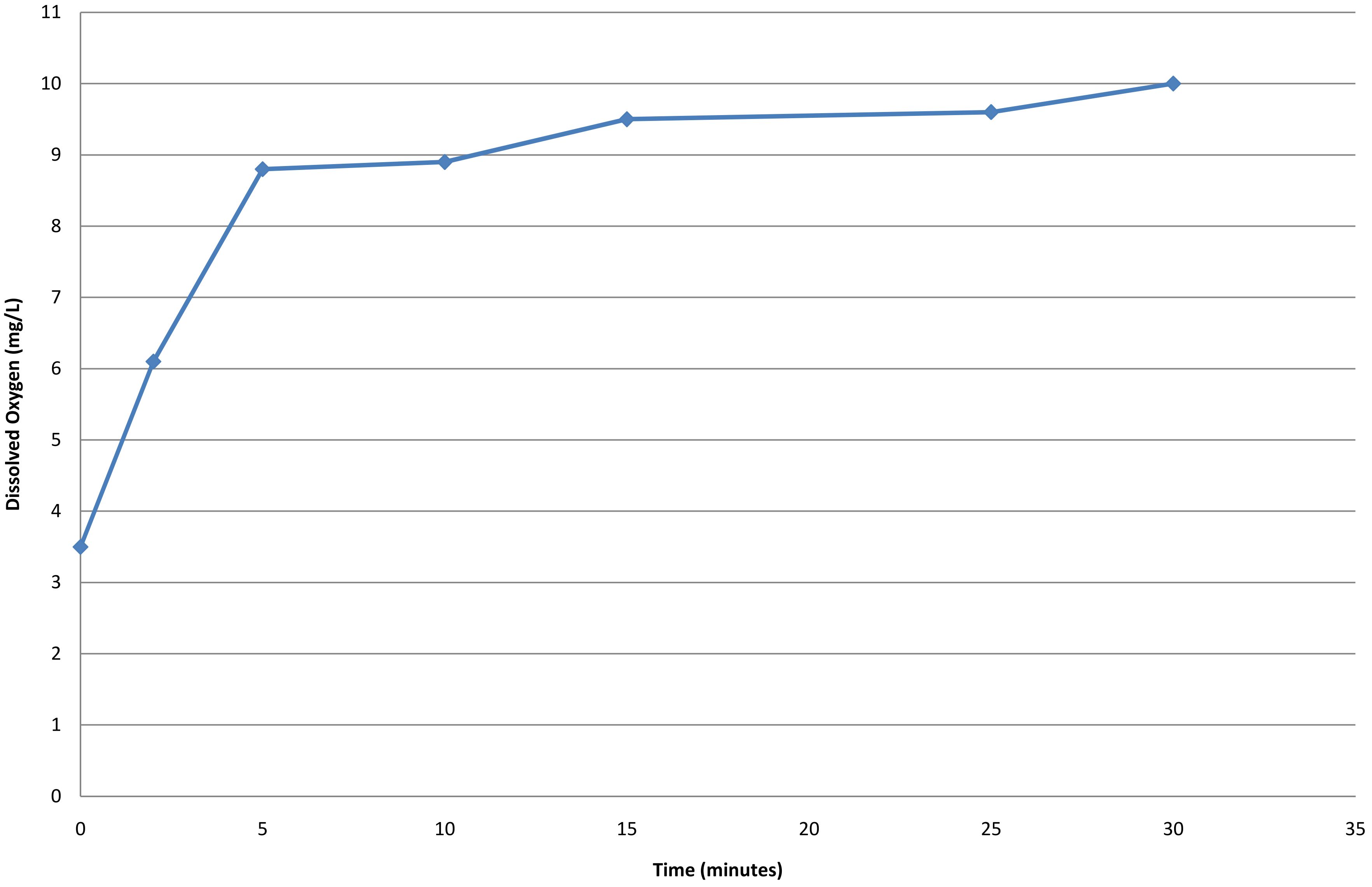
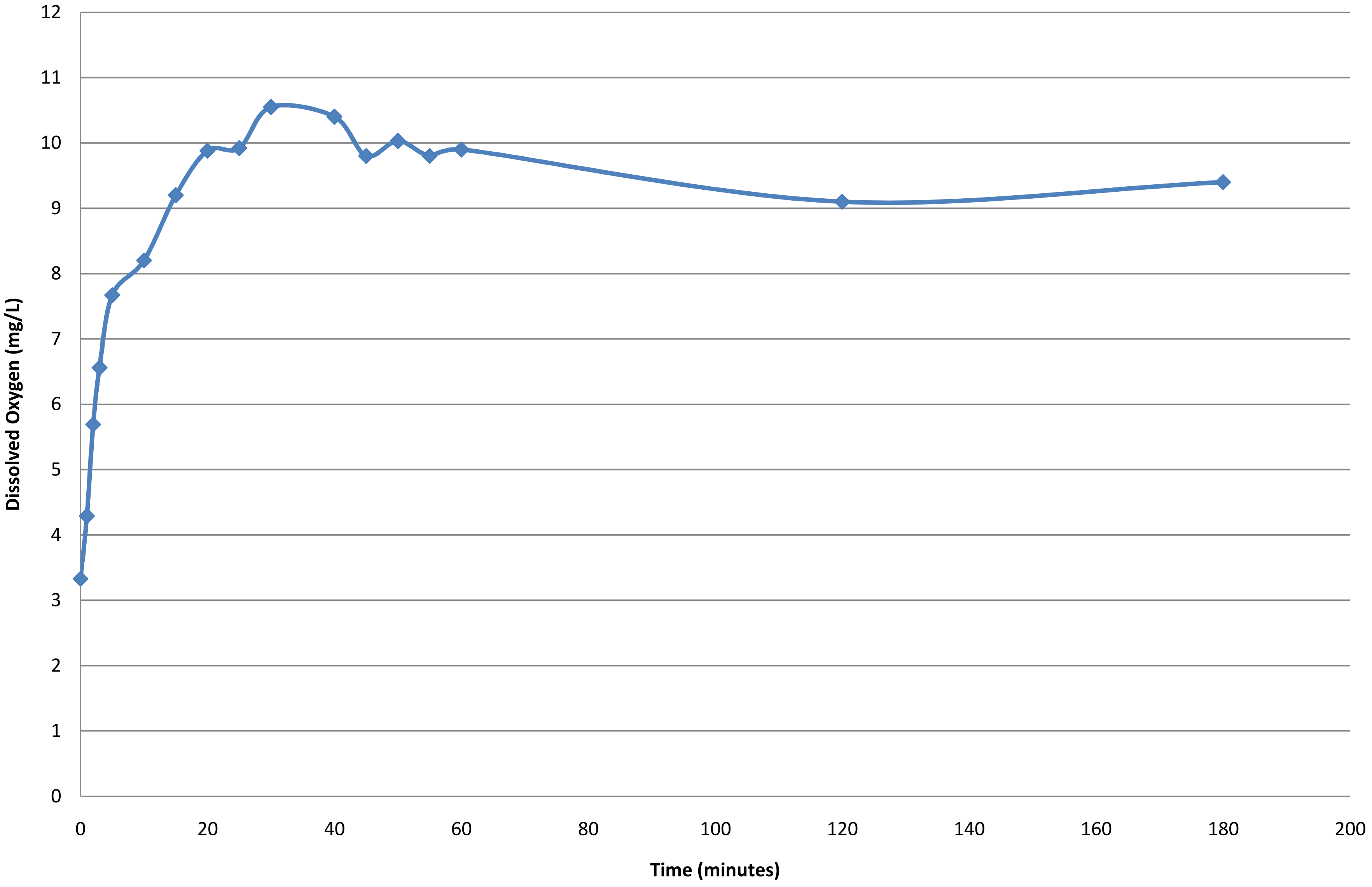


Figure A.4.2
Dissolved Oxgyen During Aeration for 3 Hours



B&L Woodwaste Site
Pierce County, Washington

Engineering Alternatives Evaluation

Attachment A.5

Phase 1 Settling Test Data

FINAL

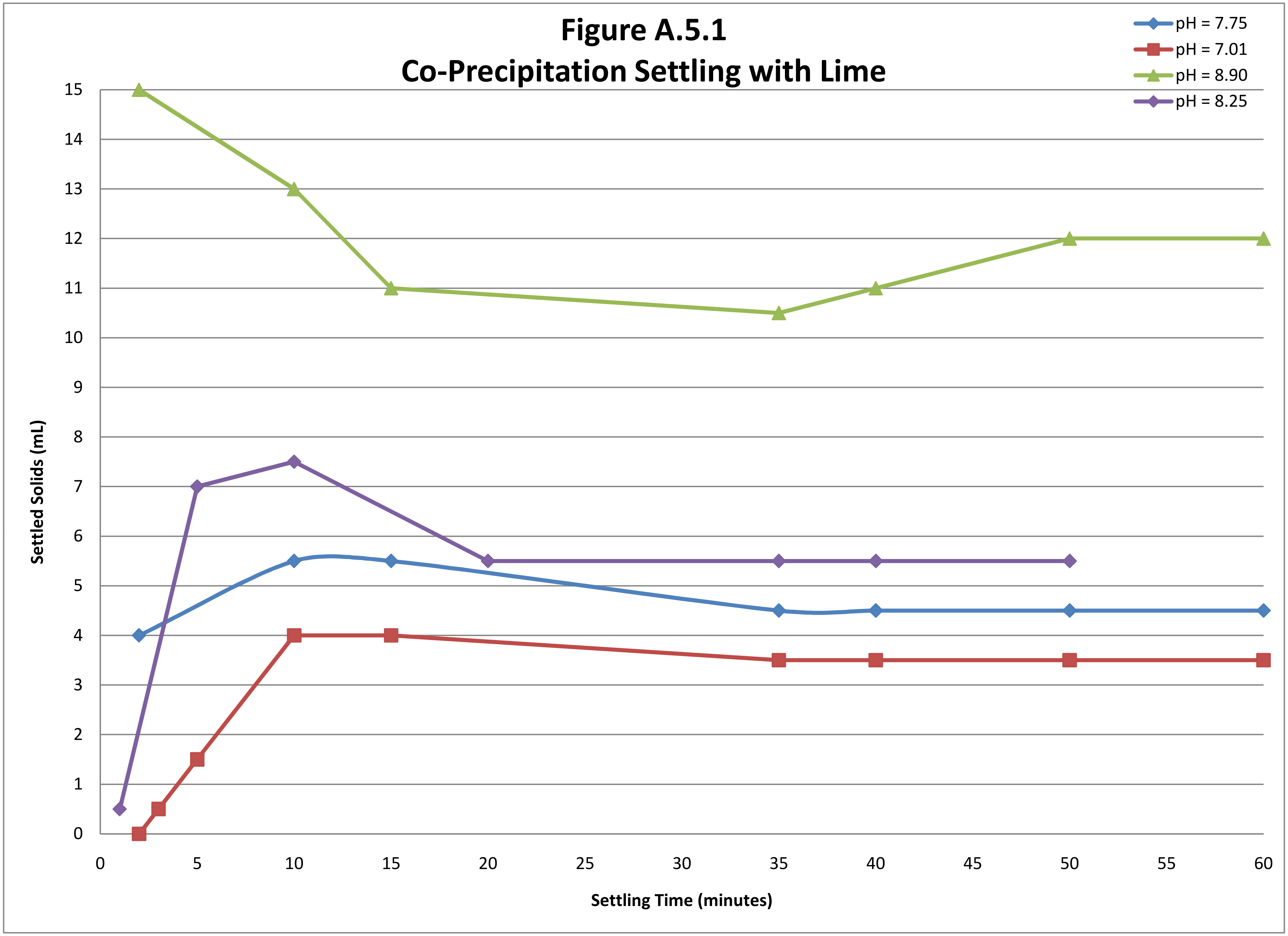


Figure A.5.1
Co-Precipitation Settling with Lime
pH = 7.75
pH = 7.01
pH = 8.90
pH = 8.25
15
14
13
12
11
10
9
8
7
6
5
4
3
2
1
0
Settled Solids (mL)
0
5
10
15
20
25
30
35
40
45
50
55
60
Settling Time (minutes)

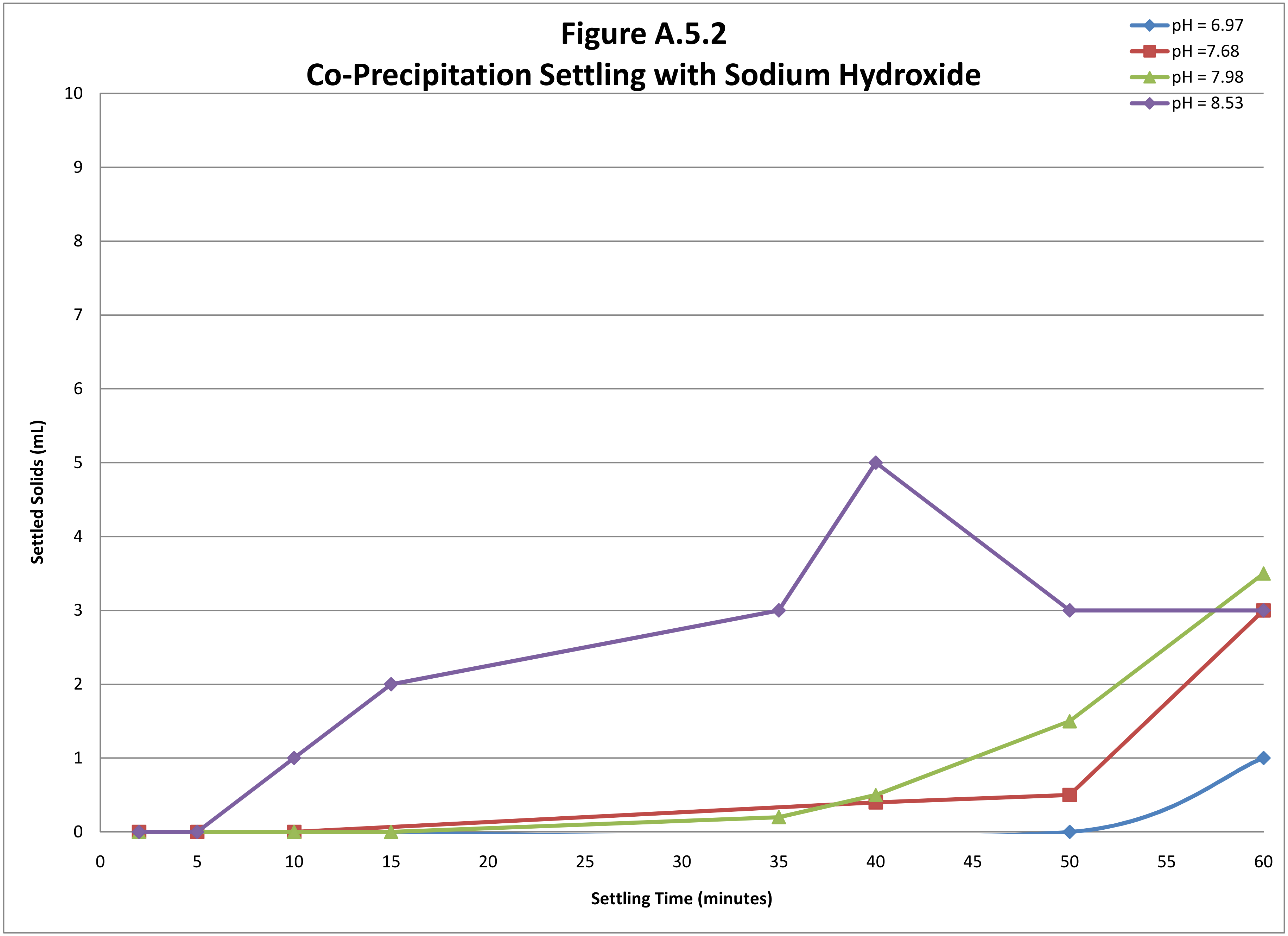


Figure A.5.2
Co-Precipitation Settling with Sodium Hydroxide

B&L Woodwaste Site
Pierce County, Washington

Engineering Alternatives Evaluation

Attachment A.6

Phase 1 and Phase 2 Analytical Data

FINAL

Table A.6.1
Phase 1 Analytical Results

Sample ID	Sample Description	Date	TOC (mg/L)	DOC (mg/L)	TSS (mg/L)	Total Arsenic (µg/L)	Dissolved Arsenic (µg/L)	Total Iron (mg/L)	Dissolved Iron (mg/L)	Total Alkalinity (mg/L)	Ca^{2+} (mg/L)	Mg^{2+} (mg/L)	Mn^{2+} (mg/L)	K^+ (mg/L)	Na^+ (mg/L)
PD-107 INFLUENT #1A	Groundwater from PD-107 for $KMnO_4$ oxidation tests	05/12/10 11:00 AM	48		73	4350		50.6		887	137	105	3.44	22.1	36.2
P.P. #2	Sample treated with $KMnO_4$, Test 2	05/12/10 04:30 PM	35.4			226				853					
P.P. #3	Sample treated with $KMnO_4$, Test 3	05/12/10 04:15 PM	35.1			183				854					
P.P. #4	Sample treated with $KMnO_4$, Test 4	05/12/10 04:00 PM	36.2			141				853					
PD-107 INFLUENT #1B	Groundwater from PD-107 for aeration tests	05/12/10 11:00 AM	50.8		95	4540		56.2		867	139	104	3.46	22	36.2
AERATION 3HRS	Sample treated with aeration	05/12/10 06:20 PM	42.4		60.2	2180	1230	15.3	0.21	647	55.7	88.1		20.6	32.7
AERATION 30 MINS	Sample treated with aeration	05/12/10 06:50 PM	43.2		128	2750	1520	22.2	1.61		118	95		20.5	33.4
PD-107 INFLUENT #2A	Groundwater from PD-107 for peroxide tests	05/13/10 10:00 AM	50	34.1	150	5150	4500	52.4	47.9	892	135	99.3		20.7	33.5
H.P. #3	Sample treated with peroxide, Test 3	05/13/10 03:50 PM	36.8	34.8	4.2		489			851					
H.P. #4	Sample treated with peroxide, Test 4	05/13/10 04:00 PM	35.4	31.2	2.8		415			861					
H.P. #5	Sample treated with peroxide, Test 5	05/13/10 04:15 PM	35.2	33.8	3.4		415			856					
H.P. pH = 5.47	Sample treated with pH adjustment followed by peroxide	05/13/10 08:10 PM	25	24	4.1		37.9		0.09	122					
H.P. pH = 4.97	Sample treated with pH adjustment followed by peroxide	05/13/10 08:25 PM	21.5	16.6	2.5		14.3		0.4	9.5					
PD-107 INFLUENT #3	Groundwater from PD-107 for co-precipitation tests	05/14/10 10:45 AM	49.2	35.1	216	4780	4680	56.6	52.4	907	146	108		22.3	35.3
INFLUENT #3 P.P. #4 Settled	Sample treated with $KMnO_4$ prior to co-precipitation and after settling	05/14/10 01:30 PM			1.3										
INFLUENT #3 P.P. #4 Suspended	Sample treated with $KMnO_4$ prior to co-precipitation and prior to settling	05/14/10 02:00 PM			256										
S.H. #1	Sampe treated during co-precipitation trials with NaOH, Test 1	05/14/10 06:30 PM			4.5	73.9		4.96	0.52						
S.H. #2	Sampe treated during co-precipitation trials with NaOH, Test 2	05/14/10 06:40 PM			26.3	68.9		3.57	0.05						
S.H. #3	Sampe treated during co-precipitation trials with NaOH, Test 3	05/14/10 06:55 PM	33.5	33.6	44.1	53.6	21.7	2.47	0.05						
S.H. #4	Sampe treated during co-precipitation trials with NaOH, Test 4	05/14/10 07:10 PM	34.2	33.4	18.5	42.1	28.6	1.21	0.09	1170					
Lime pH = 7.01	Sampe treated during co-precipitation trials with lime, Test 1	05/14/10 07:25 PM			14	32.4		1.16	0.05						
Lime pH = 7.75	Sampe treated during co-precipitation trials with lime, Test 2	05/14/10 07:45 PM	33	32.6	64.2	25	19.6	0.43	0.05						
Lime pH = 8.25	Sampe treated during co-precipitation trials with lime, Test 3	05/14/10 08:00 PM	34	31.9	35	24.1	20.6	0.44	0.05	652					
Lime pH = 8.9	Sampe treated during co-precipitation trials with lime, Test 4	05/14/10 07:35 PM			25.9	28.2		0.47							

Table A.6.2
Phase 2 Analytical Results

Sample ID	Sample Description	Date	TOC (mg/L)	DOC (mg/L)	TSS (mg/L)	Total Arsenic (µg/L)	Dissolved Arsenic (µg/L)	Total Iron (mg/L)	Dissolved Iron (mg/L)	Total Alkalinity (mg/L)	Ca^{2+} (mg/L)	Mg^{2+} (mg/L)	Mn^{2+} (mg/L)	K^+ (mg/L)	Na^+ (mg/L)
PZ - 11 #1	Groundwater collected from PZ-11 during aquifer test	06/01/10 12:25 PM	40	36.8	82	1580	1540	68.8	68	471	78	40		6.13	42.1
PZ - 11 #2	Groundwater collected from PZ-11 during aquifer test	06/01/10 04:30 PM	38.8	38.1	79.6	1600	1540	71.6	72.6	473	80.4	38.7		5.72	40.4
PZ - 11 #3	Groundwater collected from PZ-11 during aquifer test	06/02/10 10:30 AM	40.2	37.1	70.6	1630	1450	71.9	71.7	470	79.1	38		5.35	42.5
Primary Influent	Sample treated with $KMnO_4$, lime and pH adjusted to 6.5 as primary treatment	06/03/10 08:40 AM	19	20.1	30.2	13.5	3.8	10	6.98	347	99.8	35		23.1	43
AA #1 6.94L	Sample collected from the first 6.94L of water processed through the activated alumina column	06/04/10 10:00 AM	88	87.6		0.9	0.8	0.05	0.05						
Purolite #1 7.15L	Sample collected from the first 7.15L of water processed through the Purolite resin column	06/04/10 09:25 AM	19.1	16.8		1.2	0.9	0.05	0.05						
AA #2 8.77L	Sample collected from the last 8.77L of water processed through the activated alumina column	06/05/10 06:50 PM	10.3	10.6		0.9	0.9	0.05	0.05		99.6	36.8		24.2	45.2
Purolite #2 8.04L	Sample collected from the last 8.04L of water processed through the Purolite resin column	06/05/10 10:00 AM	7.31	7.24		1	0.8	0.2	0.05		99.4	36		23.2	43.8
Wetlands D - 6A	Groundwater collected from D-6A well located in the Wetlands area	06/04/10 12:00 PM	40.6	37.5	132	1360	1310	61.1	60	551	88.9	45.6		4.63	39.1
Mixed #2	Sample of mixed water from PZ-11 and D-6A treated with $KMnO_4$, Test 2	06/04/10 05:25 PM	20.2	21.7	2.3	55.4	8.2	1.61	0.05		83.9	53.2		21.6	34.2
Wetlands Treated #3	Sample of D-6A water treated with $KMnO_4$, Test 3	06/04/10 08:50 PM	21.8	22.5	12.4	35.1	13.1	1.44	0.34		83.5	46.7		20.3	40.5

B&L Woodwaste Site
Pierce County, Washington

Engineering Alternatives Evaluation

Attachment A.7

Column Tests Field Data

FINAL

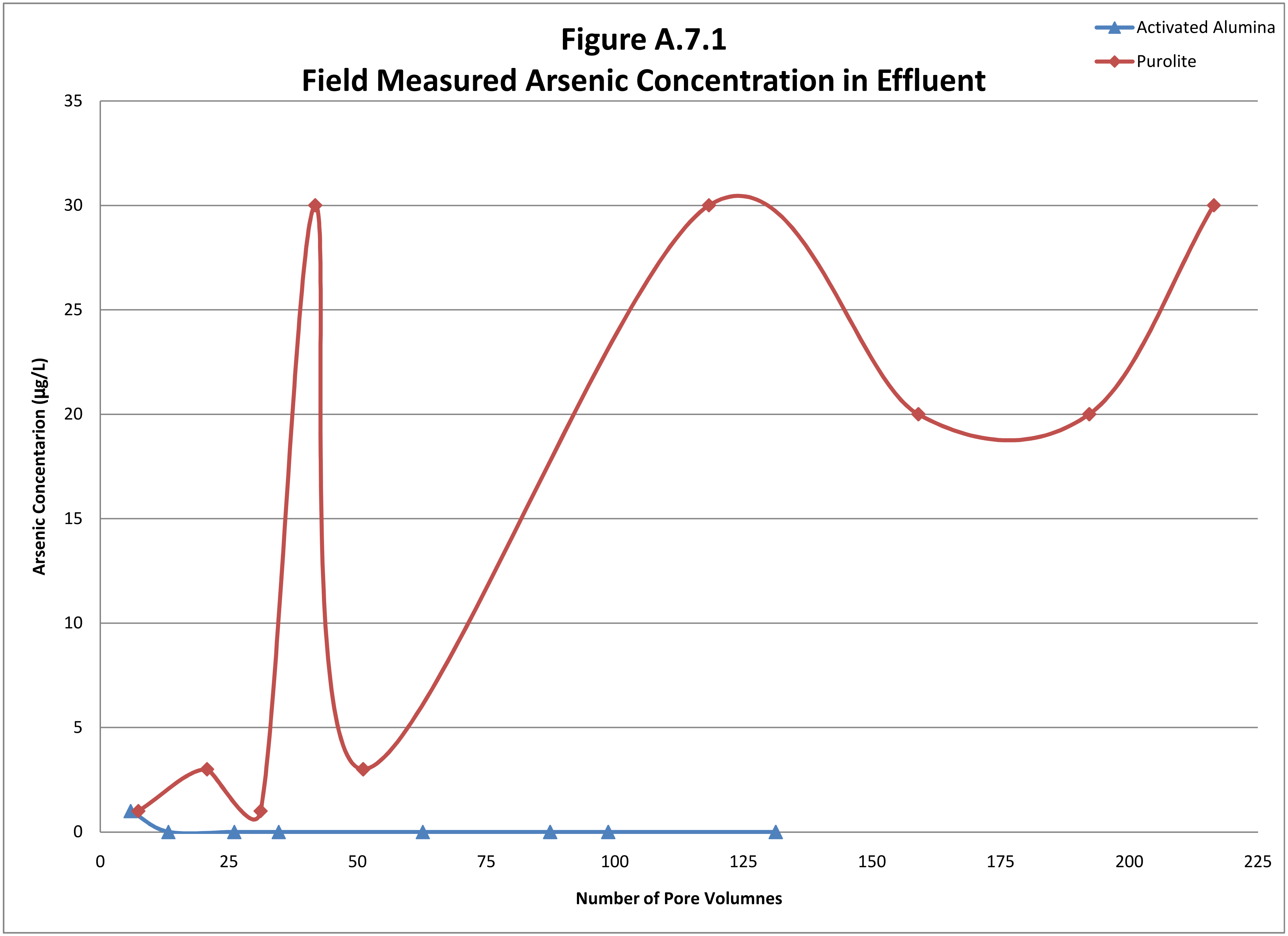


Figure A.7.1
Field Measured Arsenic Concentration in Effluent

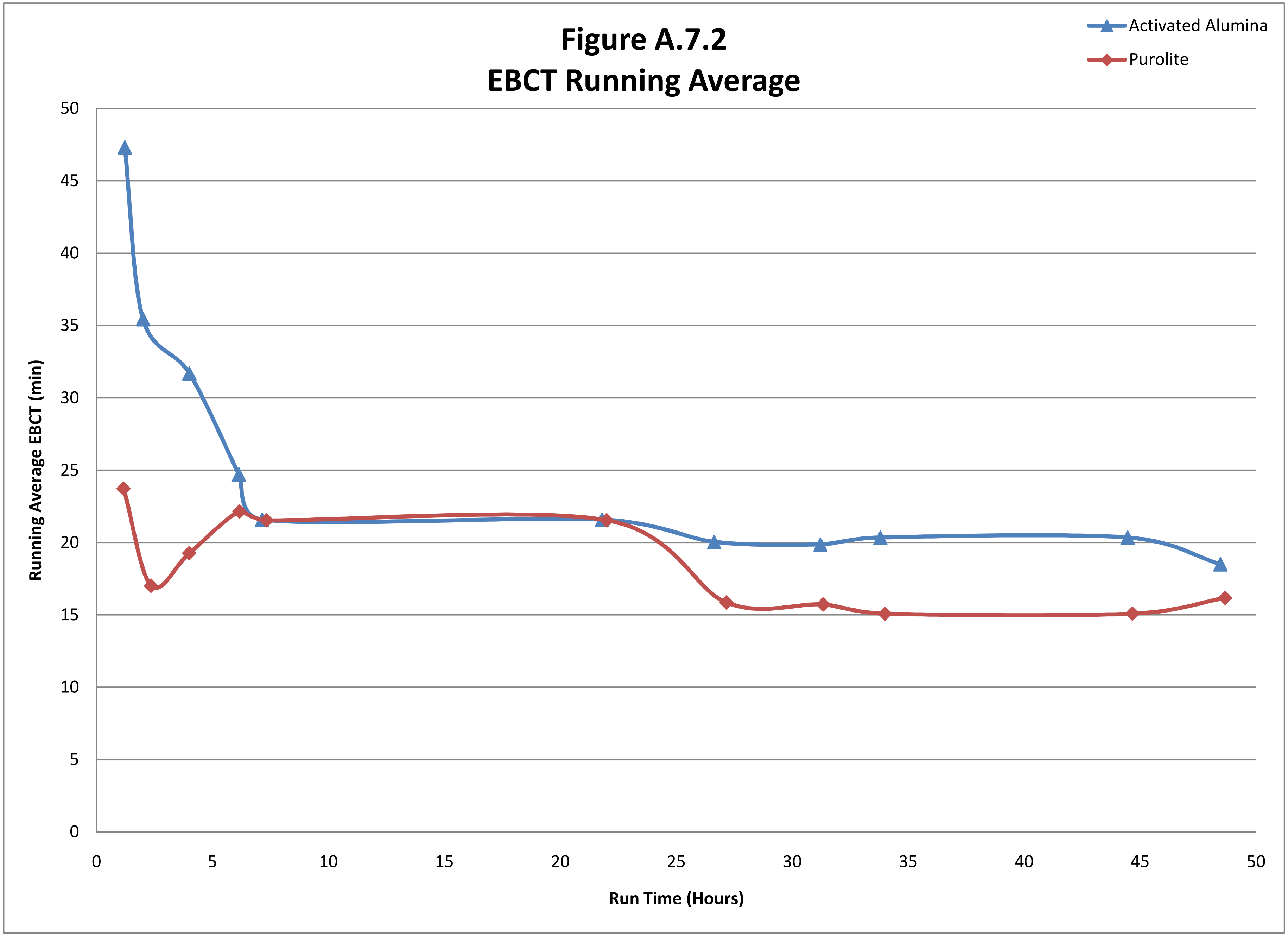


Figure A.7.2
EBCT Running Average

B&L Woodwaste Site
Pierce County, Washington

Engineering Design Report (EDR) Addendum 3

Phase 2 Part 1 Remediation Design Report

Groundwater Recovery and Treatment System

Appendix 3C
Engineering Calculations

FINAL

B&L Woodwaste Site

Process Design Calculations

Project: SE10160010

		min	avg	max		Notes
General						
	well water flow (usgpm)	15	40	60		Design Basis, Phase 2 Groundwater Remedy, B&L Woodwaste Site Cleanup Action Plan Implementation
Potassium Permanganate (KMnO4)						
	KMnO4 dose (mg per L of ww)	29	145	247		from "B&L EAE Final 12-2010.pdf" Appendix A
	KMnO4 solid consumption (lb/d)	5	70	178		
	KMnO4 solid consumption (lb/wk)	37	488	1245		
	concentration in day tank (g KMnO4 solid/L sol'n)	35	35	35		solubility is 63.8 g per L of water at 20 C, http://www.univareurope.com/uploads/documents/ie/POTPERM6PP2.pdf; reduced from 50 to 35 based on Larry's reccomendation during review of add 3
	KMnO4 sol'n usage (US gal/day)	18	239	609		
	liquid dosing rate (mL/min)	47	627	1600		
	liquid dosing rate (US gal/hr)	0.7	10	25		
	dose ratio (vol groundwater/vol KMnO4)	1207	241	142		
	KMnO4 tank vol (US gal)	1800	1800	1800		1200 from CH cost estimate, increased to 1800 after LM requested reduced concentration
	days of run time before new batch (d)	100.5	7.5	3.0		
Oxidation						
	oxidation tank volume (US gal)	1200	1200	1200		from CH cost estimate
	residence time (min)	80	30	20		
Lime						
	slurry solution (lb Ca(OH)2/US gal water)	3.5	3.5	3.5		email from Gilmour and Co. to CH, P:\B&L Landfill\IWO-013488.00 (TR1567)\Phase 3 Design\Cost Esimate\Quotes
	slurry solution (g Ca(OH)2/L)	419	419	419		unit conversion
	lime dose (g dry Ca(OH)2 / US gal ww)	5.95	5.95	5.95		B&L lab notes from CH Nov 29, 2010
	lime slurry dosing rate (US gal slurry/hr)	3.4	9.0	13.5		
	lime slurrry consumption (US gal slurry/day)	81	216	324		
	lime slurry tank vol (US gal)	4580	4580	4580		allows for 2500 US gal half load delivery, plus one week supply on hand
	days of run time before new load (d)	56.6	21.2	14.1		
Co-precipitation						
	co-precip tank volume (US gal)	1200	1200	1200		from CH cost estimate
	residence time (min)	80	30	20		
Lamella clarifier						
	design overflow rate (us gal/ft2.d)	300	300	300		300 - 800 gal/(ft2.d) is range for P removal in secondary clarifier, Table 8-7 M+E, pg 687
	effective settling area required (ft2)	72	192	288		
	angle (degrees)	55	55	55		LGN200FBX from CH cost estimate
	number of plates					
	area of each plate (ft2)					
	effective area of each plate (ft2)					
	actual total projected area (ft2)	160	160	160		LGN200FBX from CH cost estimate, larger of the two options
	actual overflow rate (us gal/ft2.d)	135	360	540		360 is appropriate according to BM; Parkson catalog info ranges from 200 to 900
	flash mix tank vol (us gal)	35	35	35		CH cost estimate, LGS 200/55
	flash mix tank res time (min)	2.3	0.9	0.6		typical rapid mix res time 5-30 sec, M+E Table 5-10 pg 348; 30 sec for metal salts from EPA P removal manual
	floc tank vol (us gal)	200	200	200		CH cost estimate, LGS 200/55
	floc tank res time (min)	13.3	5.0	3.3		typical floc res time 30-60 min, M+E Table 5-10 pg 348; 1 min for GM project, 15 min for CMP
polymer						
	polymer feed solution conc (wt/wt)	0.0005	0.001	0.002		CMP used .5%, lowered to .1% as per Dave's suggestion to reduce complications with fish-eyes, adjusted for min and max to keep 10:1 turndown for full range of pump flow
	polymer dose (L poly soln/m3 ww)	1.12	2.8	2.8		CMP design dose at floc tank, scaled up to new concentration
	consumption rate of polymer soln (us gal/d)	24.2	161.3	241.9		
	consumption rate of polymer soln (us gal/hr)	1.0	6.7	10.1		
	density of neat polymer (kg/L)	1.2	1.2	1.2		typical value selected, to be updated when polymer selected
	consumption rate of neat poly (us gal/d)	0.01	0.13	0.40		
	consumption rate of neat poly (us gal/wk)	0.1	0.9	2.8		
	polymer tank volume (us gal)	60	60	60		selected based on consumption rate above, made smaller as per WJM, only keep 3 hours on hand, automate based on level in day tank
	days of run time between batch (d)	0.8	0.1	0.1		batch volume is 1/3 of total tank volume
	hours of run time between batch (hr)	19.8	3.0	2.0		
	volume of dilute polymer batch (us gal)	20.0	20.0	20.0		
	time to make batch (min)	10.0	10.0	10.0		
	water flow (US gpm)	2.0	2.0	2.0		
	polymer per batch (mL)	31.5	63.1	126.1		
	neat polymer flow rate (ml/min)	3.2	6.3	12.6		
	neat polymer flow rate (US gal/hr)	0.05	0.1	0.2		
pH adjust						
	pH tank vol (us gal)	1200	1200	1200		from CH cost estimate
	residence time (min)	80	30	20		

	acid concentration (g H2SO4/mL of soln)	0.93	0.93	0.93		93% H2SO4, assume w/v
	H+ concentration (mol H+/L acid soln)	19.0	19.0	19.0		mw H2SO4 = 98.1
	mol H+ required (mol/US gal of ww)	0.0057	0.0287	0.0575		B&L lab notes from CH Nov 29, 2010, target pH of 6.6
	dosing rate (mL acid/min)	4.5	60.6	181.9		
	dosing rate (US gal acid/hr)	0.1	1.0	2.9		
	volume of acid tote (US gal)	265	265	265		http://www.industrial-tote.com/Totes_vs__Drums.html
	days of run time for tote (d)	153.2	11.5	3.8		
adsorption column						
	media volume per vessel (us gal)	300	300	300		200 gal from Rio Tinto Alcan email to CH Sept 21 2010; will have two vessels in series; increased by GP to 300 to have deeper bed, and provide 5 min EBCT at max flow
	bed volumes before exhaustion	40000	40000	40000		from Rio Tinto Alcan email to CH Sept 21 2010
	replacement time for media (d)	556	208	139		
	design flux rate (gpm/ft2)	3	3	5		2 to 7 gpm/ft2 recommendation from media manufacturer, email from Jon Mogan @ Axens, Apr 1, 2011
	req'd vessel area (ft2)	5	13.3	12		
	vessel diam (ft)	4	4	4		decreased from 5 to 4 by GP to get deeper bed, and still meet desired flux rate
	actual vessel area (ft2)	12.6	12.6	12.6		
	actual flux rate (gpm/ft2)	1.2	3.2	4.8		
	height of adsopbent in column (ft)	3.2	3.2	3.2		
sludge tank						
	sludge tank vol (us gal)	5264	5264	5264		flat bottom, 8 ft diam, 16 ft tall
	sludge production per day calculated (lb/d dry solids)	61	119	217		from "solids balance" sheet
	solids concentration from inf well water after chem add (mg/L)	336	247	301		from "solids balance" sheet, after oxidation and co-precip
	design value (lb dry solids/d)	61	137	325		50% safety factor added to calculated value, 15% safety factor on average
	solids to filter press (lb dry solids/d)	64	144	342		based on mass balance around filter press and around full system
	TSS to lamella clarifier (mg/L)	354	300	475		
	sludge solids content (% wt)	2.0	1.5	1.0		based on discussion with Russ Cook at Parkson, assuming solids recycle, might get 2% at best
	sludge density (kg/L)	1.0	1.0	1.0		based on density of Fe(OH)3 of about 2.6 to 3 kg/L
	sludget vol produced per day (us gal/d)	370	1123	4005		
	sludget vol produced (us gpm)	0.3	0.8	2.8		
	sludget vol produced (us gal/hr)	15	47	167		
	days of run time (d)	14.2	4.7	1.3		
sludge recycle						
	target solids content in co-precip tank mg/L	1000.0	1000.0	1000.0		as per Parkson recommendation
	sludge underflow concentration (mg/L)	20640	15360	10240		
	sludge recycle rate (us gal/hr)	29.6	117.1	204.7		
	nominal pump flow (US gpm)	2.0	6.2	6.2		
	total cycle minutes	10.0	10.0	10.0		
	minutes to sludge storage	1.3	1.3	4.5		
	minutes to recycle	2.5	3.2	5.5		
	minutes pump off	6.2	5.6	0.0		
	check gal/hr to storage	15.4	46.8	166.9		
	check gal/hr to recycle	29.6	117.1	204.7		
filter press						
	capacity (ft3 of cake per cycle)	30	30	30		changed to larger press due to 3 or 4 hour cycle time
	cake solids content (% wt)	25	25	25		Patterson, pg 18
	wet solids per cycle (lb/cycle)	2622	2622	2622		
	dry solids per cycle (lb/cycle)	655	655	655		
	cycles required per day (cycle/d)	0.1	0.2	0.5		
	cycles per week (cycle/wk)	0.6	1.5	3.5		
	solids capture (solids in cake/solids in inf sludge)	0.95	0.95	0.95		typical value with chemical, M+E pg 1593
	filter cake volume (ft3/d)	2.8	6.3	14.9		
	filter cake volume (ft3/wk)	19.4	43.8	104.2		
	filter cake solids (lb/d)	61	136.8	325		
	filter cake solids (lb/wk)	424	957	2276		
	filter cake density (kg/L)	1.4	1.4	1.4		based on density of Fe(OH)3 of about 2.6 to 3 kg/L
	filter cake volume (us gal/d)	21	47	111		
	wet filter cake wt (lb/d)	242	547	1300		
	wet filter cake wt (lb/wk)	1696	3830	9103		10 ton wt limit of roll-off
	solids in filtrate (lb/d)	3.2	7.2	17.1		
	volume of filtrate (us gal/d)	349	1076	3893		
	volume of filtrate (us gal/min)	0.24	0.75	2.70		insignificant flow increase
	conc of filtrate (mg/L)	1093	801	527		

	A	B	C	D	E
1	**B&L Woodwaste Site**				
2	Process Design Calculations				
3	Project: SE10160010				
4			**min**	**avg**	**max**
5	**General**				
6		well water flow (usgpm)	15	40	60
7					
8	**Potassium Permanganate (KMnO4)**				
9		KMnO4 dose (mg per L of ww)	=D9*0.2	=29.1/53*264.17*1000/1000	=D9*1.7
10		KMnO4 solid consumption (lb/d)	=C6*C9*1000/264.17*60*24/1000/1000*2.20462	=D6*D9*1000/264.17*60*24/1000/1000*2.20462	=E6*E9*1000/264.17*60*24/1000/1000*2.20462
11		KMnO4 solid consumption (lb/wk)	=C10*7	=D10*7	=E10*7
12		concentration in day tank (g KMnO4 solid/L sol'n)	=D12	35	=D12
13		KMnO4 sol'n usage (US gal/day)	=C10/C12*1000/2.20462*264.17/1000	=D10/D12*1000/2.20462*264.17/1000	=E10/E12*1000/2.20462*264.17/1000
14		liquid dosing rate (mL/min)	=C13*1000/264.17*1000/24/60	=D13*1000/264.17*1000/24/60	=E13*1000/264.17*1000/24/60
15		liquid dosing rate (US gal/hr)	=C13/24	=D13/24	=E13/24
16		dose ratio (vol groundwater/vol KMnO4)	=min*1000000/264.17/C14	=avg*1000000/264.17/D14	=max*1000000/264.17/E14
17		KMnO4 tank vol (US gal)	=D17	1800	=D17
18		days of run time before new batch (d)	=C17/C13	=D17/D13	=E17/E13
19					
20	**Oxidation**				
21		oxidation tank volume (US gal)	=D21	1200	=D21
22		residence time (min)	=C21/C6	=D21/D6	=E21/E6
23					
24	**Lime**				
25		slurry solution (lb Ca(OH)2/US gal water)	=D25	3.5	=D25
26		slurry solution (g Ca(OH)2/L)	=C25*1000/2.20462*264.17/1000	=D25*1000/2.20462*264.17/1000	=E25*1000/2.20462*264.17/1000
27		lime dose (g dry Ca(OH)2 / US gal ww)	=D27	=29.75/5	=D27
28		lime slurry dosing rate (US gal slurry/hr)	=C27*C6/C25*2.20462/1000*60	=D27*D6/D25*2.20462/1000*60	=E27*E6/E25*2.20462/1000*60
29		lime slurrry consumption (US gal slurry/day)	=C28*24	=D28*24	=E28*24
30		lime slurry tank vol (US gal)	=D30	4580	=D30
31		days of run time before new load (d)	=C30/C29	=D30/D29	=E30/E29
32					
33	**Co-precipitation**				
34		co-precip tank volume (US gal)	=D34	1200	=D34
35		residence time (min)	=C34/C$6	=D34/D$6	=E34/E$6
36					
37	**Lamella clarifier**				
38		design overflow rate (us gal/ft2.d)	=D38	300	300
39		effective settling area required (ft2)	=C6/C38*60*24	=D6/D38*60*24	=E6/E38*60*24
40					
41		angle (degrees)	=D41	55	=D41
42		number of plates			
43		area of each plate (ft2)			
44		effective area of each plate (ft2)			
45		actual total projected area (ft2)	=D45	160	=D45
46		actual overflow rate (us gal/ft2.d)	=C6/C45*60*24	=D6/D45*60*24	=E6/E45*60*24
47					
48		flash mix tank vol (us gal)	=D48	35	=D48
49		flash mix tank res time (min)	=C48/C$6	=D48/D$6	=E48/E$6
50					
51		floc tank vol (us gal)	=D51	200	=D51
52		floc tank res time (min)	=C51/C$6	=D51/D$6	=E51/E$6
53					
54	**polymer**				
55		polymer feed solution conc (wt/wt)	0.0005	0.001	0.002
56		polymer dose (L poly soln/m3 ww)	=0.56/C55*0.005*0.2	=0.56/D55*0.005	=0.56/E55*0.005*2
57		consumption rate of polymer soln (us gal/d)	=C56*C$6*1440/1000	=D56*D$6*1440/1000	=E56*E$6*1440/1000
58		consumption rate of polymer soln (us gal/hr)	=C57/24	=D57/24	=E57/24
59		density of neat polymer (kg/L)	=D59	1.2	=D59
60		consumption rate of neat poly (us gal/d)	=C57*C55/C59	=D57*D55/D59	=E57*E55/E59
61		consumption rate of neat poly (us gal/wk)	=C60*7	=D60*7	=E60*7
62					
63		polymer tank volume (us gal)	=D63	60	=D63
64		days of run time between batch (d)	=C63/C57*0.333	=D63/D57*0.333	=E63/E57*0.333
65		hours of run time between batch (hr)	=C64*24	=D64*24	=E64*24
66					
67		volume of dilute polymer batch (us gal)	=C63*0.333	20	=E63*0.333
68		time to make batch (min)	=D68	10	=D68
69		water flow (US gpm)	=C67/C68	=D67/D68	=E67/E68
70		polymer per batch (mL)	=C67*1000/264.17*1*C55/C59*1000	=D67*1000/264.17*1*D55/D59*1000	=E67*1000/264.17*1*E55/E59*1000
71		neat polymer flow rate (ml/min)	=C70/C68	=D70/D68	=E70/E68
72		neat polymer flow rate (US gal/hr)	=C71/1000*264.17/1000*60	=D71/1000*264.17/1000*60	=E71/1000*264.17/1000*60
73					
74	**pH adjust**				
75		pH tank vol (us gal)	=D75	1200	=D75
76		residence time (min)	=C75/C$6	=D75/D$6	=E75/E$6
77					
78		acid concentration (g H2SO4/mL of soln)	=D78	0.93	=D78
79		H+ concentration (mol H+/L acid soln)	=D79	=D78*1000/98.1*2	=D79
80		mol H+ required (mol/US gal of ww)	=D80*0.2	=535/51*2.74/1000	=D80*2
81		dosing rate (mL acid/min)	=C80*C6/C79*1000	=D80*D6/D79*1000	=E80*E6/E79*1000
82		dosing rate (US gal acid/hr)	=C81*60*264.17/1000000	=D81*60*264.17/1000000	=E81*60*264.17/1000000
83		volume of acid tote (US gal)	=D83	265	=D83
84		days of run time for tote (d)	=C83/(C82*24)	=D83/(D82*24)	=E83/(E82*24)
85					
86	**adsorption column**				
87		media volume per vessel (us gal)	=D87	300	=D87
88		bed volumes before exhaustion	=D88	40000	=D88
89		replacement time for media (d)	=C87*C88/C$6/60/24	=D87*D88/D$6/60/24	=E87*E88/E$6/60/24
90		design flux rate (gpm/ft2)	=D90	3	5
91		req'd vessel area (ft2)	=min/C90	=avg/D90	=max/E90
92		vessel diam (ft)	=D92	4	=D92
93		actual vessel area (ft2)	=C92^2*PI()/4	=D92^2*PI()/4	=E92^2*PI()/4
94		actual flux rate (gpm/ft2)	=min/C93	=avg/D93	=max/E93
95		height of adsopbent in column (ft)	=C87/7.4805/C93	=D87/7.4805/D93	=E87/7.4805/E93
96					
97	**sludge tank**				
98		sludge tank vol (us gal)	=D98	5264	5264
99		sludge production per day calculated (lb/d dry solids)	='solids balance'!F25*2.20462	='solids balance'!F9*2.20462	='solids balance'!F41*2.20462
100		solids concentration from inf well water after chem add (mg/L)	='solids balance'!F25*1000000/min/1440*264.17/1000	='solids balance'!F9*1000000/avg/1440*264.17/1000	='solids balance'!F41*1000000/max/1440*264.17/1000
101		design value (lb dry solids/d)	=C99*1	=D99*1.15	=E99*1.5
102		solids to filter press (lb dry solids/d)	=C101/C131	=D101/D131	=E101/E131
103		TSS to lamella clarifier (mg/L)	=C102/min/1440*264.17/1000/2.20462*1000000	=D102/avg/1440*264.17/1000/2.20462*1000000	=E102/max/1440*264.17/1000/2.20462*1000000
104		sludge solids content (% wt)	2	1.5	1
105		sludge density (kg/L)	=C104/100*2.6+(100-C104)/100	=D104/100*2.6+(100-D104)/100	=D105
106		sludget vol produced per day (us gal/d)	=C102/(C104/100)/C105*264.17/1000/2.20462	=D102/(D104/100)/D105*264.17/1000/2.20462	=E102/(E104/100)/E105*264.17/1000/2.20462
107		sludget vol produced (us gpm)	=C106/24/60	=D106/24/60	=E106/24/60
108		sludget vol produced (us gal/hr)	=C107*60	=D107*60	=E107*60
109		days of run time (d)	=C98/C106	=D98/D106	=E98/E106
110					
111	**sludge recycle**				
112		target solids content in co-precip tank mg/L	=D112	1000	=D112
113		sludge underflow concentration (mg/L)	=C102/C106*1000/2.20462*264.17	=D102/D106*1000/2.20462*264.17	=E102/E106*1000/2.20462*264.17
114		sludge recycle rate (us gal/hr)	=(min*60*C103-min*60*C112)/(C112-C113)	=(avg*60*D103-avg*60*D112)/(D112-D113)	=(max*60*E103-max*60*E112)/(E112-E113)
115		nominal pump flow (US gpm)	2	=E115	=(E108+E114)/60
116		total cycle minutes	=D116	10	10
117		minutes to sludge storage	=C108/(60/C116*C115)	=D108/(60/D116*D115)	=E108/(60/E116*E115)
118		minutes to recycle	=C114/(60/C116*C115)	=D114/(60/D116*D115)	=E114/(60/E116*E115)
119		minutes pump off	=C116-C117-C118	=D116-D117-D118	=E116-E117-E118
120		check gal/hr to storage	=C117*60/C116*C115	=D117*60/D116*D115	=E117*60/E116*E115
121		check gal/hr to recycle	=C118*60/C116*C115	=D118*60/D116*D115	=E118*60/E116*E115
122					
123	**filter press**				
124		capacity (ft3 of cake per cycle)	=D124	30	=D124
125		cake solids content (% wt)	=D125	25	=D125
126		wet solids per cycle (lb/cycle)	=C124*28.317*C136*2.20462	=D124*28.317*D136*2.20462	=E124*28.317*E136*2.20462
127		dry solids per cycle (lb/cycle)	=C125/100*C126	=D125/100*D126	=E125/100*E126
128		cycles required per day (cycle/d)	=C134/C127	=D134/D127	=E134/E127

	A	B	C	D	E
129		cycles per week (cycle/wk)	=C128*7	=D128*7	=E128*7
130					
131		solids capture (solids in cake/solids in inf sludge)	=D131	0.95	=D131
132		filter cake volume (ft3/d)	=C128*C124	=D128*D124	=E128*E124
133		filter cake volume (ft3/wk)	=C132*7	=D132*7	=E132*7
134		filter cake solids (lb/d)	=C102*C131	=D102*D131	=E102*E131
135		filter cake solids (lb/wk)	=C134*7	=D134*7	=E134*7
136		filter cake density (kg/L)	=D136	=D125/100*2.6+(100-D125)/100	=D136
137		filter cake volume (us gal/d)	=C124*C128*7.4805	=D124*D128*7.4805	=E124*E128*7.4805
138		wet filter cake wt (lb/d)	=C128*C126	=D128*D126	=E128*E126
139		wet filter cake wt (lb/wk)	=C138*7	=D138*7	=E138*7
140					
141		solids in filtrate (lb/d)	=(1-C131)*C102	=(1-D131)*D102	=(1-E131)*E102
142		volume of filtrate (us gal/d)	=C106-C137	=D106-D137	=E106-E137
143		volume of filtrate (us gal/min)	=C142/1440	=D142/1440	=E142/1440
144		conc of filtrate (mg/L)	=C141/C142*264.17*1000/2.20462	=D141/D142*264.17*1000/2.20462	=E141/E142*264.17*1000/2.20462

B&L Woodwaste Site
Pierce County, Washington

Engineering Design Report (EDR) Addendum 3

Phase 2 Part 1 Remediation Design Report

Groundwater Recovery and Treatment System

Appendix 3D
Spill Prevention and Containment Plan

FINAL

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Attachment 3D.1 Spill Response Notification Form

Attachment 3D.2 Material Safety Data Sheets *(to be added as materials come on-site)*

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1.0 Introduction

This Spill Prevention and Containment Plan (SPCP) has been prepared as part of the Engineering Design Report (EDR) Addendum 3 for the B&L Woodwaste Site (Site) in Pierce County, Washington. This SPCP addresses potential spills related to the construction activities associated with the Phase 2 cleanup action. Potential releases due to stormwater runoff are addressed in the Stormwater Pollution Prevention Plan (Appendix 3E to Addendum 3).

The purpose of this SPCP is to ensure practices and procedures are in place to minimize the potential for a spill or release of pollutants into the environment or the navigable waters of the United States or waters of the State during the construction activities. This SPCP addresses the following:

- Potential spill sources associated with the construction activities.
- Procedures, methods, equipment, and other requirements to prevent spills from occurring and potentially discharging into waters of the State.
- Whom to contact in the event of a spill.
- Spill response procedures in the event a spill occurs.

A copy of this SPCP shall be kept at the construction site and shall be familiar to construction personnel.

The remainder of this document is organized as follows:

- Section 2 provides facility identification information.
- Section 3 provides project background and work area description.
- Section 4 describes the existing stormwater drainage system.
- Section 5 identifies potential spill sources in the work area and describes spill prevention and containment measures that will be implemented to prevent spills/releases.
- Section 6 describes the procedures that should be implemented in the event of a spill in the work area.
- Section 7 describes training procedures that will be implemented to ensure on-site workers understand the potential spill sources and spill response procedures.

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2.0 Facility Identification

Facility Name:	B&L Woodwaste Site
Type of Facility:	Non-operating woodwaste landfill
Location of Facility:	Pierce County, Washington
Township and Range:	Township 20 North, Range 4 East, Section 5
Owner/Operator of Facility:	B&L Woodwaste Site Custodial Trust 606 Columbia Street NW Olympia, WA 98501
Spill Response Coordinator:	TBD

The spill response coordinator shall be responsible for implementation of this SPCP.

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3.0 Project Background and Work Area Description

The Site is located in unincorporated Pierce County, Washington, in Township 20 North, Range 4 East, Section 5, Willamette Meridian. The Site consists of the B&L Property (Property), which includes the B&L Woodwaste Landfill (Landfill), and adjacent areas that have been affected by releases from the Landfill. The Property occupies about 18.5 acres of undeveloped land approximately 0.25 mile east of Interstate 5 and 5 miles east of Tacoma. Within the Property, the Landfill encompasses roughly 11.5 acres and rises to an elevation of approximately 53 feet (NAVD88). Farmland borders the western and southwestern edges of the Property, the Autumn Village Apartment complex adjoins the southeastern corner, and Fife Way defines the eastern boundary. A private property is located to the northeast of the property and Puget Power Access Road, which has been converted to a bicycle trail and is now known as the Interurban Trail, borders the north side of the Property. Former farmland that has re-established itself as a grassy wetland lies to the north of the Property and Interurban Trail.

Beginning in the 1970s, the Landfill was operated as a disposal site for deck debris from log sort yards operating in the Tacoma Tideflats area. Log sort yard operators used Asarco slag as roadway and yard ballast, believing it to be inert “rock.” The slag was mixed with the bark and dirt that was periodically cleaned from the log sort yards and transported to the Landfill for disposal. During the 1980s, Ecology discovered that the slag at the Landfill was leaching arsenic at concentrations in exceedance of surface water standards. The Landfill was included as a source of metal contamination to Hylebos Waterway and the Commencement Nearshore/Tideflats CERCLA site by the U.S. Environmental Protection Agency. Remediation and monitoring activities at the Landfill began in the late 1980s and have continued through the present day.

The work area for the Phase 2 cleanup action is within the Property and adjacent wetlands, as shown in Drawing EC-01 of EDR Addendum 3. Construction activities include installation of a groundwater treatment system, installation of monitoring and extraction wells, installation of conveyance piping and utilities to transport the groundwater for treatment, and construction of a structure on the Property to house the treatment system. Treated groundwater will be piped to the North pond and overflow to the existing agricultural ditch system.

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4.0 Existing Stormwater Drainage

The ground surface on the Property is mostly vegetated with grass. The Property topography is characterized by a mound in the middle, where the Landfill and access road are located, and lower elevation in the perimeter area outside the landfill cap. The landfill cap slopes downward towards the access road from the topographical high in the middle. The access road is higher than the perimeter ground surface by approximately 4 to 5 feet. Agricultural ditches that collect surface runoff from agricultural farmlands are located along the southern, western, and northern boundaries of the Property. The agricultural ditches join with water from the Surprise Lake Drain and ultimately discharge to Hylebos Creek.

Stormwater runoff from the landfill cap presently drains to the stormwater collection ditch around the perimeter of the landfill cap. The ditch collects cap runoff and drainage and discharges to the stormwater detention pond immediately north of the Landfill through three culverts. An overflow pipe in the north detention pond discharges into the agricultural ditch along the northern boundary of the Property. Stormwater runoff from the perimeter road either drains inward to the perimeter ditch or drains outward via overland flow to the agricultural ditches. Stormwater runoff from the topographically low area to the east of the Landfill drains via a culvert to the agricultural ditch. A spill in the work area could reach waters of the state through surface runoff; therefore, spills will be removed in a timely manner in order to prevent the material from leaving the work or containment areas and affect the wetlands or the agricultural ditches.

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5.0 Potential Spill Sources, Spill Prevention, and Containment Features

This section identifies potential spill sources associated with the planned construction and describes spill prevention and containment measures that will be implemented to prevent spills/releases.

5.1 CONSTRUCTION ACTIVITIES

The Contractor will perform the work in such a way as to minimize escape of materials and pollution into the surrounding environment. This section provides general requirements for preventing spills of hazardous materials.

5.1.1 Potential Spill Source

Potential fuel spill sources associated with general construction activity include leaks of hydraulic fluid or coolant or other material used in construction from the construction equipment and leaks or spills during performance of the work, and maintenance and/or repair of construction equipment. Maintenance activities typically involve oil changes, hydraulic system drain down, coolant flushing, greasing, cleaning, etc. All equipment will have absorbent pads or other spill response materials to use in the event of spills or leaks. Other materials used in construction related activities will be stored and used in very small quantities (e.g., adhesive for bonding plastic liner in the cap or piping).

The work has been designed to minimize the potential for encountering groundwater during subsurface excavation. Any groundwater encountered during trenching activities in the wetlands will be assumed contaminated with arsenic and will be contained in the trench. If necessary to complete the work, groundwater in trenches will be pumped to a temporary storage tank, tested, and if necessary, treated or disposed of at an approved off-site facility. If groundwater is temporarily stored, there is a potential for spills during transfer or releases from the tank.

Groundwater will also be temporarily stored in tanks during startup and performance testing of the groundwater treatment system. Storage of this water creates a potential for spills during transfer or releases from the tanks.

5.1.2 Spill Prevention and Containment Features

Fuel and oil spills will be removed in a timely manner so as not to allow it to leave the work or containment areas and affect the wetlands or the agricultural ditches.

If arsenic-contaminated groundwater is spilled, the area of the spill will be bermed and contained to prevent the water from entering surface waters. The water will then be pumped to appropriate containment.

5.2 FUEL STORAGE AND HANDLING

5.2.1 Potential Spill Source

No on-site central fueling area will be established. A vendor fueling truck will periodically come on-site to fuel the equipment. Only small amounts of fuel will be stored on-site, less than 100 gallons and all fuel storage containers will be stored within secondary containment. There is a potential for fuel spills during fueling activities.

5.2.2 Spill Prevention and Containment Features

The following procedures will be implemented to prevent spills during equipment fueling and maintenance operations:

- The vendor tanker truck driver as well as an on-site construction worker will be present during fuel tank replenishment. Construction workers will be on-site during all fuel transfers.
- The amount of fuel to be added to equipment should be determined prior to starting fueling operations.
- Oil- and fuel-absorbent material will be readily available during all oil and fuel handling and transfer operations to contain any inadvertent spills that may occur.
- Spill buckets will be used during all fuel and oil transfers to catch any drips or leaks during fueling and maintenance operations.
- When transferring petroleum products, connections and transfer points will be carefully monitored for leaks.
- Equipment fuel tanks will never be topped off completely. Adequate headspace at the top of the tank will be left to allow for product expansion.
- Equipment receiving fuel and oil will be carefully checked prior to and during delivery to ensure that there are no leaks or open drain valves.
- When possible, maintenance of equipment will be performed in a contained area, such as the decontamination area.

Spill response materials including, but not limited to, the following: containers, absorbents, shovels, and personal protective equipment (PPE) will be available on-site near significant work areas. Spill response materials will be available at all times in areas where potentially hazardous materials and/or landfill refuse are being excavated, accumulated, handled, or transported. Miscellaneous equipment and tools necessary to handle hazardous materials in a safe and environmentally sound manner will be provided, including emergency response equipment to respond to releases, fires, and explosions involving hazardous materials.

6.0 Spill Response Procedures

This section describes the procedures that should be implemented in the event of a spill at the Site. Spills at the Site are not anticipated to enter the sanitary sewer system, as no inlets to the sanitary sewer are present on the Property.

6.1 NOTIFICATION

Discovery of **any** spill at the Site shall be immediately reported to the Engineer. Discovery of any spill at the Site that leaves the work area and reaches a nearby waterway (i.e., agricultural ditches) or any spill that exceeds 10,000 pounds shall be **immediately** reported to the agencies listed below:

Agencies for Spill Notification

Personnel/Agency	*Phone Number*
National Response Center (NRC)	1-800-424-8802
Washington Division of Emergency Management	1-800-258-5990 or 1-800-OILS-911
Washington Department of Ecology (Southwest Regional Office) Spill Compliance Section	1-360-407-6300
Environmental Protection Agency, Region 10	1-206-553-1263

In the event of a fire or security problem associated with the spill, the following agencies shall be immediately contacted as appropriate for emergency assistance:

FIRE:	City of Milton Fire Department, Phone 911 / (253) 922-0944
POLICE:	City of Milton Police Department, Phone 911 / (253) 922-8735

6.2 SPILL REPORTING AND DOCUMENTATION

In the event of a spill, personnel identified in Section 6.1 shall be notified. The Construction Manager shall be responsible for completing the Spill Notification Form (Attachment 3D.1). **It is not necessary to complete the Spill Notification Form before calling the agencies listed in Section 6.1.** All spills at the Site, regardless of volume, shall be documented. The designated Spill Response Coordinator is responsible for any verbal and follow-up reporting with the regulatory agencies as deemed necessary based on discussions with site personnel.

Agencies may request written follow-up notification following a verbally reported spill incident. The Spill Notification Form (Attachment 3D.1) will be used for any required written notification to local, state, and federal government agencies.

For hazardous substance releases, Washington Department of Ecology (Ecology) regulations [WAC-173-303-360(k)] require written notification within 15 days of the spill incident. The notification report must include the following:

- Name, address, and telephone number of the owner or operator.
- Name, address, and telephone number of the facility.
- Date, time, and type of incident (spill to water, spill to land, fire, etc.).
- Name and quantity of material(s) involved.
- The extent of injuries, if any.
- An assessment of actual or potential hazards to human health or the environment, where applicable.
- Estimated quantity and disposition of recovered material that resulted from the incident.
- Cause of incident.
- Description of corrective action taken to prevent reoccurrence of the incident.

The report must be submitted to the following address:

Washington Department of Ecology – Southwest Regional Office
Hazardous Waste and Toxics Reduction Department
300 Desmond Drive
Lacey, WA 98503

6.3 SPILL RESPONSE AND CONTROL

When a spill occurs, the following basic actions shall be implemented, **if it is safe to do so**:

- Control the access area.
- Identify the hazards.
- Rescue personnel.
- Stop or control further releases.
- Contain the spilled material.
- Implement clean-up measures.
- Recover the spilled substance.
- Establish proper decontamination procedures.

Section 6.3.1 describes the spill response procedures for fuel/oil spills. Section 6.3.2 describes the spill response procedures for all other types of spills.

6.3.1 Fuel/Oil Spills

This section discusses the response and control of minor fuel/oil spills (less than 10 gallons) and major fuel/oil spills (greater than 10 gallons).

Minor Spills (less than 10 gallons)

Minor spills can occur from disconnection of hoses, hose or fitting leakage or failure, pump leaks, and overfilling of tanks. These types of spills are typically less than 10 gallons and are limited to the surface area around the equipment fueling or maintenance area. These types of spills can typically be cleaned up by trained personnel or contractors.

If minor spills do occur, the on-site supervisor shall: (1) direct cleanup of the spill using personnel or contractors and absorbent materials on hand at the facility, (2) report the spill as directed in Section 6.1, and (3) fill out the Spill Notification Form (Attachment 3D.1). Do not dispose of spill cleanup waste in the facility's trash containers. Any fuel/oil that has been released or any fuel/oil-contaminated media (such as absorbent materials) from a spill or overfill must be properly disposed off-site in accordance with all applicable local, state, and federal regulations.

Major Spills (greater than 10 gallons)

In a worst-case scenario, the maximum amount of fuel/oil to be released would be the entire contents of a fuel tanker truck, estimated at approximately 5,000 gallons. A spill of this magnitude on-site could possibly enter the agricultural ditches and then discharge to the Hylebos Creek.

If a major release occurs, the following actions shall be immediately implemented, **if it is safe to do so**:

1. Stop the release if safely possible and practical. For example,
    - apply personal protective equipment,
    - close valves,
    - shut off pumps,
    - seal holes with nonmetallic plugs or caps,
    - remove fuel/oil from the tank to below the level of the hole where the oil is being released.
2. Follow the notification procedure in Section 6.1 of this SPCP.

3. Identify and mitigate fire, explosion, and vapor hazards:
    - Eliminate possible sources of ignition.
    - Shut off engines, if necessary.
    - Shut off electrical power, if necessary.
4. Contain the spill and stop it from spreading:
    - Soak up as much of the spilled material as possible with absorbent materials.
    - Identify the drainage route of the spill and locate a capture site where the spilled material may pond or be diverted or contained. Blocking drainage using absorbent materials is preferred over ditching when practical.
    - Place absorbent materials and booms at the entrance to any nearby drains (if they are not already covered) or bodies of water.
    - Put up "CAUTION" tape or other temporary barriers to prevent unauthorized personnel from entering the spill area, if necessary.
5. Assist spill response personnel, if requested to do so:
    - Continue to monitor and mitigate fire and safety hazards.
    - Clean affected surfaces of residual spillage.
    - Dispose of all dispensable contaminated materials properly. Do not place these materials in standard waste containers. Any fuel/oil that has been released or any fuel/oil-contaminated media (such as absorbent materials) from a spill or overfill must be properly disposed of in accordance with all applicable local, state, and federal regulations.
6. Document the spill:
    - Fill out the Spill Notification Form (Attachment 3D.1).

6.3.2 Other Spills

Whereas most oil products tend to behave in a consistent manner and require similar spill response procedures, spill response procedures for hazardous substances vary according to the nature of the substance. For this reason, spill response personnel should use extreme caution until the hazardous substance is identified. It may be necessary to delay response actions until safe levels of exposure are determined. Spill response procedures should be based on the hazardous substances' chemical behavior and potential health effects.

Copies of Material Safety Data Sheets (MSDS) for all hazardous materials brought on-site will be attached to this SPCP (as Attachment 3D.2) so that they are readily available in the event of a spill.

6.3.3 Spill Response Equipment

A spill kit containing the following items shall be maintained at the facility:

- 20-gallon plastic container/recovery drum
- Sorbent booms and socks
- Sorbent pads
- Sorbent material
- Disposal bags/ties
- Barrier tape
- Plastic shovel
- Broom
- Rubber boots, gloves, safety glasses, etc.

Because much of the work will be conducted in areas some distance from the staging area, small spill kits will be maintained in all vehicles and construction equipment. These smaller spill kits will include the following:

- 5-gallon plastic bucket
- Sorbent booms (if working in wetland area or near a ditch)
- Sorbent pads and socks
- Small amount of sorbent material
- Disposal bags/ties
- Rubber gloves.

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7.0 Training

All personnel on-site shall be familiar with the spill prevention and response procedures described in this SPCP. Prior to starting any work on-site, personnel shall be briefed on the contents of this SPCP and shall be made aware of where the SPCP is maintained on-site. All personnel will be aware of the locations of all spill response materials and appropriate use.

Daily tailgate safety meeting will be conducted prior to the start of the work day to discuss potential hazards and safety issues.

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B&L Woodwaste Site
Pierce County, Washington

Engineering Design Report (EDR) Addendum 3

Phase 2 Part 1 Remediation Design Report

Groundwater Recovery and Treatment System

Attachment 3D.1
Spill Response Notification Form

FINAL

Attachment 3D.1
Spill Response Notification Form

NAME AND PHONE NUMBER OF PERSON COMPLETING FORM	
Date & Time Form Completed/Updated	
REPORTER INFORMATION	
Date and Time Initial Spill Report Received	
REPORTER'S NAME (LAST, FIRST)	
REPORTER'S PHONE NUMBER	
Company	
Position	
Reporter's Location	Street:
	City:
	State and Zip Code:
INCIDENT DESCRIPTION	
MATERIAL RELEASED	☐ Oil/Fuel Type of Fuel _________________ ☐ Hazmat/Unknown Chemical Name & CHRIS Code__________
	Is material a CERCLA Hazardous Substance? ☐ Yes ☐ No Is material an Extremely Hazardous Substance? ☐ Yes ☐ No
	Best Estimate of Quantity Released to Land ____________(include units) Best Estimate of Quantity Released to Water ____________(include units)
	Is material still being released ☐ Yes ☐ No Current Spill Rate__________
TYPE OF INCIDENT **(CHECK ALL THAT APPLY)**	______ Inside building or containment area ______ Navigable water (freshwater, marine, wetland, storm drain) ______ Release to sanitary sewer ______ Fire ______ Explosion ______ Air release
SOURCE AND CAUSE OF INCIDENT	
DATE AND TIME OF INCIDENT	

Attachment 3D.1
Spill Response Notification Form

INCIDENT ADDRESS/LOCATION	
Street	
City, State and Zip Code	
County	
Township, Range, Section	
Nearest City & Distance from City (miles)	
Container Type & Capacity (include units)	
Weather Conditions	
Wind speed and direction; Temperature	
Precipitation Rate and Type	
Wave\Current Information	
RESPONSE ACTIONS	
Initial Actions Taken	
Actions Taken to Stop Release	
Actions Taken to Contain Release	
Actions Taken to Cleanup Release	
IMPACT/HEALTH THREATS	
NUMBER OF INJURIES	
NUMBER OF DEATHS	
EVACUATION(S) REQUIRED	Yes NO
Description of Areas to be Evacuated and Areas Already Evacuated including Number Evacuated	
Was There Any Property Damage?	YES NO

Attachment 3D.1
Spill Response Notification Form

Damage in Dollars (estimated)			
Environmental Media Affected			
Description of Environmental and Health Threats			
Additional Information: Any information about the incident not recorded elsewhere in the report			
AGENCY NOTIFICATIONS			
National Response Center	YES TIME:	NO	NRC Call No.___________________
WA State Dept. of Emergency Management	YES	NO	TIME:
WA State Dept. of Ecology	YES	NO	TIME:
Environmental Protection Agency, Region 10	YES	NO	TIME:
Other (List)	YES	NO	TIME:
Other (List)	YES	NO	TIME:
Other (List)	YES	NO	TIME:
Other (List)	YES	NO	TIME:

B&L Woodwaste Site
Pierce County, Washington

Engineering Design Report (EDR) Addendum 3

Phase 2 Part 1 Remediation Design Report

Groundwater Recovery and Treatment System

Attachment 3D.2
Material Safety Data Sheets

(To be added as materials come on-site)

FINAL

B&L Woodwaste Site
Pierce County, Washington

Engineering Design Report (EDR) Addendum 3

Phase 2 Part 1 Remediation Design Report

Groundwater Recovery and Treatment System

Appendix 3E
Stormwater Pollution Prevention Plan

FINAL

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1.0 Introduction

This Construction Stormwater Pollution Prevention Plan (SWPPP) has been prepared as part of the Engineering Design Report Addendum 3 (EDR Addendum 3) for the B&L Woodwaste Site (Site) in Pierce County, Washington. This SWPPP addresses management of stormwater runoff from the construction activities associated with Phase 2 of the cleanup action, which will include construction of a groundwater extraction system, treatment plant, and the associated network of piping.

This SWPPP does not address spills of materials used during construction; the plans and procedures for spill management are presented in the Spill Prevention and Containment Plan (Appendix 3D to EDR Addendum 3).

Based on consultation with the Washington State Department of Ecology (Ecology), a Construction Stormwater General Permit will not be required because the construction activities are limited to less than an acre of disturbed area during construction. However, the project will maintain monitoring and implementation of best management practices (BMPs) to ensure stormwater discharges from the site do not adversely impact surface waters. Therefore, the objectives of this SWPPP are as follows:

- Describe the BMPs to prevent erosion and sedimentation and identify, reduce, and eliminate or prevent stormwater contamination and water pollution from construction activity.
- Describe measures to prevent violations of surface water quality, groundwater quality, or sediment management standards.
- Describe measures to control peak volumetric flow rates and velocities of stormwater discharges.

This SWPPP was prepared to meet the requirements set forth in the Stormwater Management Manual for Western Washington (Manual; Ecology 2005). This SWPPP is divided into the following seven main sections:

- **Section 1 – Introduction.** This section describes the objectives and organization of this SWPPP.
- **Section 2 – Project Background and Work Area Description.** This section describes project background, existing conditions in the work area, and construction activities.
- **Section 3 – Construction BMPs.** This section provides a detailed description of the BMPs to be implemented based on the 12 required elements in the Manual.
- **Section 4 – Construction Phasing and BMP Implementation.** This section provides a description of the timing of the BMP implementation in relation to the project schedule.

- **Section 5 – Pollution Prevention Team.** This section identifies the appropriate contact names (emergency and non-emergency), monitoring personnel, and the on-site temporary erosion and sedimentation control inspector.
- **Section 6 – Inspection and Monitoring.** This section provides a description of the inspection and monitoring requirements for maintaining zero stormwater discharge from disturbed areas.
- **Section 7 – Reporting and Recordkeeping.** This section describes the requirements for documentation of the BMP implementation, site inspections and monitoring, and changes to the implementation of certain BMPs necessitated by construction activities.

Supporting documentation and forms are provided in the Attachments.

2.0 Project Background and Work Area Description

2.1 PROJECT BACKGROUND

The Site is located in unincorporated Pierce County, Washington, in Township 20 North, Range 4 East, Section 5, Willamette Meridian (EDR Addendum 3, Drawing G-1). The Site consists of the B&L Property (Property), which includes the B&L Woodwaste Landfill (Landfill), and adjacent areas that have been affected by releases from the Landfill. The Property occupies about 18.5 acres of undeveloped land approximately 0.25 mile east of Interstate 5 and 5 miles east of Tacoma. Within the Property, the pentagonal-shaped landfill encompasses roughly 11.5 acres and rises to an elevation of approximately 53 feet (NAVD88). Farmland borders the western and southwestern edges of the Property, the Autumn Village Apartment complex adjoins the southeastern corner, and Fife Way defines the eastern boundary. A private property is located to the northeast. Puget Power Access Road, which was converted to a bicycle trail and is now known as the Interurban Trail, borders the north side of the property. Former farmland that has re-established itself as a grassy wetland lies to the north of the Landfill and Interurban Trail.

Beginning in the 1970s, the Landfill was operated as a disposal site for deck debris from log sort yards operating in the Tacoma Tideflats area. Log sort yard operators used Asarco slag as roadway and yard ballast, believing it to be inert “rock.” The slag was mixed with the bark and dirt that was periodically cleaned from the log sort yards and transported to the Landfill for disposal. During the 1980s, Ecology discovered that the slag at the Landfill was leaching arsenic at concentrations in exceedance of surface water standards. The Landfill was included as a source of metal contamination to Hylebos Waterway and the Commencement Nearshore/Tideflats CERCLA site by the U.S. Environmental Protection Agency. Remediation and monitoring activities at the Landfill began in the late 1980s and have continued through the present day.

2.2 EXISTING CONDITIONS IN THE WORK AREA

The work for the Phase 2 cleanup action includes installation of groundwater recovery wells and piping on adjacent properties as well as extraction wells, piping, and a building to house the treatment system within the Property. The ground surface on the Property is mostly vegetated with grass. The adjacent properties are primarily wetland areas and agricultural fields. No impervious surface is currently present within the work area and no structures currently exist on the Property. Farming structures and an apartment complex exist on an adjacent property but not near or within the area affected by the construction work. The Property topography is characterized by a mound in the middle (i.e., the Landfill), a perimeter access road around the Landfill at a lower elevation, and decreasing elevations around the perimeter. The landfill cap slopes downward towards the access road from the topographical high in the middle. The access road is higher than the perimeter ground surface by approximately 4 to 5 feet. Agricultural ditches that collect surface runoff from agricultural farmlands are located along the southern, western, and northern boundaries of the Property. The agricultural ditches join with water from the Surprise Lake Drain and ultimately discharge to Hylebos Creek.

The Landfill is covered by an engineered, multi-layer cap that includes surface grass and impermeable linesr that limit rainfall infiltration into the landfill wastes. Stormwater runoff and drainage from the landfill cap drains to the perimeter stormwater collection ditch around the Landfill. The ditch conveys the runoff from south to north and discharges to the stormwater detention pond immediately north of the Landfill through three culverts. An overflow pipe in the detention pond discharges into the agricultural ditch along the northern boundary of the Property. Stormwater runoff from the perimeter road either drains inward to the stormwater ditch or drains outward to the agricultural ditches. Stormwater runoff from topographically low area on the east side of the Landfill drains via a culvert to the agricultural ditch.

An organic silt and peat unit lies beneath the landfill material and forms the near-surface soils beneath much of the area surrounding the Landfill. These deposits are 4- to 7-feet thick and correspond to the pre-landfill ground surface. A thin layer of fill material from the 1993 remedy covers much of the Property ground surface surrounding the Landfill. Saturated alluvial deposits (primarily sands) directly underlie the organic silt and peat unit and comprise the Upper Sand Aquifer. The soils beneath the area upgradient of the Landfill consist of a silty, gravelly colluvium deposit with generally low permeability.

Several distinct wetlands, Wetlands A, B, C, and F, are located near the work area on and off the Property (Drawing EC-01 provided as Attachment 3E.1). All of the wetlands are ultimately connected to Hylebos Creek through a series of smaller surface drainages and the Surprise Lake Drain. Wetland A covers approximately 0.2 acres on the southeast side of Property. According to the Ecology rating system, Wetland A is a Category IV wetland. Wetland B is a Category III wetland, and occupies approximately 0.7 acres on the northeast side of the Property. Wetland C covers at least 59 acres north of the Property and is classified as a Category 1 wetland. Wetland F, approximately 1 acre in size, is a Category IV wetland located in the agricultural field, adjacent the northwest corner of the Property (AMEC 2011).

2.3 CONSTRUCTION ACTIVITIES

The planned activities include installing groundwater extraction wells, power lines, controls, and groundwater collection piping to transfer the contaminated groundwater to a central groundwater treatment station that will be constructed on the Property. The groundwater extraction and remediation system will remove these contaminated waters from the subsurface environment to protect the health of the human and natural environment.

Construction activities include drilling of groundwater recovery wells, groundwater monitoring wells, and installation of underground piping and wiring to supply power and controls to the pumping wells within the Landfill and in adjacent wetland areas, and to collect and treat recovered groundwater. A 40-foot by 60-foot structure will also be constructed to house the treatment system. The treatment system consists of several tanks, chemical storage and feed systems, and treatment vessels designed to remove groundwater contaminants and discharge clean water.

The initial work will include construction of geotechnical reinforcement piers and placement of an earthen pad to support the groundwater treatment building. The pad will be allowed to settle prior to remaining construction. The remaining construction will then be implemented, consisting of well installation, trenching for piping and conduits can be placed below grade. After placement of piping and conduits, the trenches will be backfilled to grade and the surface will be hydroseeded. Well surface completions will then be placed to protect the wellheads from potential damage and unauthorized access. Wetlands vegetation will be restored by hydroseeding the excavated areas. Work will also concurrently proceed for construction of the concrete building foundation. After the foundation has cured, major equipment will be placed on the concrete foundation and the building will be erected around the equipment. Final construction, consisting of finishing the building interior and installation of piping, instruments, machines, and controls will be done inside the building. All subsurface work conducted in the wetlands and the landfill area will be performed during the dry season when there is no or minimal standing surface water present and rainfall is at a minimum.

The surface condition in the work area before and after construction is summarized below:

- Total work area: 24 acres
- Percent impervious area before construction: 0 percent
- Percent impervious area after construction: less than 1 percent (the building and loading area constitute less than 4,000 square feet of constructed impervious surface)
- Disturbed area during construction: less than 40,000 square feet
- Disturbed area that is characterized as impervious (i.e., access roads, staging, parking): 0 acres

Because only minimal change in impervious areas will occur during construction, and most of the grading will be done to match the pre-construction drainage conditions, no increase in stormwater velocity or peak volumetric flow rate will occur. Flow from the building and associated impervious surfaces will flow from the pad to a rock-lined ditch following the natural drainage of the area, ultimately discharging to a vegetated swale. Thus, no stormwater flow calculations were necessary to protect downstream properties or wetlands.

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3.0 Construction Stormwater BMPs

3.1 THE 12 BMP ELEMENTS

Planned BMPs are shown on Drawings EC-01and EC-02 of EDR Addendum 3. Construction BMPs are described in detail in Attachment 3E.2.

3.1.1 Element #1 – Mark Clearing Limits

To protect adjacent properties and to reduce the area of soil exposed to construction, the limits of construction will be clearly marked before land-disturbing activities begin. Trees that are to be preserved, as well as all sensitive areas and their buffers, shall be clearly delineated, both in the field and on the plans. In general, natural vegetation and native topsoil shall be retained in an undisturbed state to the maximum extent possible. The BMPs relevant to marking the clearing limits that will be applied to this project include the following:

- Preserving Natural Vegetation (BMP C101)
- High Visibility Plastic or Metal Fence (BMP C103)

Temporary chain-link fence will be installed as appropriate around the contractor staging area before any construction work begins. Natural vegetation will be preserved outside the delineated work area. The perimeter of Wetland A and Wetland B will be delineated with survey flags; the relevant perimeters of Wetlands C and F are marked by existing features (the edge of the Interurban Trail and the edge of the agricultural field, respectively).

3.1.2 Element #2 – Establish Construction Access

Construction access or activities will be minimized where necessary, access points will be stabilized to minimize the tracking of sediment onto public roads, and wheel washing, street sweeping, and street cleaning will be employed to prevent sediment from entering State waters if necessary. All wash wastewater will be controlled on-site and will not be discharged to surface waters. The specific BMPs related to establishing construction access that may be used on this project include the following:

- Stabilized Construction Entrance (BMP C105)
- Wheel Wash (BMP C106)
- Construction Road/Parking Area Stabilization (BMP C107)

There will be only one access road to the work area from Fife Way. The access road will be stabilized with a layer of crushed rock during contractor mobilization. A wheel wash will be available on-site for the duration of the construction work, if necessary. However, based on previous construction activity at the Site, tracking dirt onto the public roads is not expected to be an issue.

3.1.3 Element #3 – Control Flow Rates

The existing stormwater drainage in the landfill area and other locations of the Property will be utilized for stormwater runoff during the construction period. Runoff from the area of the building pad will be directed toward a vegetated swale and, if necessary, slowed by BMPs prior to discharging to the vegetated swale. Because of the flat grade in this area, minimal controls are anticipated to slow runoff rates. Refer to Drawing EC-01. Stormwater runoff generally is expected to be contained within the staging area and infiltrated within the staging area or vegetated swale. As a result, no increase in the volume, velocity, and peak flow rate of stormwater runoff from the work area is expected to occur.

The project site is located west of the Cascade Mountain Crest. Therefore, the project must comply with Minimum Requirement 7 (Ecology 2005).

3.1.4 Element #4 – Install Sediment Controls

It is anticipated that there will be zero discharge of stormwater runoff from the disturbed areas; however, BMPs for sediment controls, such as silt fence (BMP C233), gravel berms, straw wattles, and compost socks will be implemented. If earthen containment berms are used to control sediment, they will be wrapped in plastic sheeting to prevent erosion and release of sediments.

3.1.5 Element #5 – Stabilize Soils

Exposed and unworked soils will be stabilized with the application of effective BMPs to prevent erosion throughout the life of the project. The specific BMPs for soil stabilization that may be used on this project include the following:

- Temporary and Permanent Seeding (BMP C120)
- Mulching (BMP C121)
- Nets and Blankets (BMP C122)
- Plastic Covering (BMP C123)
- Sodding (BMP C124)
- Topsoiling (BMP C125)
- Polyacrylamide (PAM) for Soil Erosion Protection (BMP C126)
- Surface Roughening (BMP C130)
- Gradient Terraces (BMP C131)
- Dust Control (BMP C140)
- Materials on Hand (BMP C150)

The project site is located west of the Cascade Mountain Crest. As such, no soils, including open trenches, will remain exposed and unworked for more than 7 days during the dry season

(May 1 to September 30) and for more than 2 days during the wet season (October 1 to April 30). Regardless of the time of year, all soils will be stabilized at the end of the shift before a holiday or non-working weekend days if needed, based on weather forecasts.

In general, cut-and-fill slopes will be stabilized as soon as possible and soil stockpiles will be temporarily covered with plastic sheeting. Stockpiled soils will be stabilized from erosion, protected with sediment trapping measures, and, where possible, be located away from waterways and drainage channels as illustrated in Drawing EC-02.

The Contractor and the Engineer will choose one or more of the above BMPs based on the time of year, site conditions, and the estimated duration of work activities. Stormwater containment berms will be covered with 10 mil plastic sheeting. All stockpiled soils will be stabilized from erosion, protected with sediment trapping measures, and where possible, be located away from drainage channels. In the wetlands, once grading is completed, a mulch and hydroseed application will be performed to reintroduce vegetation across disturbed soils.

3.1.6 Element #6 – Protect Slopes

All cut-and-fill slopes will be designed, constructed, and protected in a manner that minimizes erosion. The following specific BMPs may be used to protect slopes for this project:

- Interceptor Dike and Swale (BMP C200)
- Outlet Protection (BMP C209)
- Materials on Hand (BMP C150)

3.1.7 Element #7 – Protect Drain Inlets

Because there are no storm drain inlets on or near the work area that could potentially receive stormwater runoff from the work area, no BMPs for protection of drain inlets will be necessary.

3.1.8 Element #8 – Stabilize Channels and Outlets

During construction, stormwater runoff from the undisturbed portion of the landfill cap will drain through the existing conveyances to the stormwater ponds. Pipe discharges are equipped with riprap armoring for outlet protection. If necessary, at the pipe discharge, appropriate additional outlet protection will be selected based upon guidelines in BMP C209 (Outlet Protection).

3.1.9 Element #9 – Control Pollutants

All pollutants, including waste materials and construction debris, that occur on-site will be handled and disposed of in a manner that does not cause contamination of stormwater. Good housekeeping and preventative measures will be taken to ensure that the Site will be kept clean, well organized, and free of debris. (Refer to the Spill Prevention and Containment Plan, Appendix 3D to the EDR Addendum 3 for details regarding storage and handling of oil and chemical products.) If required, BMPs will be implemented to control the following potential sources of pollutants:

Chemicals Associated with Vehicle Maintenance and Repair

- All on-site fuel storage tank(s) will have secondary containment.
- All vehicles and construction equipment will be regularly inspected to detect any leaks or spills, and to identify maintenance needs to prevent leaks or spills.
- Spill prevention measures, such as drip pans, will be used when conducting maintenance and repair of vehicles or equipment.
- When performing emergency repairs, temporary plastic will be placed beneath, and, if raining, over the vehicle.
- Contaminated surfaces will be immediately cleaned following any discharge or spill incident.
- The provisions of the Spill Prevention and Containment Plan will be followed.

Wastewater

- Portable sanitation facilities will be firmly secured, regularly maintained, and emptied by vacuum trucks.
- If BMP C106 (Wheel Wash) is implemented, wheel wash or tire bath wastewater will be collected and disposed off-site in an appropriate facility.

Arsenic-contaminated Groundwater

- Arsenic-contaminated groundwater will only be encountered in during well installation and potentially trenching activities in the wetland areas. This water will be collected and disposed of at an appropriate off-site facility.

3.1.10 Element #10 – Control Dewatering

If high groundwater table or rainfall requires an excavated trench to be dewatered, water will be pumped from the trench to a storage tank for temporary storage and appropriate management. Any accumulated water that remains in storage tanks at the end of construction will be tested and disposed off-site in an appropriate facility and in accordance with applicable regulatory requirements.

3.1.11 Element #11 – Maintain BMPs

The applied temporary erosion and sediment control BMPs, if any, will be visually inspected at least once a week and within 24 hours of any rainfall event. All temporary BMPs will be maintained and repaired as needed to assure continued performance of their intended function. All temporary BMPs will be removed within 30 days after the final site stabilization is achieved or after the temporary BMPs are no longer needed. Disturbed soil resulting from removal of BMPs or vegetation will be permanently stabilized.

3.1.12 Element #12 – Manage the Project

The construction will be managed in accordance with the following key project components:

- The major earthwork will be conducted in the dry season (between July and September).
- The construction will be phased to minimize the amount of exposed soil at any one time.
- Once earthwork is completed in any area, the exposed soil in this area will be immediately stabilized per BMP C 162 (Scheduling).
- Inspection of BMPs will be conducted by a person knowledgeable in the principles and practices of erosion and sediment control.
- A Certified Erosion and Sediment Control Lead will be on-call at all times.
- Whenever inspection and/or monitoring reveals that the BMPs identified in this SWPPP are inadequate, appropriate BMPs or design changes will be implemented as soon as possible.
- This SWPPP shall be retained on-site.
- When a change is made in the design, construction, operation, or maintenance that has, or could have, a significant effect on the zero stormwater discharge status at this construction site, this SWPPP will be modified as necessary.
- If an inspection reveals that the SWPPP is ineffective in achieving zero discharge from disturbed areas or in eliminating or significantly minimizing pollutants in stormwater discharges from the construction site, this SWPPP shall be modified as necessary within seven (7) days of the inspection to include additional or modified BMPs designed to correct the identified problems.

3.2 SITE SPECIFIC BMPS

Site-specific BMPs are shown on Drawings EC-01 and EC-02 (refer to Attachment 3E.1).

3.3 ADDITIONAL ADVANCED BMPS

If stormwater cannot be managed to meet turbidity goals, the stormwater will be pumped to a storage tank and will be treated to achieve stormwater quality requirements prior to discharge to the nearby ditches. The water will be filtered for suspended solids using a Chitosan sand bed filter system. The effluent from this system will be below 25 NTUs. Filtered water will then be discharged to the surface, north of the staging area, such that it drains via surface flow to the agricultural ditch adjacent to the Landfill along the Interurban Trail.

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4.0 Construction Phasing and BMP Implementation

The BMP implementation schedule will be driven by the construction schedule and includes general site-wide BMPs that will be implemented during preliminary mobilization as well as activity-specific BMPs that will be implemented as needed for specific activities. The dates presented below may be revised as necessary to address changed conditions or other unforeseen events; the items included in the schedule will not be changed. BMPs will be installed in each disturbed area prior to any soil-disturbing activity.

- **General BMP installation with equipment mobilization.** Clearing limits will be delineated, construction access will be established. Secondary containment for hazardous materials will be established.
- **Construction of earthen pad and geo-piers.** Construction of the geo-piers and earthen pad will be completed in June 2011. Filter BMPs will be implemented in the immediate area, including straw wattles, compost socks, and silt fence, if needed. The material used to construct the pad will be well draining and permeable to minimize the need for stormwater management following construction. A drainage ditch and vegetated swale will be used to collect and control runoff and allow infiltration. This channel will allow additional filtration BMPs if needed prior to discharge off-site. The surface of the pad will be stabilized prior to the onset of the rainy season.
- **Installation of groundwater extraction wells and trenching in the Landfill—the wells and trenching is scheduled for completion in August and September 2011.** Filter BMPs will be implemented directly downgradient of the soil disturbing activities as needed. Side-casted soils will be covered in the case of rain to minimize erosion.
- **Installation of monitoring/extraction wells and trenching in surrounding areas and wetlands—the wells and trenching is scheduled for completion in August and September 2011.** Soil disturbing activities will be conducted during the dry season to minimize the potential for standing surface water in the work area. Filter BMPs will be implemented if warranted. Side-casted materials will be covered in the event of a rainstorm to minimize runoff.
- **Construction of the building.** Work on the building foundation will commence in August 2011. The building shell will be erected in later September/early October 2011. The treatment system will be constructed inside the building during fall and winter. Stormwater in the area will be directed toward the drainage channel and controlled. Standard filtration BMPs may be implemented if warranted.

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5.0 Pollution Prevention Team

5.1 ROLES AND RESPONSIBILITIES

The pollution prevention team consists of personnel responsible for implementation of the SWPPP, including the following:

- Certified Erosion and Sediment Control Lead (CESCL)—to be called upon in case of failure of any erosion and sediment control measures.
- Construction Manager—primary construction contact; site representative for the Owner; responsible for site inspections of BMPs and issuing instructions and drawings to the contractor's site supervisor or representative.
- Contractor Superintendent—the contractor superintendent will assist the CESCL in observations for erosion control issues and implementation and maintenance of BMPs.
- Emergency Ecology Contact—individual to be contacted at Ecology in case of emergency.
- Emergency Owner Contact—individual that is the Owner or representative of the Owner to be contacted in the case of an emergency.
- Non-Emergency Ecology Contact—individual at Ecology that can be contacted if required.
- Monitoring Personnel—personnel responsible for conducting water quality monitoring; for most sites, this person is also the Certified Erosion and Sediment Control Lead (CESCL).

5.2 TEAM MEMBERS

Names and contact information for those identified as members of the pollution prevention team are provided in the following table. The personnel designated below, in conjunction with the Construction Manager, will be responsible for assigning their project responsibilities to a qualified and competent person during times they may be unavailable.

Title	Name(s)	Phone Number
Certified Erosion and Sediment Control Lead (CESCL)	TBD	TBD
Construction Manager	TBD	TBD
Emergency Ecology Contact	24-Hour Emergency Response	425-649-7000
Emergency Owner Contact	Dan Silver	360-754-9343

Title	Name(s)	Phone Number
Non-Emergency Ecology Contact	Dom Reale	360-407-6266
Monitoring Personnel	TBD	TBD

6.0 Site Inspections and Monitoring

Monitoring includes visual inspection and documentation of the inspection and monitoring findings in a site log book (see Section 7.0).

6.1 SITE INSPECTION

All BMPs will be inspected, maintained, and repaired as needed to assure continued performance of their intended function. Inspections will be conducted by or under the direction of the site CESCL. The name and contact information for the site CESCL is provided in Section 5.0 of this SWPPP.

The site CESCL will evaluate and document the effectiveness of the installed BMPs and determine if it is necessary to repair or replace any of the BMPs. All maintenance and repairs will be documented in the site log book or forms provided in this document. All new BMPs or design changes will be documented in the SWPPP as soon as possible. Site inspections will be conducted at least once a week and within 24 hours following any rainfall event. Stormwater quality from the undisturbed portion of the landfill cap will be inspected for turbidity during rainfall events occurring while construction work is underway.

6.2 STORMWATER QUALITY MONITORING

Under normal precipitation conditions, stormwater runoff from the disturbed areas will be addressed by the BMPs. If stormwater accumulates in the disturbed areas or if it appears that the BMPs may not be effective in controlling the discharge of turbid water, stormwater will be collected and transferred to a temporary storage tank. If necessary, the stored stormwater will be treated and discharged to the nearby ditches, consistent with pre-construction conditions. The water will be filtered for suspended solids using a Chitosan sand bed filter system. The effluent from this system will be below 25 NTUs. Filtered water will then be discharged to the surface, north of the staging area, such that it drains via surface flow to the agricultural ditch adjacent to the Landfill along the Interurban Trail. The discharge point will be protected against erosion.

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7.0 Reporting and Recordkeeping

7.1 RECORDKEEPING

A site log book will be maintained for all on-site construction activities including the following:

- A record of the implementation of the SWPPP
- Site inspection forms

An inspection form is included in Attachment 3E.3.

The site log book, inspection forms, the SWPPP, and any other relevant documentation will be retained during the life of the construction project and for a minimum of 3 years after construction.

The SWPPP and site log book will be retained on-site or within reasonable access to the construction site, and will be made immediately available upon request to Ecology or to representatives of local jurisdictions. A copy of this SWPPP will be provided to Ecology within 14 days of receipt of a written request for the SWPPP from Ecology. A copy of the SWPPP or access to the SWPPP will be provided to the public within a reasonable amount of time when requested in writing.

7.2 UPDATING THE SWPPP

This SWPPP will be modified if it is determined to be ineffective in eliminating or significantly minimizing pollutants in stormwater discharges from the work areas, or if there has been a change in design, construction, operation, or maintenance at the Site that has a significant effect on the discharge, or potential for discharge, of pollutants to the waters of the State. The SWPPP will be modified within seven (7) days of a determination by a CESCL, based on inspection(s), that additional or modified BMPs are necessary to correct problems identified, and an updated timeline for BMP implementation will be prepared.

7.3 NOTIFICATION OF DISCHARGE

If there is discharge from the work area and it causes a potential threat to human health or the environment, the following steps will be taken:

1. Ecology will be immediately notified.
2. Immediate action will be taken to sample and control the discharge and to correct the problem. If applicable, sampling and analysis results will be submitted to Ecology within 5 days of the initial discharge.
3. A detailed written report describing the discharge will be submitted to Ecology within 5 days, unless requested otherwise by Ecology.

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8.0 References

AMEC Earth and Environmental, Inc. (AMEC). 2011. *Wetland Determination and Delineation, B&L Woodwaste Site Remediation*. Prepared for Floyd|Snider. May.

Washington State Department of Ecology (Ecology). 2005. *Stormwater Management Manual for Western Washington, Publication Numbers 05-10-029 through 05-10-033:* Washington State Department of Ecology, Water Quality Program. Olympia, Washington. February.

B&L Woodwaste Site
Pierce County, Washington

Engineering Design Report (EDR) Addendum 3

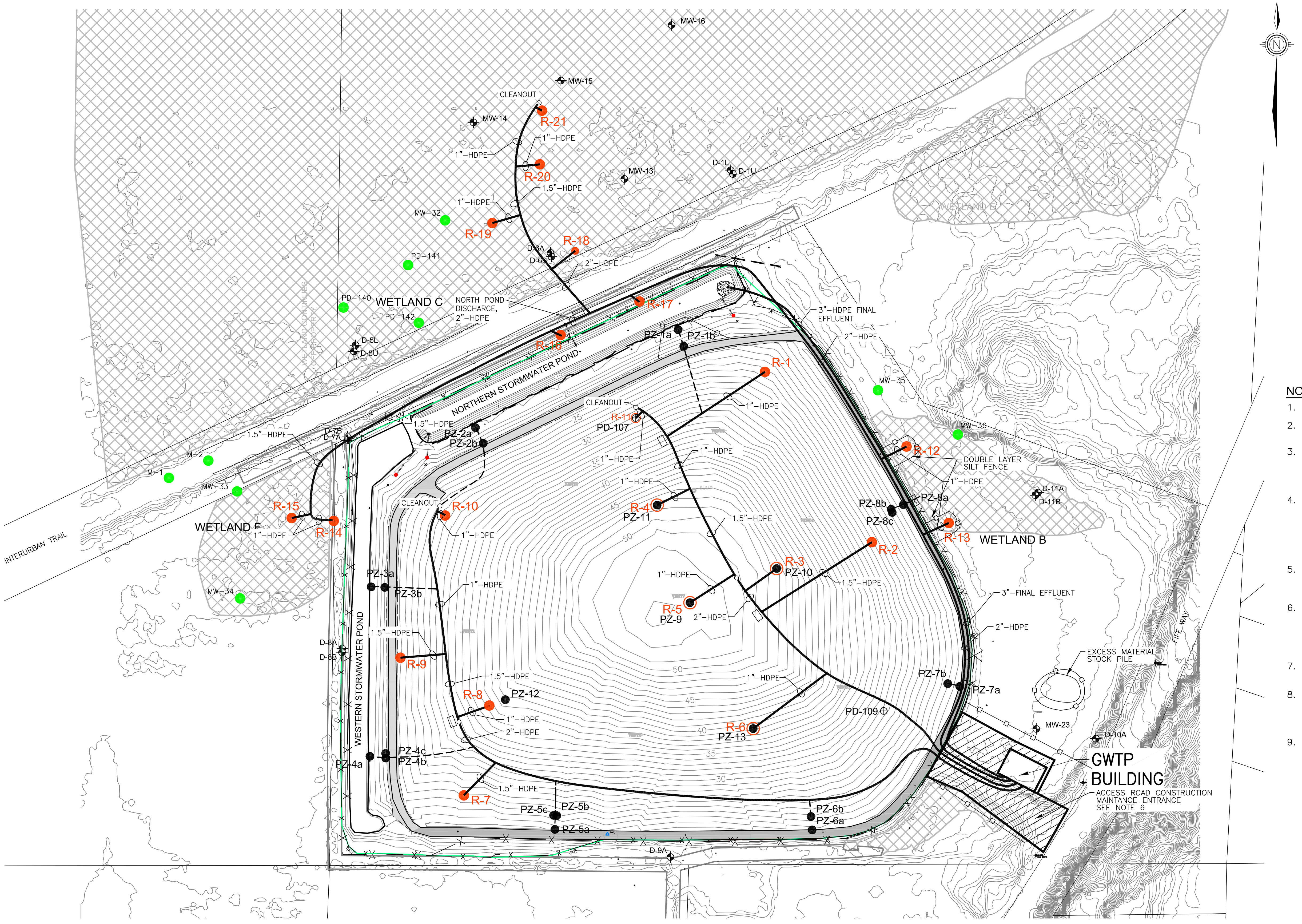
Phase 2 Part 1 Remediation Design Report

Groundwater Recovery and Treatment System

Attachment 3E.1
Drawings

FINAL

Plot Date: 05/25/11 - 1:31pm, Plotted by: Dell Survey2
Drawing Path: T:\Pete\Geomatrix\2011\112500-I B&L Woodwaste Site (SE10160010)\, Drawing Name: SE10160010-EC01,2 & C12,20.dwg



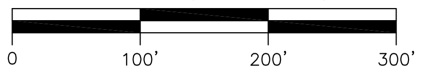
LEGEND:

— X — FENCE LINE
— — 12" DIAMETER CULVERT
🟩 AGRICULTURAL DITCH
☐ WETLAND
▨ STABILIZE AREA WITH CRUSHED ROCK
▬ PERIMETER ROAD
— — — METAL CLAD INSTRUMENT CABLE
—□—□— SILT FENCE
● R-21 NEW EXTRACTION WELL (BY OTHERS)
○ R-11 EXISTING WELL INCLUDED IN EXTRACTION NETWORK
● NEW MONITORING WELL
● PZ-7a PIEZOMETER (EXISTING)

NOTES:

1. ALL ELEVATIONS ARE IN FEET UNLESS OTHERWISE NOTED.
2. SILT FENCE SHALL BE INSTALLED DOWN-GRADIENT OF CONSTRUCTION AND CLEARING ACTIVITIES.
3. THE SILT FENCE SHALL BE CONSTRUCTED AT THE INITIATION OF THE PROJECT BEFORE ANY SITE GRADING OR EARTHWORKS FOR THE GROUNDWATER TREATMENT PLANT AND WELL PIPING ARE STARTED.
4. ALL WORK WITHIN THE WETLAND AREAS WILL BE CONDUCTED DURING THE DRY SEASON TO AVOID/MINIMIZE IMPACTS TO SURFACE WATERS. ANY STORMWATER IS EXPECTED TO INFILTRATE. STOCKPILE SLOPES WILL BE PROTECTED/COVERED. FILTRATION BMPs WILL BE AVAILABLE AND IMPLEMENTED IF NEEDED.
5. TEMPORARY SWALES MAY BE REQUIRED BASED ON THE CONSTRUCTION ACTIVITIES AND SHALL BE APPROVED BY THE ENGINEER.
6. THE EXCESS EXCAVATED MATERIAL THAT WILL BE STOCK PILED FOR MORE THAN 30 DAYS SHALL BE SURROUNDED BY SILT FENCE. ALL WETLAND AREAS THAT ARE DISTURBED DURING CONSTRUCTION SHALL BE BACK-FILLED AND RESTORED WITHIN 30 DAYS.
7. CONTRACTOR SHALL WASH SOIL FROM TRUCKS (IF REQUIRED) BEFORE LEAVING THE AREA.
8. SWALES AND SILT FENCE SHALL BE INSPECTED AT LEAST WEEKLY AND AFTER EVERY RAIN EVENT AND REPAIRED AS REQUIRED TO MAINTAIN THE EFFECTIVENESS OF THE EROSION MANAGEMENT SYSTEM.
9. FILTRATION BEST MANAGEMENT PRACTICES WILL BE IMPLEMENTED DOWN GRADIENT OF EARTH DISTURBING ACTIVITIES AS NEEDED, SUCH AS COMPOST SACKS, STRAW WATTLES, GRAVEL BERMS AND POTENTIALLY SILT FENCE.

SCALE BAR (1" = 150'-0")



REFERENCES:
PLANS

DATUM
HORIZONTAL: WASP-NAD83-S FEET
VERTICAL: NAVD88 FEET

NO.	REVISION	DATE	APRVD
1	ISSUED FOR PLANS AND SPECIFICATIONS	APR 8	WJM
2	ISSUED FOR TENDER	MAY 26	WJM

DRAWN JR
DESIGNED ES
CHECKED GP
REVIEWED WJM

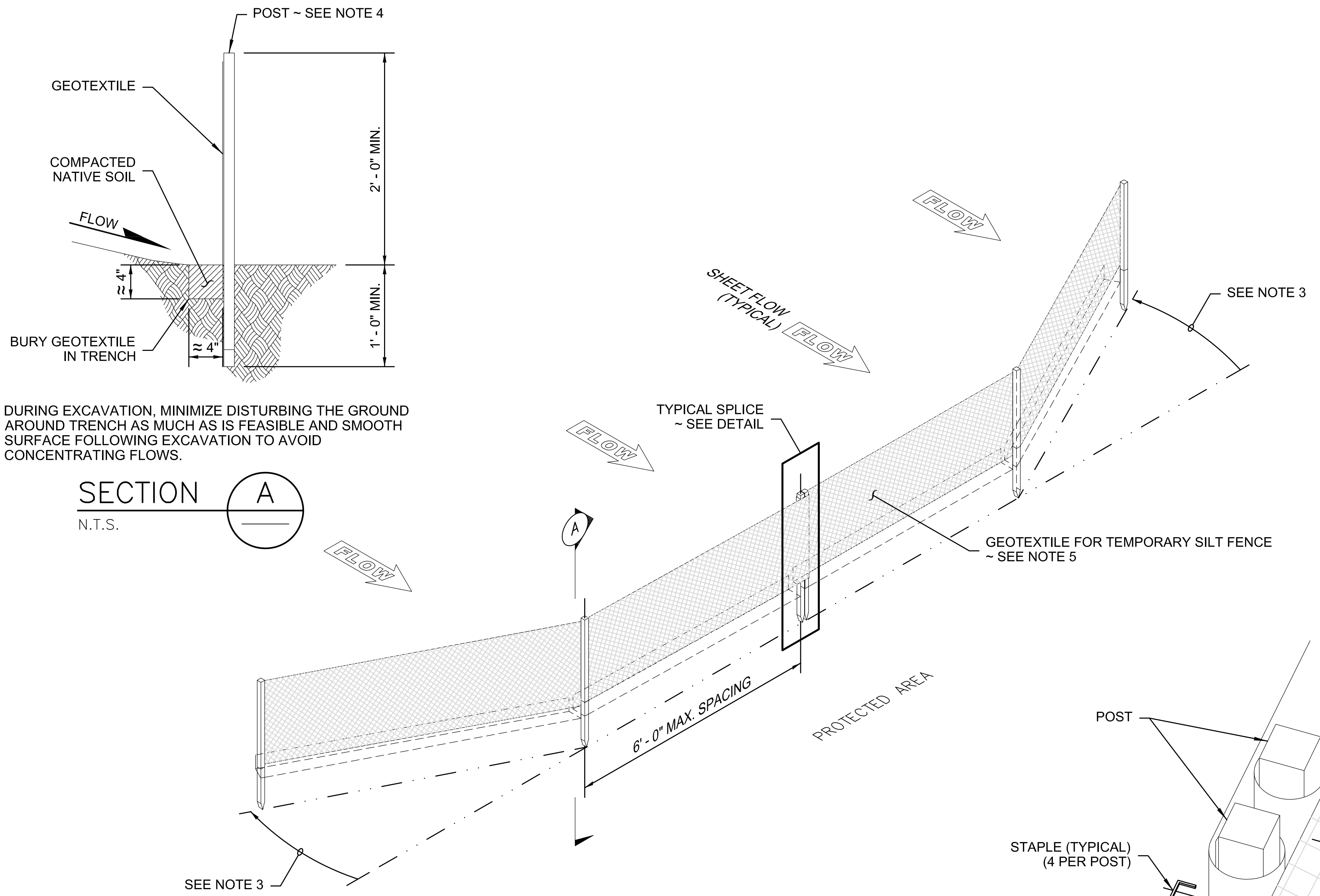
AMEC Geomatrix

EROSION CONTROL PLAN

B&L WOODWASTE SITE
PIERCE COUNTY, WASHINGTON

DATE: 05/25/11
PROJECT NO.: SE10160010

DRAWING
EC-01

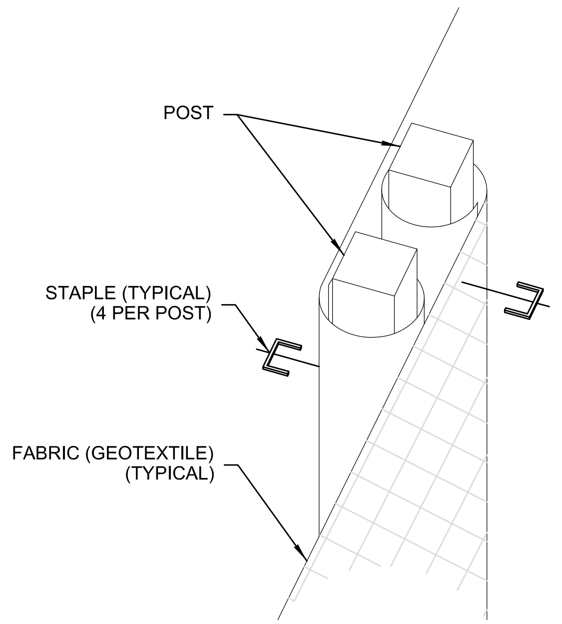


DURING EXCAVATION, MINIMIZE DISTURBING THE GROUND AROUND TRENCH AS MUCH AS IS FEASIBLE AND SMOOTH SURFACE FOLLOWING EXCAVATION TO AVOID CONCENTRATING FLOWS.

SECTION A
N.T.S.

1. Maximize detention of stormwater by placing fence as far away from toe of slope as possible without encroaching on sensitive areas or outside of the clearing boundaries.
2. Install silt fencing along contours.
3. Install the ends of the silt fence to point slightly up-slope to prevent sediment from flowing around the ends of the fence.
4. Posts shall be hardwood of sound quality. Min 1 1/4 inch by 1-1/4 inch.
5. Geotextile for temporary silt fence

Geotextile Property	ASTM Test Method	Geotextile Property Requirements	
		Unsupported Between Posts	Supported Between Posts with Wire or Polymeric Mesh
AOS	D 4751	No. 30 max. for slit wovens, No. 50 for all other geotextile types, No. 100 min.	
Water Permittivity	D 4491	0.02 sec min.	
Grab Tensile Strength, in machine and x-machine direction	D 4632	180 lb min. in machine direction, 100 lb min. in x-machine direction	100 lb min.
Grab Tensile Strain, in machine and x-machine direction	D 4632	30% max. at 180 lb or more	
Ultraviolet (UV) Radiation Stability	D 4355	70% strength retained min. after 500 hours in xenon arc device	



SPLICED FENCE SECTIONS SHALL BE CLOSE ENOUGH TOGETHER TO PREVENT SILT LADEN WATER FROM ESCAPING THROUGH THE FENCE AT THE OVERLAP. JOINING SECTIONS SHALL NOT BE PLACED IN LOW SPOTS OR IN SUMP LOCATIONS.

Plot Date: 05/25/11 - 2:50pm, Plotted by: Dell Survey2
Drawing Path: T:\Pete\Geomatrix\2011\112500-I B&L Woodwaste Site (SE10160010)\, Drawing Name: SE10160010-EC01,2 & C12,20.dwg

REFERENCES:
PLANS

DATUM
HORIZONTAL: WASP–NAD83–S FEET
VERTICAL: NAVD88 FEET

NO.	REVISION	DATE	APRVD
1	ISSUED FOR PLANS AND SPECIFICATIONS	APR 8	WJM
2	ISSUED FOR TENDER	MAY 26	WJM

DRAWN JR
DESIGNED ES
CHECKED GP
REVIEWED WJM

AMEC Geomatrix

EROSION CONTROL PLAN
DETAILS

B&L WOODWASTE SITE
PIERCE COUNTY, WASHINGTON

DATE: 05/25/11
PROJECT NO.: SE10160010
DRAWING
EC–2

B&L Woodwaste Site
Pierce County, Washington

Engineering Design Report (EDR) Addendum 3

Phase 2 Part 1 Remediation Design Report

Groundwater Recovery and Treatment System

Attachment 3E.2
Construction BMPs

FINAL

Table of Contents

BMP C101: Perserving Natural Vegetation

BMP C103: High Visibility Plastic or Metal Fence

BMP C105: Stabilized Construction Entrance

BMP C106: Wheel Wash

BMP C107: Construction Road/Parking Area Stabilization

BMP C120: Temporary and Permanent Seeding

BMP C121: Mulching

BMP C122: Nets and Blankets

BMP C123: Plastic Covering

BMP C124: Sodding

BMP C125: Topsoiling

BMP C126: Polyacrylamide for Soil Erosion Protection

BMP C130: Surface Roughening

BMP C131: Gradient Terraces

BMP C140: Dust Control

BMP C150: Materials On Hand

BMP C162: Scheduling

BMP C200: Interceptor Dike and Swale

BMP C204: Pipe Slope Drains

BMP C209: Outlet Protection

BMP C233: Silt Fence

4.1 Source Control BMPs

BMP C101: Preserving Natural Vegetation

Purpose

The purpose of preserving natural vegetation is to reduce erosion wherever practicable. Limiting site disturbance is the single most effective method for reducing erosion. For example, conifers can hold up to about 50 percent of all rain that falls during a storm. Up to 20-30 percent of this rain may never reach the ground but is taken up by the tree or evaporates. Another benefit is that the rain held in the tree can be released slowly to the ground after the storm.

Conditions of Use

- Natural vegetation should be preserved on steep slopes, near perennial and intermittent watercourses or swales, and on building sites in wooded areas.
- As required by local governments.

Design and Installation Specifications

Natural vegetation can be preserved in natural clumps or as individual trees, shrubs and vines.

The preservation of individual plants is more difficult because heavy equipment is generally used to remove unwanted vegetation. The points to remember when attempting to save individual plants are:

- Is the plant worth saving? Consider the location, species, size, age, vigor, and the work involved. Local governments may also have ordinances to save natural vegetation and trees.
- Fence or clearly mark areas around trees that are to be saved. It is preferable to keep ground disturbance away from the trees at least as far out as the dripline.

Plants need protection from three kinds of injuries:

- *Construction Equipment* - This injury can be above or below the ground level. Damage results from scarring, cutting of roots, and compaction of the soil. Placing a fenced buffer zone around plants to be saved prior to construction can prevent construction equipment injuries.
- *Grade Changes* - Changing the natural ground level will alter grades, which affects the plant's ability to obtain the necessary air, water, and minerals. Minor fills usually do not cause problems although sensitivity between species does vary and should be checked. Trees can tolerate fill of 6 inches or less. For shrubs and other plants, the fill should be less.

  When there are major changes in grade, it may become necessary to supply air to the roots of plants. This can be done by placing a layer of gravel and a tile system over the roots before the fill is made. A tile system protects a tree from a raised grade. The tile system should be laid out on the original grade leading from a dry well around the tree trunk. The system should then be covered with small stones to allow air to circulate over the root area.

Lowering the natural ground level can seriously damage trees and shrubs. The highest percentage of the plant roots are in the upper 12 inches of the soil and cuts of only 2-3 inches can cause serious injury. To protect the roots it may be necessary to terrace the immediate area around the plants to be saved. If roots are exposed, construction of retaining walls may be needed to keep the soil in place. Plants can also be preserved by leaving them on an undisturbed, gently sloping mound. To increase the chances for survival, it is best to limit grade changes and other soil disturbances to areas outside the dripline of the plant.

- *Excavations* **-** Protect trees and other plants when excavating for drainfields, power, water, and sewer lines. Where possible, the trenches should be routed around trees and large shrubs. When this is not possible, it is best to tunnel under them. This can be done with hand tools or with power augers. If it is not possible to route the trench around plants to be saved, then the following should be observed:

  Cut as few roots as possible. When you have to cut, cut clean. Paint cut root ends with a wood dressing like asphalt base paint.

  Backfill the trench as soon as possible.

  Tunnel beneath root systems as close to the center of the main trunk to preserve most of the important feeder roots.

Some problems that can be encountered with a few specific trees are:

- Maple, Dogwood, Red alder, Western hemlock, Western red cedar, and Douglas fir do not readily adjust to changes in environment and special care should be taken to protect these trees.
- The windthrow hazard of Pacific silver fir and madronna is high, while that of Western hemlock is moderate. The danger of windthrow increases where dense stands have been thinned. Other species (unless they are on shallow, wet soils less than 20 inches deep) have a low windthrow hazard.
- Cottonwoods, maples, and willows have water-seeking roots. These can cause trouble in sewer lines and infiltration fields. On the other hand, they thrive in high moisture conditions that other trees would not.
- Thinning operations in pure or mixed stands of Grand fir, Pacific silver fir, Noble fir, Sitka spruce, Western red cedar, Western hemlock,

Pacific dogwood, and Red alder can cause serious disease problems. Disease can become established through damaged limbs, trunks, roots, and freshly cut stumps. Diseased and weakened trees are also susceptible to insect attack.

Maintenance Standards

- Inspect flagged and/or fenced areas regularly to make sure flagging or fencing has not been removed or damaged. If the flagging or fencing has been damaged or visibility reduced, it shall be repaired or replaced immediately and visibility restored.
- If tree roots have been exposed or injured, “prune” cleanly with an appropriate pruning saw or lopers directly above the damaged roots and recover with native soils. Treatment of sap flowing trees (fir, hemlock, pine, soft maples) is not advised as sap forms a natural healing barrier.

BMP C103: High Visibility Plastic or Metal Fence

Purpose

Fencing is intended to: (1) restrict clearing to approved limits; (2) prevent disturbance of sensitive areas, their buffers, and other areas required to be left undisturbed; (3) limit construction traffic to designated construction entrances or roads; and, (4) protect areas where marking with survey tape may not provide adequate protection.

Conditions of Use

To establish clearing limits, plastic or metal fence may be used:

- At the boundary of sensitive areas, their buffers, and other areas required to be left uncleared.
- As necessary to control vehicle access to and on the site.

Design and Installation Specifications

- High visibility plastic fence shall be composed of a high-density polyethylene material and shall be at least four feet in height. Posts for the fencing shall be steel or wood and placed every 6 feet on center (maximum) or as needed to ensure rigidity. The fencing shall be fastened to the post every six inches with a polyethylene tie. On long continuous lengths of fencing, a tension wire or rope shall be used as a top stringer to prevent sagging between posts. The fence color shall be high visibility orange. The fence tensile strength shall be 360 lbs./ft. using the ASTM D4595 testing method.

- Metal fences shall be designed and installed according to the manufacturer's specifications.
- Metal fences shall be at least 3 feet high and must be highly visible.
- Fences shall not be wired or stapled to trees.

Maintenance Standards

- If the fence has been damaged or visibility reduced, it shall be repaired or replaced immediately and visibility restored.

BMP C105: Stabilized Construction Entrance

Purpose

Construction entrances are stabilized to reduce the amount of sediment transported onto paved roads by vehicles or equipment by constructing a stabilized pad of quarry spalls at entrances to construction sites.

Conditions of Use

Construction entrances shall be stabilized wherever traffic will be leaving a construction site and traveling on paved roads or other paved areas within 1,000 feet of the site.

On large commercial, highway, and road projects, the designer should include enough extra materials in the contract to allow for additional stabilized entrances not shown in the initial Construction SWPPP. It is difficult to determine exactly where access to these projects will take place; additional materials will enable the contractor to install them where needed.

Design and Installation Specifications

- See Figure 4.2 for details. Note: the 100’ minimum length of the entrance shall be reduced to the maximum practicable size when the size or configuration of the site does not allow the full length (100’).
- A separation geotextile shall be placed under the spalls to prevent fine sediment from pumping up into the rock pad. The geotextile shall meet the following standards:

Grab Tensile Strength (ASTM D4751)	200 psi min.
Grab Tensile Elongation (ASTM D4632)	30% max.
Mullen Burst Strength (ASTM D3786-80a)	400 psi min.
AOS (ASTM D4751)	20-45 (U.S. standard sieve size)

- Consider early installation of the first lift of asphalt in areas that will paved; this can be used as a stabilized entrance. Also consider the installation of excess concrete as a stabilized entrance. During large concrete pours, excess concrete is often available for this purpose.
- Hog fuel (wood-based mulch) may be substituted for or combined with quarry spalls in areas that will not be used for permanent roads. Hog fuel is generally less effective at stabilizing construction entrances and should be used only at sites where the amount of traffic is very limited. Hog fuel is not recommended for entrance stabilization in urban areas. The effectiveness of hog fuel is highly variable and it generally requires more maintenance than quarry spalls. The inspector may at any time require the use of quarry spalls if the hog fuel is not preventing sediment from being tracked onto pavement or if the hog fuel is being carried onto pavement. Hog fuel is prohibited in permanent roadbeds because organics in the subgrade soils cause degradation of the subgrade support over time.
- Fencing (see BMPs C103 and C104) shall be installed as necessary to restrict traffic to the construction entrance.

- Whenever possible, the entrance shall be constructed on a firm, compacted subgrade. This can substantially increase the effectiveness of the pad and reduce the need for maintenance.

Maintenance Standards

- Quarry spalls (or hog fuel) shall be added if the pad is no longer in accordance with the specifications.
- If the entrance is not preventing sediment from being tracked onto pavement, then alternative measures to keep the streets free of sediment shall be used. This may include street sweeping, an increase in the dimensions of the entrance, or the installation of a wheel wash.
- Any sediment that is tracked onto pavement shall be removed by shoveling or street sweeping. The sediment collected by sweeping shall be removed or stabilized on site. The pavement shall not be cleaned by washing down the street, except when sweeping is ineffective and there is a threat to public safety. If it is necessary to wash the streets, the construction of a small sump shall be considered. The sediment would then be washed into the sump where it can be controlled.
- Any quarry spalls that are loosened from the pad, which end up on the roadway shall be removed immediately.
- If vehicles are entering or exiting the site at points other than the construction entrance(s), fencing (see BMPs C103 and C104) shall be installed to control traffic.
- Upon project completion and site stabilization, all construction accesses intended as permanent access for maintenance shall be permanently stabilized.

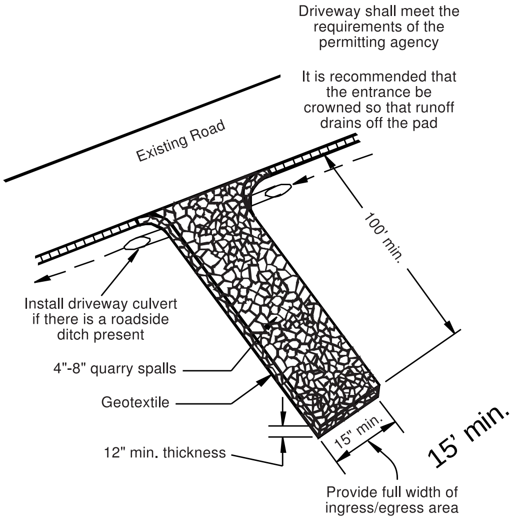


Figure 4.2 – Stabilized Construction Entrance

BMP C106: Wheel Wash

Purpose

Wheel washes reduce the amount of sediment transported onto paved roads by motor vehicles.

Conditions of Use

When a stabilized construction entrance (see BMP C105) is not preventing sediment from being tracked onto pavement.

- Wheel washing is generally an effective BMP when installed with careful attention to topography. For example, a wheel wash can be detrimental if installed at the top of a slope abutting a right-of-way where the water from the dripping truck can run unimpeded into the street.
- Pressure washing combined with an adequately sized and surfaced pad with direct drainage to a large 10-foot x 10-foot sump can be very effective.

Design and Installation Specifications

Suggested details are shown in Figure 4.3. The Local Permitting Authority may allow other designs. A minimum of 6 inches of asphalt treated base (ATB) over crushed base material or 8 inches over a good subgrade is recommended to pave the wheel wash.

Use a low clearance truck to test the wheel wash before paving. Either a belly dump or lowboy will work well to test clearance.

Keep the water level from 12 to 14 inches deep to avoid damage to truck hubs and filling the truck tongues with water.

Midpoint spray nozzles are only needed in extremely muddy conditions.

Wheel wash systems should be designed with a small grade change, 6 to 12 inches for a 10-foot-wide pond, to allow sediment to flow to the low side of pond to help prevent re-suspension of sediment. A drainpipe with a 2- to 3-foot riser should be installed on the low side of the pond to allow for easy cleaning and refilling. Polymers may be used to promote coagulation and flocculation in a closed-loop system. Polyacrylamide (PAM) added to the wheel wash water at a rate of 0.25 - 0.5 pounds per 1,000 gallons of water increases effectiveness and reduces cleanup time. If PAM is already being used for dust or erosion control and is being applied by a water truck, the same truck can be used to change the wash water.

Maintenance Standards

The wheel wash should start out the day with fresh water.

The wash water should be changed a minimum of once per day. On large earthwork jobs where more than 10-20 trucks per hour are expected, the wash water will need to be changed more often.

Wheel wash or tire bath wastewater shall be discharged to a separate on-site treatment system, such as closed-loop recirculation or land application, or to the sanitary sewer with proper local sewer district approval.

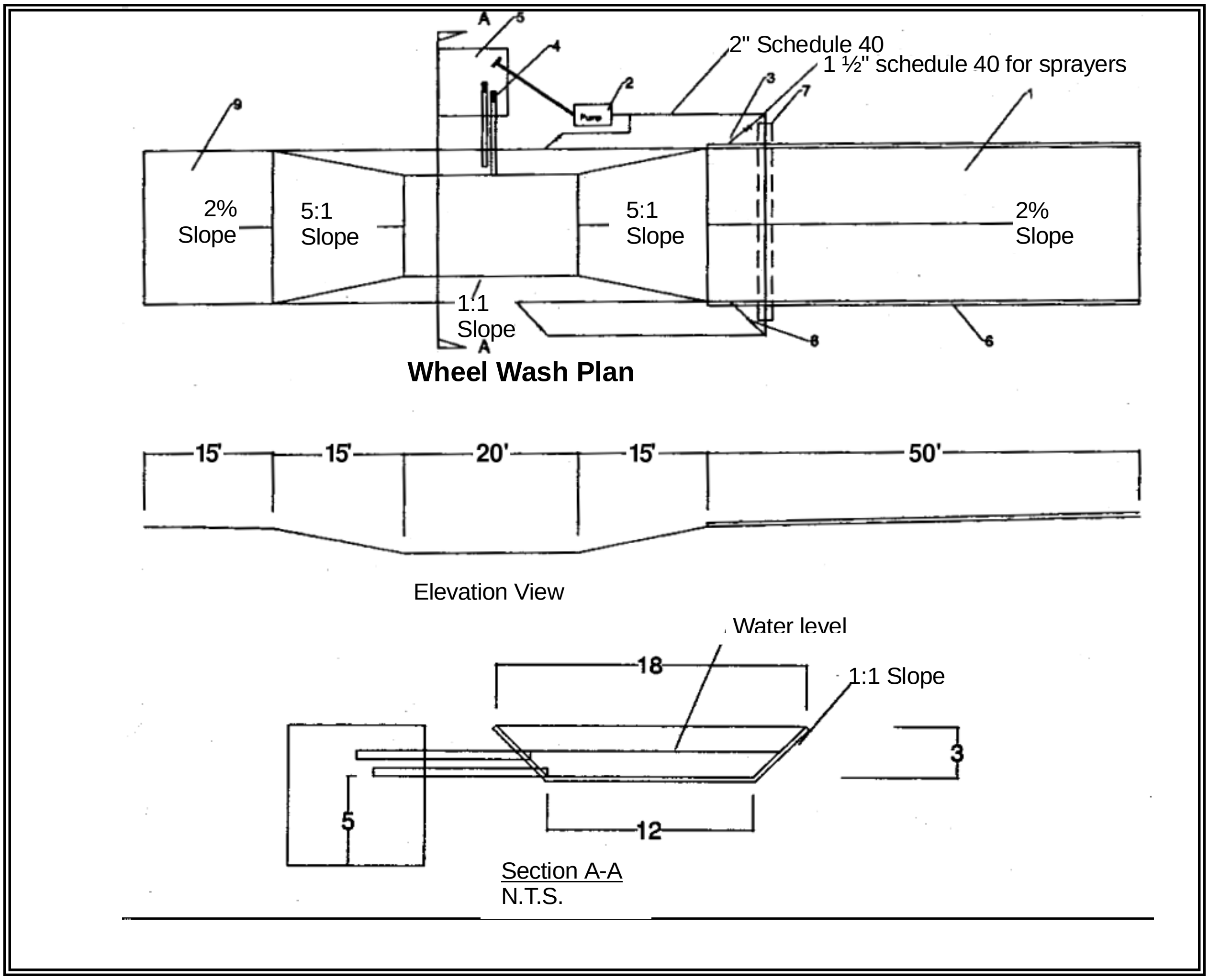


Figure 4.3 Wheel Wash

Notes:

1. Asphalt construction entrance 6 in. asphalt treated base (ATB).
2. 3-inch trash pump with floats on the suction hose.
3. Midpoint spray nozzles, if needed.
4. 6-inch sewer pipe with butterfly valves. Bottom one is a drain. Locate top pipe's invert 1 foot above bottom of wheel wash.
5. 8 foot x 8 foot sump with 5 feet of catch. Build so can be cleaned with trackhoe.
6. Asphalt curb on the low road side to direct water back to pond.
7. 6-inch sleeve under road.
8. Ball valves.
9. 15 foot. ATB apron to protect ground from splashing water.

BMP C107: Construction Road/Parking Area Stabilization

Purpose

Stabilizing subdivision roads, parking areas, and other onsite vehicle transportation routes immediately after grading reduces erosion caused by construction traffic or runoff.

Conditions of Use

- Roads or parking areas shall be stabilized wherever they are constructed, whether permanent or temporary, for use by construction traffic.
- Fencing (see BMPs C103 and C104) shall be installed, if necessary, to limit the access of vehicles to only those roads and parking areas that are stabilized.

Design and Installation Specifications

- On areas that will receive asphalt as part of the project, install the first lift as soon as possible.
- A 6-inch depth of 2- to 4-inch crushed rock, gravel base, or crushed surfacing base course shall be applied immediately after grading or utility installation. A 4-inch course of asphalt treated base (ATB) may also be used, or the road/parking area may be paved. It may also be possible to use cement or calcium chloride for soil stabilization. If cement or cement kiln dust is used for roadbase stabilization, pH monitoring and BMPs are necessary to evaluate and minimize the effects on stormwater. If the area will not be used for permanent roads, parking areas, or structures, a 6-inch depth of hog fuel may also be used, but this is likely to require more maintenance. Whenever possible, construction roads and parking areas shall be placed on a firm, compacted subgrade.
- Temporary road gradients shall not exceed 15 percent. Roadways shall be carefully graded to drain. Drainage ditches shall be provided on each side of the roadway in the case of a crowned section, or on one side in the case of a super-elevated section. Drainage ditches shall be directed to a sediment control BMP.
- Rather than relying on ditches, it may also be possible to grade the road so that runoff sheet-flows into a heavily vegetated area with a well-developed topsoil. Landscaped areas are not adequate. If this area has at least 50 feet of vegetation, then it is generally preferable to use the vegetation to treat runoff, rather than a sediment pond or trap. The 50 feet shall not include wetlands. If runoff is allowed to sheetflow through adjacent vegetated areas, it is vital to design the roadways and parking areas so that no concentrated runoff is created.
- Storm drain inlets shall be protected to prevent sediment-laden water entering the storm drain system (see BMP C220).

Maintenance Standards

- Inspect stabilized areas regularly, especially after large storm events.
- Crushed rock, gravel base, hog fuel, etc. shall be added as required to maintain a stable driving surface and to stabilize any areas that have eroded.
- Following construction, these areas shall be restored to pre-construction condition or better to prevent future erosion.

BMP C120: Temporary and Permanent Seeding

Purpose

Seeding is intended to reduce erosion by stabilizing exposed soils. A well-established vegetative cover is one of the most effective methods of reducing erosion.

Conditions of Use

- Seeding may be used throughout the project on disturbed areas that have reached final grade or that will remain unworked for more than 30 days.
- Channels that will be vegetated should be installed before major earthwork and hydroseeded with a Bonded Fiber Matrix. The vegetation should be well established (i.e., 75 percent cover) before water is allowed to flow in the ditch. With channels that will have high flows, erosion control blankets should be installed over the hydroseed. If vegetation cannot be established from seed before water is allowed in the ditch, sod should be installed in the bottom of the ditch over hydromulch and blankets.
- Retention/detention ponds should be seeded as required.
- Mulch is required at all times because it protects seeds from heat, moisture loss, and transport due to runoff.
- All disturbed areas shall be reviewed in late August to early September and all seeding should be completed by the end of September. Otherwise, vegetation will not establish itself enough to provide more than average protection.
- At final site stabilization, all disturbed areas not otherwise vegetated or stabilized shall be seeded and mulched. Final stabilization means the completion of all soil disturbing activities at the site and the establishment of a permanent vegetative cover, or equivalent permanent stabilization measures (such as pavement, riprap, gabions or geotextiles) which will prevent erosion.

Design and Installation Specifications

- Seeding should be done during those seasons most conducive to growth and will vary with the climate conditions of the region. Local experience should be used to determine the appropriate seeding periods.
- The optimum seeding windows for western Washington are April 1 through June 30 and September 1 through October 1. Seeding that occurs between July 1 and August 30 will require irrigation until 75 percent grass cover is established. Seeding that occurs between October 1 and March 30 will require a mulch or plastic cover until 75 percent grass cover is established.
- To prevent seed from being washed away, confirm that all required surface water control measures have been installed.

- The seedbed should be firm and rough. All soil should be roughened no matter what the slope. If compaction is required for engineering purposes, slopes must be track walked before seeding. Backblading or smoothing of slopes greater than 4:1 is not allowed if they are to be seeded.
- New and more effective restoration-based landscape practices rely on deeper incorporation than that provided by a simple single-pass rototilling treatment. Wherever practical the subgrade should be initially ripped to improve long-term permeability, infiltration, and water inflow qualities. At a minimum, permanent areas shall use soil amendments to achieve organic matter and permeability performance defined in engineered soil/landscape systems. For systems that are deeper than 8 inches the rototilling process should be done in multiple lifts, or the prepared soil system shall be prepared properly and then placed to achieve the specified depth.
- Organic matter is the most appropriate form of "fertilizer" because it provides nutrients (including nitrogen, phosphorus, and potassium) in the least water-soluble form. A natural system typically releases 2-10 percent of its nutrients annually. Chemical fertilizers have since been formulated to simulate what organic matter does naturally.
- In general, 10-4-6 N-P-K (nitrogen-phosphorus-potassium) fertilizer can be used at a rate of 90 pounds per acre. Slow-release fertilizers should always be used because they are more efficient and have fewer environmental impacts. It is recommended that areas being seeded for final landscaping conduct soil tests to determine the exact type and quantity of fertilizer needed. This will prevent the over-application of fertilizer. Fertilizer should not be added to the hydromulch machine and agitated more than 20 minutes before it is to be used. If agitated too much, the slow-release coating is destroyed.
- There are numerous products available on the market that take the place of chemical fertilizers. These include several with seaweed extracts that are beneficial to soil microbes and organisms. If 100 percent cottonseed meal is used as the mulch in hydroseed, chemical fertilizer may not be necessary. Cottonseed meal is a good source of long-term, slow-release, available nitrogen.
- Hydroseed applications shall include a minimum of 1,500 pounds per acre of mulch with 3 percent tackifier. Mulch may be made up of 100 percent: cottonseed meal; fibers made of wood, recycled cellulose, hemp, and kenaf; compost; or blends of these. Tackifier shall be plant-based, such as guar or alpha plantago, or chemical-based such as polyacrylamide or polymers. Any mulch or tackifier product used shall be installed per manufacturer's instructions. Generally, mulches come in 40-50 pound bags. Seed and fertilizer are added at time of application.

- Mulch is always required for seeding. Mulch can be applied on top of the seed or simultaneously by hydroseeding.
- On steep slopes, Bonded Fiber Matrix (BFM) or Mechanically Bonded Fiber Matrix (MBFM) products should be used. BFM/MBFM products are applied at a minimum rate of 3,000 pounds per acre of mulch with approximately 10 percent tackifier. Application is made so that a minimum of 95 percent soil coverage is achieved. Numerous products are available commercially and should be installed per manufacturer's instructions. Most products require 24-36 hours to cure before a rainfall and cannot be installed on wet or saturated soils. Generally, these products come in 40-50 pound bags and include all necessary ingredients except for seed and fertilizer.

BFMs and MBFMs have some advantages over blankets:

- No surface preparation required;
- Can be installed via helicopter in remote areas;
- On slopes steeper than 2.5:1, blanket installers may need to be roped and harnessed for safety;
- They are at least $1,000 per acre cheaper installed.

In most cases, the shear strength of blankets is not a factor when used on slopes, only when used in channels. BFMs and MBFMs are good alternatives to blankets in most situations where vegetation establishment is the goal.

- When installing seed via hydroseeding operations, only about 1/3 of the seed actually ends up in contact with the soil surface. This reduces the ability to establish a good stand of grass quickly. One way to overcome this is to increase seed quantities by up to 50 percent.
- Vegetation establishment can also be enhanced by dividing the hydromulch operation into two phases:
    1. Phase 1- Install all seed and fertilizer with 25-30 percent mulch and tackifier onto soil in the first lift;
    2. Phase 2- Install the rest of the mulch and tackifier over the first lift.

An alternative is to install the mulch, seed, fertilizer, and tackifier in one lift. Then, spread or blow straw over the top of the hydromulch at a rate of about 800-1000 pounds per acre. Hold straw in place with a standard tackifier. Both of these approaches will increase cost moderately but will greatly improve and enhance vegetative establishment. The increased cost may be offset by the reduced need for:

1. Irrigation
2. Reapplication of mulch
3. Repair of failed slope surfaces

This technique works with standard hydromulch (1,500 pounds per acre minimum) and BFM/MBFMs (3,000 pounds per acre minimum).

- Areas to be permanently landscaped shall provide a healthy topsoil that reduces the need for fertilizers, improves overall topsoil quality, provides for better vegetal health and vitality, improves hydrologic characteristics, and reduces the need for irrigation. This can be accomplished in a number of ways:

  Recent research has shown that the best method to improve till soils is to amend these soils with compost. The optimum mixture is approximately two parts soil to one part compost. This equates to 4 inches of compost mixed to a depth of 12 inches in till soils. Increasing the concentration of compost beyond this level can have negative effects on vegetal health, while decreasing the concentrations can reduce the benefits of amended soils. Please note: The compost should meet specifications for Grade A quality compost in Ecology Publication 94-038.

  Other soils, such as gravel or cobble outwash soils, may require different approaches. Organics and fines easily migrate through the loose structure of these soils. Therefore, the importation of at least 6 inches of quality topsoil, underlain by some type of filter fabric to prevent the migration of fines, may be more appropriate for these soils.

  Areas that already have good topsoil, such as undisturbed areas, do not require soil amendments.

- Areas that will be seeded only and not landscaped may need compost or meal-based mulch included in the hydroseed in order to establish vegetation. Native topsoil should be re-installed on the disturbed soil surface before application.
- Seed that is installed as a temporary measure may be installed by hand if it will be covered by straw, mulch, or topsoil. Seed that is installed as a permanent measure may be installed by hand on small areas (usually less than 1 acre) that will be covered with mulch, topsoil, or erosion blankets. The seed mixes listed below include recommended mixes for both temporary and permanent seeding. These mixes, with the exception of the wetland mix, shall be applied at a rate of 120 pounds per acre. This rate can be reduced if soil amendments or slow-release fertilizers are used. Local suppliers or the local conservation district should be consulted for their recommendations because the appropriate mix depends on a variety of factors, including location, exposure, soil type, slope, and expected foot traffic. Alternative seed mixes approved by the local authority may be used.

Table 4.1 represents the standard mix for those areas where just a temporary vegetative cover is required.

Table 4.1
Temporary Erosion Control Seed Mix

	% Weight	% Purity	% Germination
Chewings or annual blue grass *Festuca rubra var. commutata* or *Poa anna*	40	98	90
Perennial rye - *Lolium perenne*	50	98	90
Redtop or colonial bentgrass *Agrostis alba* or *Agrostis tenuis*	5	92	85
White dutch clover *Trifolium repens*	5	98	90

Table 4.2 provides just one recommended possibility for landscaping seed.

Table 4.2
Landscaping Seed Mix

	% Weight	% Purity	% Germination
Perennial rye blend *Lolium perenne*	70	98	90
Chewings and red fescue blend *Festuca rubra var. commutata* or *Festuca rubra*	30	98	90

This turf seed mix in Table 4.3 is for dry situations where there is no need for much water. The advantage is that this mix requires very little maintenance.

Table 4.3
Low-Growing Turf Seed Mix

	% Weight	% Purity	% Germination
Dwarf tall fescue (several varieties) *Festuca arundinacea var.*	45	98	90
Dwarf perennial rye (Barclay) *Lolium perenne var. barclay*	30	98	90
Red fescue *Festuca rubra*	20	98	90
Colonial bentgrass *Agrostis tenuis*	5	98	90

Table 4.4 presents a mix recommended for bioswales and other intermittently wet areas.

Table 4.4
Bioswale Seed Mix*

	% Weight	% Purity	% Germination
Tall or meadow fescue *Festuca arundinacea* or *Festuca elatior*	75-80	98	90
Seaside/Creeping bentgrass *Agrostis palustris*	10-15	92	85
Redtop bentgrass *Agrostis alba* or *Agrostis gigantea*	5-10	90	80

** Modified Briargreen, Inc. Hydroseeding Guide Wetlands Seed Mix*

The seed mix shown in Table 4.5 is a recommended low-growing, relatively non-invasive seed mix appropriate for very wet areas that are not regulated wetlands. Other mixes may be appropriate, depending on the soil type and hydrology of the area. Recent research suggests that bentgrass (agrostis sp.) should be emphasized in wet-area seed mixes. Apply this mixture at a rate of 60 pounds per acre.

Table 4.5
Wet Area Seed Mix*

	% Weight	% Purity	% Germination
Tall or meadow fescue *Festuca arundinacea* or *Festuca elatior*	60-70	98	90
Seaside/Creeping bentgrass *Agrostis palustris*	10-15	98	85
Meadow foxtail *Alepocurus pratensis*	10-15	90	80
Alsike clover *Trifolium hybridum*	1-6	98	90
Redtop bentgrass *Agrostis alba*	1-6	92	85

** Modified Briargreen, Inc. Hydroseeding Guide Wetlands Seed Mix*

The meadow seed mix in Table 4.6 is recommended for areas that will be maintained infrequently or not at all and where colonization by native plants is desirable. Likely applications include rural road and utility right-of-way. Seeding should take place in September or very early October in order to obtain adequate establishment prior to the winter months. The appropriateness of clover in the mix may need to be considered, as this can be a fairly invasive species. If the soil is amended, the addition of clover may not be necessary.

Table 4.6
Meadow Seed Mix

	% Weight	% Purity	% Germination
Redtop or Oregon bentgrass *Agrostis alba* or *Agrostis oregonensis*	20	92	85
Red fescue *Festuca rubra*	70	98	90
White dutch clover *Trifolium repens*	10	98	90

Maintenance Standards

- Any seeded areas that fail to establish at least 80 percent cover (100 percent cover for areas that receive sheet or concentrated flows) shall be reseeded. If reseeding is ineffective, an alternate method, such as sodding, mulching, or nets/blankets, shall be used. If winter weather prevents adequate grass growth, this time limit may be relaxed at the discretion of the local authority when sensitive areas would otherwise be protected.

- After adequate cover is achieved, any areas that experience erosion shall be reseeded and protected by mulch. If the erosion problem is drainage related, the problem shall be fixed and the eroded area reseeded and protected by mulch.
- Seeded areas shall be supplied with adequate moisture, but not watered to the extent that it causes runoff.

BMP C121: Mulching

Purpose

The purpose of mulching soils is to provide immediate temporary protection from erosion. Mulch also enhances plant establishment by conserving moisture, holding fertilizer, seed, and topsoil in place, and moderating soil temperatures. There is an enormous variety of mulches that can be used. Only the most common types are discussed in this section.

Conditions of Use

As a temporary cover measure, mulch should be used:

- On disturbed areas that require cover measures for less than 30 days.
- As a cover for seed during the wet season and during the hot summer months.
- During the wet season on slopes steeper than 3H:1V with more than 10 feet of vertical relief.
- Mulch may be applied at any time of the year and must be refreshed periodically.

Design and Installation Specifications

For mulch materials, application rates, and specifications, see Table 4.7. Note: Thicknesses may be increased for disturbed areas in or near sensitive areas or other areas highly susceptible to erosion.

Mulch used within the ordinary high-water mark of surface waters should be selected to minimize potential flotation of organic matter. Composted organic materials have higher specific gravities (densities) than straw, wood, or chipped material.

Maintenance Standards

- The thickness of the cover must be maintained.
- Any areas that experience erosion shall be remulched and/or protected with a net or blanket. If the erosion problem is drainage related, then the problem shall be fixed and the eroded area remulched.

Table 4.7
Mulch Standards and Guidelines

Mulch Material	Quality Standards	Application Rates	Remarks
Straw	Air-dried; free from undesirable seed and coarse material.	2"-3" thick; 5 bales per 1000 sf or 2-3 tons per acre	Cost-effective protection when applied with adequate thickness. Hand-application generally requires greater thickness than blown straw. The thickness of straw may be reduced by half when used in conjunction with seeding. In windy areas straw must be held in place by crimping, using a tackifier, or covering with netting. Blown straw always has to be held in place with a tackifier as even light winds will blow it away. Straw, however, has several deficiencies that should be considered when selecting mulch materials. It often introduces and/or encourages the propagation of weed species and it has no significant long-term benefits. Straw should be used only if mulches with long-term benefits are unavailable locally. It should also not be used within the ordinary high-water elevation of surface waters (due to flotation).
Hydromulch	No growth inhibiting factors.	Approx. 25-30 lbs per 1000 sf or 1500 - 2000 lbs per acre	Shall be applied with hydromulcher. Shall not be used without seed and tackifier unless the application rate is at least doubled. Fibers longer than about ¾-1 inch clog hydromulch equipment. Fibers should be kept to less than ¾ inch.
Composted Mulch and Compost	No visible water or dust during handling. Must be purchased from supplier with Solid Waste Handling Permit (unless exempt).	2" thick min.; approx. 100 tons per acre (approx. 800 lbs per yard)	More effective control can be obtained by increasing thickness to 3". Excellent mulch for protecting final grades until landscaping because it can be directly seeded or tilled into soil as an amendment. Composted mulch has a coarser size gradation than compost. It is more stable and practical to use in wet areas and during rainy weather conditions.
Chipped Site Vegetation	Average size shall be several inches. Gradations from fines to 6 inches in length for texture, variation, and interlocking properties.	2" minimum thickness	This is a cost-effective way to dispose of debris from clearing and grubbing, and it eliminates the problems associated with burning. Generally, it should not be used on slopes above approx. 10% because of its tendency to be transported by runoff. It is not recommended within 200 feet of surface waters. If seeding is expected shortly after mulch, the decomposition of the chipped vegetation may tie up nutrients important to grass establishment.
Wood-based Mulch	No visible water or dust during handling. Must be purchased from a supplier with a Solid Waste Handling Permit or one exempt from solid waste regulations.	2” thick; approx. 100 tons per acre (approx. 800 lbs. per cubic yard)	This material is often called “hog or hogged fuel.” It is usable as a material for Stabilized Construction Entrances (BMP C105) and as a mulch. The use of mulch ultimately improves the organic matter in the soil. Special caution is advised regarding the source and composition of wood-based mulches. Its preparation typically does not provide any weed seed control, so evidence of residual vegetation in its composition or known inclusion of weed plants or seeds should be monitored and prevented (or minimized).

BMP C122: Nets and Blankets

Purpose

Erosion control nets and blankets are intended to prevent erosion and hold seed and mulch in place on steep slopes and in channels so that vegetation can become well established. In addition, some nets and blankets can be used to permanently reinforce turf to protect drainage ways during high flows. Nets (commonly called matting) are strands of material woven into an open, but high-tensile strength net (for example, coconut fiber matting). Blankets are strands of material that are not tightly woven, but instead form a layer of interlocking fibers, typically held together by a biodegradable or photodegradable netting (for example, excelsior or straw blankets). They generally have lower tensile strength than nets, but cover the ground more completely. Coir (coconut fiber) fabric comes as both nets and blankets.

Conditions of Use

Erosion control nets and blankets should be used:

- To aid permanent vegetated stabilization of slopes 2H:1V or greater and with more than 10 feet of vertical relief.
- For drainage ditches and swales (highly recommended). The application of appropriate netting or blanket to drainage ditches and swales can protect bare soil from channelized runoff while vegetation is established. Nets and blankets also can capture a great deal of sediment due to their open, porous structure. Synthetic nets and blankets can be used to permanently stabilize channels and may provide a cost-effective, environmentally preferable alternative to riprap. 100 percent synthetic blankets manufactured for use in ditches may be easily reused as temporary ditch liners.

Disadvantages of blankets include:

- Surface preparation required;
- On slopes steeper than 2.5:1, blanket installers may need to be roped and harnessed for safety;
- They cost at least $4,000-6,000 per acre installed.

Advantages of blankets include:

- Can be installed without mobilizing special equipment;
- Can be installed by anyone with minimal training;
- Can be installed in stages or phases as the project progresses;
- Seed and fertilizer can be hand-placed by the installers as they progress down the slope;
- Can be installed in any weather;
- There are numerous types of blankets that can be designed with various parameters in mind. Those parameters include: fiber blend, mesh strength, longevity, biodegradability, cost, and availability.

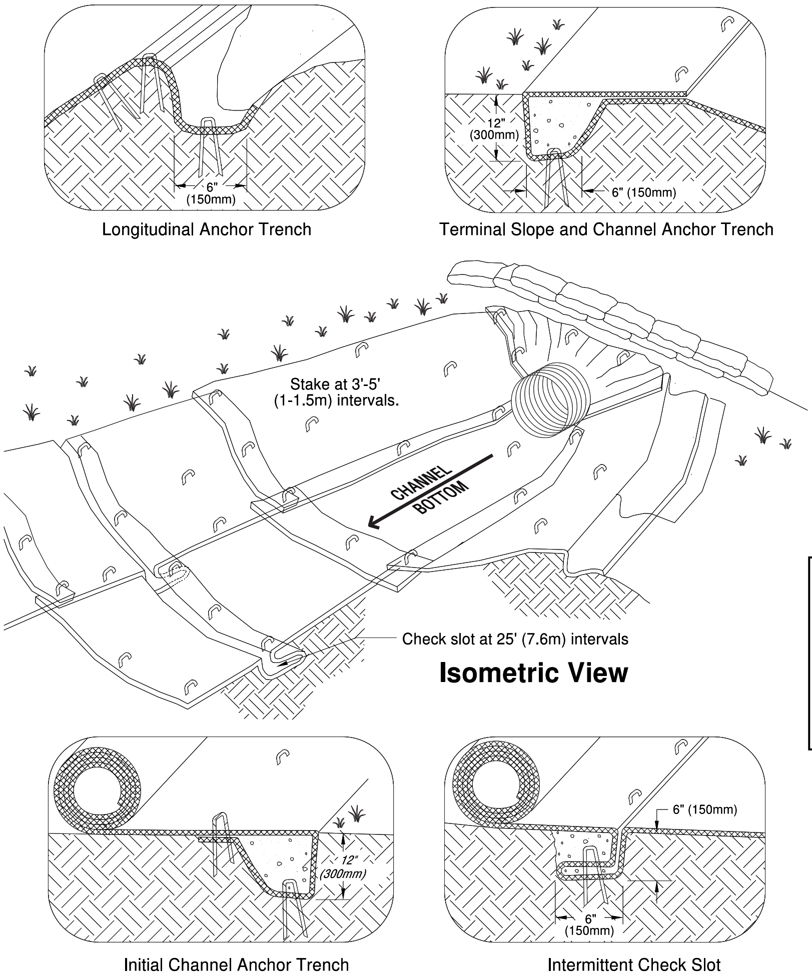
Design and Installation Specifications

- See Figure 4.4 and Figure 4.5 for typical orientation and installation of blankets used in channels and as slope protection. Note: these are typical only; all blankets must be installed per manufacturer's installation instructions.
- Installation is critical to the effectiveness of these products. If good ground contact is not achieved, runoff can concentrate under the product, resulting in significant erosion.
- Installation of Blankets on Slopes:
  1. Complete final grade and track walk up and down the slope.
  2. Install hydromulch with seed and fertilizer.
  3. Dig a small trench, approximately 12 inches wide by 6 inches deep along the top of the slope.
  4. Install the leading edge of the blanket into the small trench and staple approximately every 18 inches. NOTE: Staples are metal,"U"-shaped, and a minimum of 6 inches long. Longer staples are used in sandy soils. Biodegradable stakes are also available.
  5. Roll the blanket slowly down the slope as installer walks backwards. NOTE: The blanket rests against the installer's legs. Staples are installed as the blanket is unrolled. It is critical that the proper staple pattern is used for the blanket being installed. The blanket is not to be allowed to roll down the slope on its own as this stretches the blanket making it impossible to maintain soil contact. In addition, no one is allowed to walk on the blanket after it is in place.
  6. If the blanket is not long enough to cover the entire slope length, the trailing edge of the upper blanket should overlap the leading edge of the lower blanket and be stapled. On steeper slopes, this overlap should be installed in a small trench, stapled, and covered with soil.
- With the variety of products available, it is impossible to cover all the details of appropriate use and installation. Therefore, it is critical that the design engineer consults the manufacturer's information and that a site visit takes place in order to insure that the product specified is appropriate. Information is also available at the following web sites:
  1. WSDOT: http://www.wsdot.wa.gov/eesc/environmental/
  2. Texas Transportation Institute: http://www.dot.state.tx.us/insdtdot/orgchart/cmd/erosion/contents.htm

- Jute matting must be used in conjunction with mulch (BMP C121). Excelsior, woven straw blankets and coir (coconut fiber) blankets may be installed without mulch. There are many other types of erosion control nets and blankets on the market that may be appropriate in certain circumstances.
- In general, most nets (e.g., jute matting) require mulch in order to prevent erosion because they have a fairly open structure. Blankets typically do not require mulch because they usually provide complete protection of the surface.
- Extremely steep, unstable, wet, or rocky slopes are often appropriate candidates for use of synthetic blankets, as are riverbanks, beaches and other high-energy environments. If synthetic blankets are used, the soil should be hydromulched first.
- 100 percent biodegradable blankets are available for use in sensitive areas. These organic blankets are usually held together with a paper or fiber mesh and stitching which may last up to a year.
- Most netting used with blankets is photodegradable, meaning they break down under sunlight (not UV stabilized). However, this process can take months or years even under bright sun. Once vegetation is established, sunlight does not reach the mesh. It is not uncommon to find non-degraded netting still in place several years after installation. This can be a problem if maintenance requires the use of mowers or ditch cleaning equipment. In addition, birds and small animals can become trapped in the netting.

Maintenance Standards

- Good contact with the ground must be maintained, and erosion must not occur beneath the net or blanket.
- Any areas of the net or blanket that are damaged or not in close contact with the ground shall be repaired and stapled.
- If erosion occurs due to poorly controlled drainage, the problem shall be fixed and the eroded area protected.



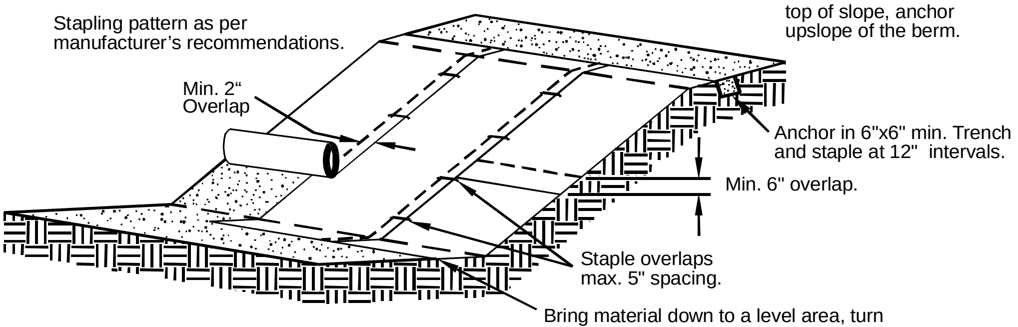
NOTES:
1. Check slots to be constructed per manufacturers specifications.
2. Staking or stapling layout per manufacturers specifications.

Figure 4.4 – Channel Installation

Slope surface shall be smooth before placement for proper soil contact.

Stapling pattern as per manufacturer's recommendations.

If there is a berm at the top of slope, anchor upslope of the berm.



Bring material down to a level area, turn the end under 4" and staple at 12" intervals.

Do not stretch blankets/mattings tight - allow the rolls to mold to any irregularities.

For slopes less than 3H:1V, rolls may be placed in horizontal strips.

Lime, fertilize, and seed before installation. Planting of shrubs, trees, etc. Should occur after installation.

Figure 4.5 – Slope Installation

BMP C123: Plastic Covering

Purpose

Plastic covering provides immediate, short-term erosion protection to slopes and disturbed areas.

Conditions of Use

- Plastic covering may be used on disturbed areas that require cover measures for less than 30 days, except as stated below.
- Plastic is particularly useful for protecting cut and fill slopes and stockpiles. Note: The relatively rapid breakdown of most polyethylene sheeting makes it unsuitable for long-term (greater than six months) applications.
- Clear plastic sheeting can be used over newly-seeded areas to create a greenhouse effect and encourage grass growth if the hydroseed was installed too late in the season to establish 75 percent grass cover, or if the wet season started earlier than normal. Clear plastic should not be used for this purpose during the summer months because the resulting high temperatures can kill the grass.
- Due to rapid runoff caused by plastic sheeting, this method shall not be used upslope of areas that might be adversely impacted by concentrated runoff. Such areas include steep and/or unstable slopes.
- While plastic is inexpensive to purchase, the added cost of installation, maintenance, removal, and disposal make this an expensive material, up to $1.50-2.00 per square yard.
- Whenever plastic is used to protect slopes, water collection measures must be installed at the base of the slope. These measures include plastic-covered berms, channels, and pipes used to covey clean rainwater away from bare soil and disturbed areas. At no time is clean runoff from a plastic covered slope to be mixed with dirty runoff from a project.
- Other uses for plastic include:
    1. Temporary ditch liner;
    2. Pond liner in temporary sediment pond;
    3. Liner for bermed temporary fuel storage area if plastic is not reactive to the type of fuel being stored;
    4. Emergency slope protection during heavy rains; and,
    5. Temporary drainpipe (“elephant trunk”) used to direct water.

Design and Installation Specifications

- Plastic slope cover must be installed as follows:
  1. Run plastic up and down slope, not across slope;
  2. Plastic may be installed perpendicular to a slope if the slope length is less than 10 feet;
  3. Minimum of 8-inch overlap at seams;
  4. On long or wide slopes, or slopes subject to wind, all seams should be taped;
  5. Place plastic into a small (12-inch wide by 6-inch deep) slot trench at the top of the slope and backfill with soil to keep water from flowing underneath;
  6. Place sand filled burlap or geotextile bags every 3 to 6 feet along seams and pound a wooden stake through each to hold them in place;
  7. Inspect plastic for rips, tears, and open seams regularly and repair immediately. This prevents high velocity runoff from contacting bare soil which causes extreme erosion;
  8. Sandbags may be lowered into place tied to ropes. However, all sandbags must be staked in place.
- Plastic sheeting shall have a minimum thickness of 0.06 millimeters.
- If erosion at the toe of a slope is likely, a gravel berm, riprap, or other suitable protection shall be installed at the toe of the slope in order to reduce the velocity of runoff.

Maintenance Standards

- Torn sheets must be replaced and open seams repaired.
- If the plastic begins to deteriorate due to ultraviolet radiation, it must be completely removed and replaced.
- When the plastic is no longer needed, it shall be completely removed.
- Dispose of old tires appropriately.

BMP C124: Sodding

Purpose

The purpose of sodding is to establish permanent turf for immediate erosion protection and to stabilize drainage ways where concentrated overland flow will occur.

Conditions of Use

Sodding may be used in the following areas:

- Disturbed areas that require short-term or long-term cover.
- Disturbed areas that require immediate vegetative cover.
- All waterways that require vegetative lining. Waterways may also be seeded rather than sodded, and protected with a net or blanket.

Design and Installation Specifications

Sod shall be free of weeds, of uniform thickness (approximately 1-inch thick), and shall have a dense root mat for mechanical strength.

The following steps are recommended for sod installation:

- Shape and smooth the surface to final grade in accordance with the approved grading plan. The swale needs to be overexcavated 4 to 6 inches below design elevation to allow room for placing soil amendment and sod.
- Amend 4 inches (minimum) of compost into the top 8 inches of the soil if the organic content of the soil is less than ten percent or the permeability is less than 0.6 inches per hour. Compost used should meet Ecology publication 94-038 specifications for Grade A quality compost.
- Fertilize according to the supplier's recommendations.
- Work lime and fertilizer 1 to 2 inches into the soil, and smooth the surface.
- Lay strips of sod beginning at the lowest area to be sodded and perpendicular to the direction of water flow. Wedge strips securely into place. Square the ends of each strip to provide for a close, tight fit. Stagger joints at least 12 inches. Staple on slopes steeper than 3H:1V. Staple the upstream edge of each sod strip.
- Roll the sodded area and irrigate.
- When sodding is carried out in alternating strips or other patterns, seed the areas between the sod immediately after sodding.

Maintenance Standards

If the grass is unhealthy, the cause shall be determined and appropriate action taken to reestablish a healthy groundcover. If it is impossible to establish a healthy groundcover due to frequent saturation, instability, or some other cause, the sod shall be removed, the area seeded with an appropriate mix, and protected with a net or blanket.

BMP C125: Topsoiling

Purpose

To provide a suitable growth medium for final site stabilization with vegetation. While not a permanent cover practice in itself, topsoiling is an integral component of providing permanent cover in those areas where there is an unsuitable soil surface for plant growth. Native soils and disturbed soils that have been organically amended not only retain much more stormwater, but they also serve as effective biofilters for urban pollutants and, by supporting more vigorous plant growth, reduce the water, fertilizer and pesticides needed to support installed landscapes. Topsoil does not include any subsoils but only the material from the top several inches including organic debris.

Conditions of Use

- Native soils should be left undisturbed to the maximum extent practicable. Native soils disturbed during clearing and grading should be restored, to the maximum extent practicable, to a condition where moisture-holding capacity is equal to or better than the original site conditions. This criterion can be met by using on-site native topsoil, incorporating amendments into on-site soil, or importing blended topsoil.
- Topsoiling is a required procedure when establishing vegetation on shallow soils, and soils of critically low pH (high acid) levels.
- Stripping of existing, properly functioning soil system and vegetation for the purpose of topsoiling during construction is not acceptable. If an existing soil system is functioning properly it shall be preserved in its undisturbed and uncompacted condition.
- Depending on where the topsoil comes from, or what vegetation was on site before disturbance, invasive plant seeds may be included and could cause problems for establishing native plants, landscaped areas, or grasses.
- Topsoil from the site will contain mycorrhizal bacteria that are necessary for healthy root growth and nutrient transfer. These native mycorrhiza are acclimated to the site and will provide optimum conditions for establishing grasses. Commercially available mycorrhiza products should be used when topsoil is brought in from off-site.

Design and Installation Specifications

If topsoiling is to be done, the following items should be considered:

- Maximize the depth of the topsoil wherever possible to provide the maximum possible infiltration capacity and beneficial growth medium. Topsoil depth shall be at least 8 inches with a minimum organic content of 10 percent dry weight and pH between 6.0 and 8.0 or matching the pH of the undisturbed soil. This can be accomplished either by returning native topsoil to the site and/or incorporating organic amendments. Organic amendments should be incorporated to a minimum 8-inch depth except where tree roots or other natural features limit the depth of incorporation. Subsoils below the 12-inch depth should be scarified at least 2 inches to avoid stratified layers, where feasible. The decision to either layer topsoil over a subgrade or incorporate topsoil into the underlying layer may vary depending on the planting specified.

- If blended topsoil is imported, then fines should be limited to 25 percent passing through a 200 sieve.
- The final composition and construction of the soil system will result in a natural selection or favoring of certain plant species over time. For example, recent practices have shown that incorporation of topsoil may favor grasses, while layering with mildly acidic, high-carbon amendments may favor more woody vegetation.
- Locate the topsoil stockpile so that it meets specifications and does not interfere with work on the site. It may be possible to locate more than one pile in proximity to areas where topsoil will be used.
- Allow sufficient time in scheduling for topsoil to be spread prior to seeding, sodding, or planting.
- Care must be taken not to apply to subsoil if the two soils have contrasting textures. Sandy topsoil over clayey subsoil is a particularly poor combination, as water creeps along the junction between the soil layers and causes the topsoil to slough.
- If topsoil and subsoil are not properly bonded, water will not infiltrate the soil profile evenly and it will be difficult to establish vegetation. The best method to prevent a lack of bonding is to actually work the topsoil into the layer below for a depth of at least 6 inches.
- Ripping or re-structuring the subgrade may also provide additional benefits regarding the overall infiltration and interflow dynamics of the soil system.
- Field exploration of the site shall be made to determine if there is surface soil of sufficient quantity and quality to justify stripping. Topsoil shall be friable and loamy (loam, sandy loam, silt loam, sandy clay loam, clay loam). Areas of natural ground water recharge should be avoided.
- Stripping shall be confined to the immediate construction area. A 4- to 6- inch stripping depth is common, but depth may vary depending on the particular soil. All surface runoff control structures shall be in place prior to stripping.

Stockpiling of topsoil shall occur in the following manner:

- Side slopes of the stockpile shall not exceed 2:1.
- An interceptor dike with gravel outlet and silt fence shall surround all topsoil stockpiles between October 1 and April 30. Between May 1

and September 30, an interceptor dike with gravel outlet and silt fence shall be installed if the stockpile will remain in place for a longer period of time than active construction grading.

- Erosion control seeding or covering with clear plastic or other mulching materials of stockpiles shall be completed within 2 days (October 1 through April 30) or 7 days (May 1 through September 30) of the formation of the stockpile. Native topsoil stockpiles shall not be covered with plastic.
- Topsoil shall not be placed while in a frozen or muddy condition, when the subgrade is excessively wet, or when conditions exist that may otherwise be detrimental to proper grading or proposed sodding or seeding.
- Previously established grades on the areas to be topsoiled shall be maintained according to the approved plan.
- When native topsoil is to be stockpiled and reused the following should apply to ensure that the mycorrhizal bacterial, earthworms, and other beneficial organisms will not be destroyed:
  1. Topsoil is to be re-installed within 4 to 6 weeks;
  2. Topsoil is not to become saturated with water;
  3. Plastic cover is not allowed.

Maintenance Standards

- Inspect stockpiles regularly, especially after large storm events. Stabilize any areas that have eroded.

BMP C126: Polyacrylamide for Soil Erosion Protection

Purpose

Polyacrylamide (PAM) is used on construction sites to prevent soil erosion.

Applying PAM to bare soil in advance of a rain event significantly reduces erosion and controls sediment in two ways. First, PAM increases the soil's available pore volume, thus increasing infiltration through flocculation and reducing the quantity of stormwater runoff. Second, it increases flocculation of suspended particles and aids in their deposition, thus reducing stormwater runoff turbidity and improving water quality.

Conditions of Use

PAM shall not be directly applied to water or allowed to enter a water body.

In areas that drain to a sediment pond, PAM can be applied to bare soil under the following conditions:

- During rough grading operations.
- Staging areas.
- Balanced cut and fill earthwork.
- Haul roads prior to placement of crushed rock surfacing.
- Compacted soil roadbase.
- Stockpiles.
- After final grade and before paving or final seeding and planting.
- Pit sites.
- Sites having a winter shut down. In the case of winter shut down, or where soil will remain unworked for several months, PAM should be used together with mulch.

Design and Installation Specifications

PAM may be applied in dissolved form with water, or it may be applied in dry, granular or powdered form. The preferred application method is the dissolved form.

PAM is to be applied at a maximum rate of 2/3 pound PAM per 1000 gallons water (80 mg/L) per 1 acre of bare soil. Table 4.8 can be used to determine the PAM and water application rate for a disturbed soil area. Higher concentrations of PAM **do not** provide any additional effectiveness.

Table 4.8
PAM and Water Application Rates

Disturbed Area (ac)	PAM (lbs)	Water (gal)
0.50	0.33	500
1.00	0.66	1,000
1.50	1.00	1,500
2.00	1.32	2,000
2.50	1.65	2,500
3.00	2.00	3,000
3.50	2.33	3,500
4.00	2.65	4,000
4.50	3.00	4,500
5.00	3.33	5,000

The Preferred Method:

- Pre-measure the area where PAM is to be applied and calculate the amount of product and water necessary to provide coverage at the specified application rate (2/3 pound PAM/1000 gallons/acre).
- PAM has infinite solubility in water, but dissolves very slowly. Dissolve pre-measured dry granular PAM with a known quantity of clean water in a bucket several hours or overnight. Mechanical mixing will help dissolve the PAM. Always add PAM to water - not water to PAM.
- Pre-fill the water truck about 1/8 full with water. The water does not have to be potable, but it must have relatively low turbidity – in the range of 20 NTU or less.
- Add PAM /Water mixture to the truck
- Completely fill the water truck to specified volume.
- Spray PAM/Water mixture onto dry soil until the soil surface is uniformly and completely wetted.

An Alternate Method:

PAM may also be applied as a powder at the rate of 5 lbs. per acre. This must be applied on a day that is dry. For areas less than 5-10 acres, a hand-held “organ grinder” fertilizer spreader set to the smallest setting will work. Tractor-mounted spreaders will work for larger areas.

The following shall be used for application of PAM:

- PAM shall be used in conjunction with other BMPs and not in place of other BMPs.
- Do not use PAM on a slope that flows directly into a stream or wetland. The stormwater runoff shall pass through a sediment control BMP prior to discharging to surface waters.
- Do not add PAM to water discharging from site.
- When the total drainage area is greater than or equal to 5 acres, PAM treated areas shall drain to a sediment pond.
- Areas less than 5 acres shall drain to sediment control BMPs, such as a minimum of 3 check dams per acre. The total number of check dams used shall be maximized to achieve the greatest amount of settlement of sediment prior to discharging from the site. Each check dam shall be spaced evenly in the drainage channel through which stormwater flows are discharged off-site.
- On all sites, the use of silt fence shall be maximized to limit the discharges of sediment from the site.
- All areas not being actively worked shall be covered and protected from rainfall. PAM shall not be the only cover BMP used.

- PAM can be applied to wet soil, but dry soil is preferred due to less sediment loss.
- PAM will work when applied to saturated soil but is not as effective as applications to dry or damp soil.
- Keep the granular PAM supply out of the sun. Granular PAM loses its effectiveness in three months after exposure to sunlight and air.
- Proper application and re-application plans are necessary to ensure total effectiveness of PAM usage.
- PAM, combined with water, is very slippery and can be a safety hazard. Care must be taken to prevent spills of PAM powder onto paved surfaces. During an application of PAM, prevent over-spray from reaching pavement as pavement will become slippery. If PAM powder gets on skin or clothing, wipe it off with a rough towel rather than washing with water-this only makes cleanup messier and take longer.
- Some PAMs are more toxic and carcinogenic than others. Only the most environmentally safe PAM products should be used.

  The specific PAM copolymer formulation must be anionic. **Cationic PAM shall not be used in any application because of known aquatic toxicity problems.** Only the highest drinking water grade PAM, certified for compliance with ANSI/NSF Standard 60 for drinking water treatment, will be used for soil applications. Recent media attention and high interest in PAM has resulted in some entrepreneurial exploitation of the term "polymer." All PAM are polymers, but not all polymers are PAM, and not all PAM products comply with ANSI/NSF Standard 60. PAM use shall be reviewed and approved by the local permitting authority. The Washington State Department of Transportation (WSDOT) has listed approved PAM products on their web page.
- PAM designated for these uses should be "water soluble" or "linear" or "non-crosslinked". Cross-linked or water absorbent PAM, polymerized in highly acidic (pH<2) conditions, are used to maintain soil moisture content.
- The PAM anionic charge density may vary from 2-30 percent; a value of 18 percent is typical. Studies conducted by the United States Department of Agriculture (USDA)/ARS demonstrated that soil stabilization was optimized by using very high molecular weight (12-15 mg/mole), highly anionic (>20% hydrolysis) PAM.
- PAM tackifiers are available and being used in place of guar and alpha plantago. Typically, PAM tackifiers should be used at a rate of no more than 0.5-1 lb. per 1000 gallons of water in a hydromulch machine. Some tackifier product instructions say to use at a rate of 3 –

5 lbs. per acre, which can be too much. In addition, pump problems can occur at higher rates due to increased viscosity.

Maintenance Standards

- PAM may be reapplied on actively worked areas after a 48-hour period.
- Reapplication is not required unless PAM treated soil is disturbed or unless turbidity levels show the need for an additional application. If PAM treated soil is left undisturbed a reapplication may be necessary after two months. More PAM applications may be required for steep slopes, silty and clayey soils (USDA Classification Type "C" and "D" soils), long grades, and high precipitation areas. When PAM is applied first to bare soil and then covered with straw, a reapplication may not be necessary for several months.
- Loss of sediment and PAM may be a basis for penalties per RCW 90.48.080.

BMP C130: Surface Roughening

Purpose

Surface roughening aids in the establishment of vegetative cover, reduces runoff velocity, increases infiltration, and provides for sediment trapping through the provision of a rough soil surface. Horizontal depressions are created by operating a tiller or other suitable equipment on the contour or by leaving slopes in a roughened condition by not fine grading them.

Conditions for Use

- All slopes steeper than 3:1 and greater than 5 vertical feet require surface roughening.
- Areas with grades steeper than 3:1 should be roughened to a depth of 2 to 4 inches prior to seeding.
- Areas that will not be stabilized immediately may be roughened to reduce runoff velocity until seeding takes place.
- Slopes with a stable rock face do not require roughening.
- Slopes where mowing is planned should not be excessively roughened.

Design and Installation Specifications

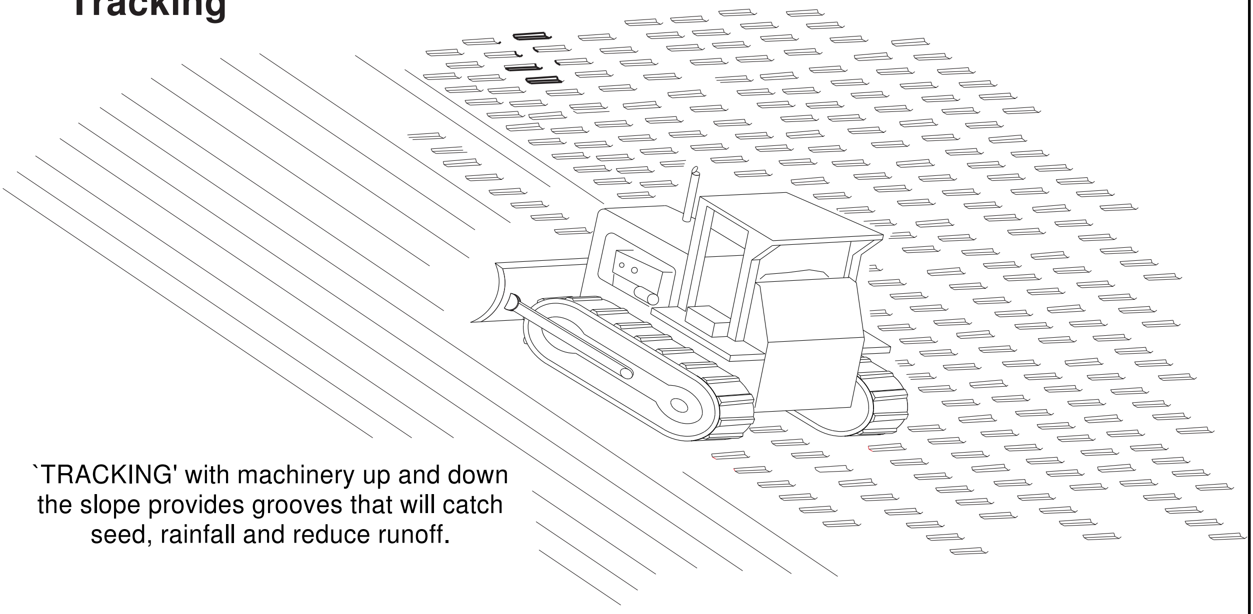
There are different methods for achieving a roughened soil surface on a slope, and the selection of an appropriate method depends upon the type of slope. Roughening methods include stair-step grading, grooving, contour furrows, and tracking. See Figure 4.6 for tracking and contour furrows. Factors to be considered in choosing a method are slope steepness, mowing requirements, and whether the slope is formed by cutting or filling.

- Disturbed areas that will not require mowing may be stair-step graded, grooved, or left rough after filling.
- Stair-step grading is particularly appropriate in soils containing large amounts of soft rock. Each "step" catches material that sloughs from above, and provides a level site where vegetation can become established. Stairs should be wide enough to work with standard earth moving equipment. Stair steps must be on contour or gullies will form on the slope.
- Areas that will be mowed (these areas should have slopes less steep than 3:1) may have small furrows left by disking, harrowing, raking, or seed-planting machinery operated on the contour.
- Graded areas with slopes greater than 3:1 but less than 2:1 should be roughened before seeding. This can be accomplished in a variety of ways, including "track walking," or driving a crawler tractor up and down the slope, leaving a pattern of cleat imprints parallel to slope contours.
- Tracking is done by operating equipment up and down the slope to leave horizontal depressions in the soil.

Maintenance Standards

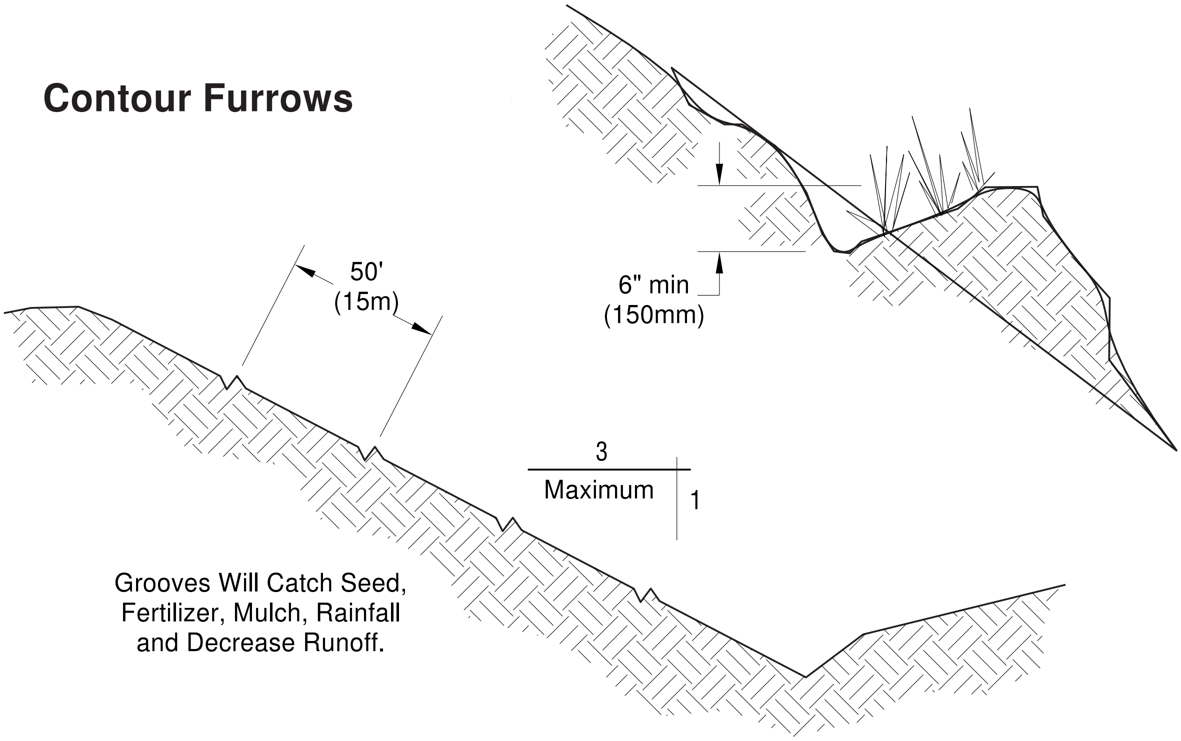
- Areas that are graded in this manner should be seeded as quickly as possible.
- Regular inspections should be made of the area. If rills appear, they should be re-graded and re-seeded immediately.

Tracking



`TRACKING' with machinery up and down the slope provides grooves that will catch seed, rainfall and reduce runoff.

Contour Furrows



Grooves Will Catch Seed, Fertilizer, Mulch, Rainfall and Decrease Runoff.

Figure 4.6 – Surface Roughening by Tracking and Contour Furrows

BMP C131: Gradient Terraces

Purpose

Gradient terraces reduce erosion damage by intercepting surface runoff and conducting it to a stable outlet at a non-erosive velocity.

Conditions of Use

- Gradient terraces normally are limited to denuded land having a water erosion problem. They should not be constructed on deep sands or on soils that are too stony, steep, or shallow to permit practical and economical installation and maintenance. Gradient terraces may be used only where suitable outlets are or will be made available. See Figure 4.7 for gradient terraces.

Design and Installation Specifications

- The maximum spacing of gradient terraces should be determined by the following method:

  $$VI = (0.8)s + y$$

  Where: VI = vertical interval in feet

  s = land rise per 100 feet, expressed in feet

  y = a soil and cover variable with values from 1.0 to 4.0

  Values of “y” are influenced by soil erodibility and cover practices. The lower values are applicable to erosive soils where little to no residue is left on the surface. The higher value is applicable only to erosion-resistant soils where a large amount of residue (1½ tons of straw/acre equivalent) is on the surface.

- The minimum constructed cross-section should meet the design dimensions.

- The top of the constructed ridge should not be lower at any point than the design elevation plus the specified overfill for settlement. The opening at the outlet end of the terrace should have a cross section equal to that specified for the terrace channel.

- Channel grades may be either uniform or variable with a maximum grade of 0.6 feet per 100 feet length. For short distances, terrace grades may be increased to improve alignment. The channel velocity should not exceed that which is nonerosive for the soil type with the planned treatment.

- All gradient terraces should have adequate outlets. Such an outlet may be a grassed waterway, vegetated area, or tile outlet. In all cases the outlet must convey runoff from the terrace or terrace system to a point where the outflow will not cause damage. Vegetative cover should be used in the outlet channel.

- The design elevation of the water surface of the terrace should not be lower than the design elevation of the water surface in the outlet at their junction, when both are operating at design flow.

- Vertical spacing determined by the above methods may be increased as much as 0.5 feet or 10 percent, whichever is greater, to provide better alignment or location, to avoid obstacles, to adjust for equipment size, or to reach a satisfactory outlet.
- The drainage area above the top should not exceed the area that would be drained by a terrace with normal spacing.
- The terrace should have enough capacity to handle the peak runoff expected from a 2-year, 24-hour design storm without overtopping.
- The terrace cross-section should be proportioned to fit the land slope. The ridge height should include a reasonable settlement factor. The ridge should have a minimum top width of 3 feet at the design height. The minimum cross-sectional area of the terrace channel should be 8 square feet for land slopes of 5 percent or less, 7 square feet for slopes from 5 to 8 percent, and 6 square feet for slopes steeper than 8 percent. The terrace can be constructed wide enough to be maintained using a small cat.

Maintenance Standards

- Maintenance should be performed as needed. Terraces should be inspected regularly; at least once a year, and after large storm events.

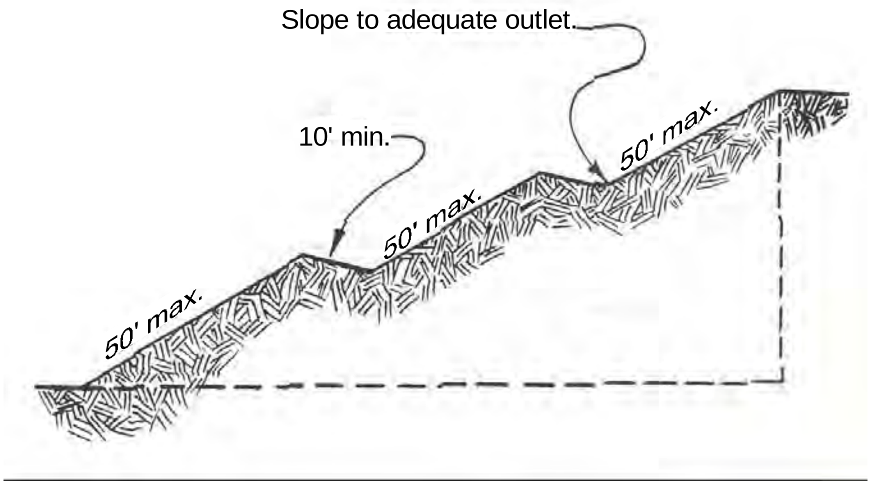


Figure 4.7 - Gradient Terraces

BMP C140: Dust Control

Purpose Dust control prevents wind transport of dust from disturbed soil surfaces onto roadways, drainage ways, and surface waters.

Conditions of Use

- In areas (including roadways) subject to surface and air movement of dust where on-site and off-site impacts to roadways, drainage ways, or surface waters are likely.

Design and Installation Specifications

- Vegetate or mulch areas that will not receive vehicle traffic. In areas where planting, mulching, or paving is impractical, apply gravel or landscaping rock.
- Limit dust generation by clearing only those areas where immediate activity will take place, leaving the remaining area(s) in the original condition, if stable. Maintain the original ground cover as long as practical.
- Construct natural or artificial windbreaks or windscreens. These may be designed as enclosures for small dust sources.
- Sprinkle the site with water until surface is wet. Repeat as needed. To prevent carryout of mud onto street, refer to Stabilized Construction Entrance (BMP C105).
- Irrigation water can be used for dust control. Irrigation systems should be installed as a first step on sites where dust control is a concern.
- Spray exposed soil areas with a dust palliative, following the manufacturer’s instructions and cautions regarding handling and application. Used oil is prohibited from use as a dust suppressant. Local governments may approve other dust palliatives such as calcium chloride or PAM.
- PAM (BMP C126) added to water at a rate of 0.5 lbs. per 1,000 gallons of water per acre and applied from a water truck is more effective than water alone. This is due to the increased infiltration of water into the soil and reduced evaporation. In addition, small soil particles are bonded together and are not as easily transported by wind. Adding PAM may actually reduce the quantity of water needed for dust control, especially in eastern Washington. Since the wholesale cost of PAM is about $ 4.00 per pound, this is an extremely cost-effective dust control method.

Techniques that can be used for unpaved roads and lots include:

- Lower speed limits. High vehicle speed increases the amount of dust stirred up from unpaved roads and lots.
- Upgrade the road surface strength by improving particle size, shape, and mineral types that make up the surface and base materials.

- Add surface gravel to reduce the source of dust emission. Limit the amount of fine particles (those smaller than .075 mm) to 10 to 20 percent.
- Use geotextile fabrics to increase the strength of new roads or roads undergoing reconstruction.
- Encourage the use of alternate, paved routes, if available.
- Restrict use by tracked vehicles and heavy trucks to prevent damage to road surface and base.
- Apply chemical dust suppressants using the admix method, blending the product with the top few inches of surface material. Suppressants may also be applied as surface treatments.
- Pave unpaved permanent roads and other trafficked areas.
- Use vacuum street sweepers.
- Remove mud and other dirt promptly so it does not dry and then turn into dust.
- Limit dust-causing work on windy days.
- Contact your local Air Pollution Control Authority for guidance and training on other dust control measures. Compliance with the local Air Pollution Control Authority constitutes compliance with this BMP.

Maintenance Standards

Respray area as necessary to keep dust to a minimum.

BMP C150: Materials On Hand

Purpose

Quantities of erosion prevention and sediment control materials can be kept on the project site at all times to be used for emergency situations such as unexpected heavy summer rains. Having these materials on-site reduces the time needed to implement BMPs when inspections indicate that existing BMPs are not meeting the Construction SWPPP requirements. In addition, contractors can save money by buying some materials in bulk and storing them at their office or yard.

Conditions of Use

- Construction projects of any size or type can benefit from having materials on hand. A small commercial development project could have a roll of plastic and some gravel available for immediate protection of bare soil and temporary berm construction. A large earthwork project, such as highway construction, might have several tons of straw, several rolls of plastic, flexible pipe, sandbags, geotextile fabric and steel "T" posts.
- Materials are stockpiled and readily available before any site clearing, grubbing, or earthwork begins. A large contractor or developer could keep a stockpile of materials that are available to be used on several projects.
- If storage space at the project site is at a premium, the contractor could maintain the materials at their office or yard. The office or yard must be less than an hour from the project site.

Design and Installation Specifications

Depending on project type, size, complexity, and length, materials and quantities will vary. A good minimum that will cover numerous situations includes:

Material	Measure	Quantity
Clear Plastic, 6 mil	100 foot roll	1-2
Drainpipe, 6 or 8 inch diameter	25 foot section	4-6
Sandbags, filled	each	25-50
Straw Bales for mulching,	approx. 50# each	10-20
Quarry Spalls	ton	2-4
Washed Gravel	cubic yard	2-4
Geotextile Fabric	100 foot roll	1-2
Catch Basin Inserts	each	2-4
Steel "T" Posts	each	12-24

Maintenance Standards

- All materials with the exception of the quarry spalls, steel "T" posts, and gravel should be kept covered and out of both sun and rain.
- Re-stock materials used as needed.

BMP C162: Scheduling

Purpose

Sequencing a construction project reduces the amount and duration of soil exposed to erosion by wind, rain, runoff, and vehicle tracking.

Conditions of Use

The construction sequence schedule is an orderly listing of all major land-disturbing activities together with the necessary erosion and sedimentation control measures planned for the project. This type of schedule guides the contractor on work to be done before other work is started so that serious erosion and sedimentation problems can be avoided.

Following a specified work schedule that coordinates the timing of land-disturbing activities and the installation of control measures is perhaps the most cost-effective way of controlling erosion during construction. The removal of surface ground cover leaves a site vulnerable to accelerated erosion. Construction procedures that limit land clearing, provide timely installation of erosion and sedimentation controls, and restore protective cover quickly can significantly reduce the erosion potential of a site.

Design Considerations

- Avoid rainy periods.
- Schedule projects to disturb only small portions of the site at any one time. Complete grading as soon as possible. Immediately stabilize the disturbed portion before grading the next portion. Practice staged seeding in order to revegetate cut and fill slopes as the work progresses.

4.2 Runoff Conveyance and Treatment BMPs

BMP C200: Interceptor Dike and Swale

Purpose

Provide a ridge of compacted soil, or a ridge with an upslope swale, at the top or base of a disturbed slope or along the perimeter of a disturbed construction area to convey stormwater. Use the dike and/or swale to intercept the runoff from unprotected areas and direct it to areas where erosion can be controlled. This can prevent storm runoff from entering the work area or sediment-laden runoff from leaving the construction site.

Conditions of Use

Where the runoff from an exposed site or disturbed slope must be conveyed to an erosion control facility which can safely convey the stormwater.

- Locate upslope of a construction site to prevent runoff from entering disturbed area.
- When placed horizontally across a disturbed slope, it reduces the amount and velocity of runoff flowing down the slope.
- Locate downslope to collect runoff from a disturbed area and direct it to a sediment basin.

Design and Installation Specifications

- Dike and/or swale and channel must be stabilized with temporary or permanent vegetation or other channel protection during construction.
- Channel requires a positive grade for drainage; steeper grades require channel protection and check dams.
- Review construction for areas where overtopping may occur.
- Can be used at top of new fill before vegetation is established.
- May be used as a permanent diversion channel to carry the runoff.
- Sub-basin tributary area should be one acre or less.
- Design capacity for the peak flow from a 10-year, 24-hour storm, assuming a Type 1A rainfall distribution, for temporary facilities. Alternatively, use 1.6 times the 10-year, 1-hour flow indicated by an approved continuous runoff model. For facilities that will also serve on a permanent basis, consult the local government's drainage requirements.

Interceptor dikes shall meet the following criteria:

Top Width	2 feet minimum.
Height	1.5 feet minimum on berm.
Side Slope	2:1 or flatter.
Grade	Depends on topography, however, dike system minimum is 0.5%, maximum is 1%.
Compaction	Minimum of 90 percent ASTM D698 standard proctor.

Horizontal Spacing of Interceptor Dikes:

Average Slope	**Slope Percent**	**Flowpath Length**
20H:1V or less	3-5%	300 feet
(10 to 20)H:1V	5-10%	200 feet
(4 to 10)H:1V	10-25%	100 feet
(2 to 4)H:1V	25-50%	50 feet

Stabilization depends on velocity and reach

Slopes <5%	Seed and mulch applied within 5 days of dike construction (*see BMP C121, Mulching*).
Slopes 5 - 40%	**Dependent on runoff velocities and dike materials. Stabilization should be done immediately using either sod or riprap or other measures to avoid erosion.**

- The upslope side of the dike shall provide positive drainage to the dike outlet. No erosion shall occur at the outlet. Provide energy dissipation measures as necessary. Sediment-laden runoff must be released through a sediment trapping facility.
- Minimize construction traffic over temporary dikes. Use temporary cross culverts for channel crossing.

Interceptor swales shall meet the following criteria:

Bottom Width	2 feet minimum; the bottom shall be level.
Depth	1-foot minimum.
Side Slope	2:1 or flatter.
Grade	Maximum 5 percent, with positive drainage to a suitable outlet (such as a sediment pond).
Stabilization	Seed as per *BMP C120*, *Temporary and Permanent Seeding*, or *BMP C202*, *Channel Lining*, 12 inches thick of riprap pressed into the bank and extending at least 8 inches vertical from the bottom.

- Inspect diversion dikes and interceptor swales once a week and after every rainfall. Immediately remove sediment from the flow area.
- Damage caused by construction traffic or other activity must be repaired before the end of each working day.

Check outlets and make timely repairs as needed to avoid gully formation. When the area below the temporary diversion dike is permanently stabilized, remove the dike and fill and stabilize the channel to blend with the natural surface.

BMP C204: Pipe Slope Drains

Purpose

To use a pipe to convey stormwater anytime water needs to be diverted away from or over bare soil to prevent gullies, channel erosion, and saturation of slide-prone soils.

Conditions of Use

Pipe slope drains should be used when a temporary or permanent stormwater conveyance is needed to move the water down a steep slope to avoid erosion (Figure 4.10).

On highway projects, they should be used at bridge ends to collect runoff and pipe it to the base of the fill slopes along bridge approaches. These can be designed into a project and included as bid items. Another use on road projects is to collect runoff from pavement and pipe it away from side slopes. These are useful because there is generally a time lag between having the first lift of asphalt installed and the curbs, gutters, and permanent drainage installed. Used in conjunction with sand bags, or other temporary diversion devices, these will prevent massive amounts of sediment from leaving a project.

Water can be collected, channeled with sand bags, Triangular Silt Dikes, berms, or other material, and piped to temporary sediment ponds.

Pipe slope drains can be:

- Connected to new catch basins and used temporarily until all permanent piping is installed;
- Used to drain water collected from aquifers exposed on cut slopes and take it to the base of the slope;
- Used to collect clean runoff from plastic sheeting and direct it away from exposed soil;
- Installed in conjunction with silt fence to drain collected water to a controlled area;
- Used to divert small seasonal streams away from construction. They have been used successfully on culvert replacement and extension jobs. Large flex pipe can be used on larger streams during culvert removal, repair, or replacement; and,
- Connected to existing down spouts and roof drains and used to divert water away from work areas during building renovation, demolition, and construction projects.

There are now several commercially available collectors that are attached to the pipe inlet and help prevent erosion at the inlet.

Design and Installation Specifications

Size the pipe to convey the flow. The capacity for temporary drains shall be sufficient to handle the peak flow from a 10-year, 24-hour storm event, assuming a Type 1A rainfall distribution. Alternatively, use 1.6 times the 10-year, 1-hour flow indicated by an approved continuous runoff model. Consult local drainage requirements for sizing permanent pipe slope drains.

- Use care in clearing vegetated slopes for installation.
- Re-establish cover immediately on areas disturbed by installation.
- Use temporary drains on new cut or fill slopes.
- Use diversion dikes or swales to collect water at the top of the slope.
- Ensure that the entrance area is stable and large enough to direct flow into the pipe.
- Piping of water through the berm at the entrance area is a common failure mode.
- The entrance shall consist of a standard flared end section for culverts 12 inches and larger with a minimum 6-inch metal toe plate to prevent runoff from undercutting the pipe inlet. The slope of the entrance shall be at least 3 percent. Sand bags may also be used at pipe entrances as a temporary measure.
- The soil around and under the pipe and entrance section shall be thoroughly compacted to prevent undercutting.
- The flared inlet section shall be securely connected to the slope drain and have watertight connecting bands.
- Slope drain sections shall be securely fastened together, fused or have gasketed watertight fittings, and shall be securely anchored into the soil.
- Thrust blocks should be installed anytime 90 degree bends are utilized. Depending on size of pipe and flow, these can be constructed with sand bags, straw bales staked in place, “t” posts and wire, or ecology blocks.
- Pipe needs to be secured along its full length to prevent movement. This can be done with steel “t” posts and wire. A post is installed on each side of the pipe and the pipe is wired to them. This should be done every 10-20 feet of pipe length or so, depending on the size of the pipe and quantity of water to diverted.
- Interceptor dikes shall be used to direct runoff into a slope drain. The height of the dike shall be at least 1 foot higher at all points than the top of the inlet pipe.
- The area below the outlet must be stabilized with a riprap apron (see BMP C209 Outlet Protection, for the appropriate outlet material).

- If the pipe slope drain is conveying sediment-laden water, direct all flows into the sediment trapping facility.
- Materials specifications for any permanent piped system shall be set by the local government.

Maintenance Standards

Check inlet and outlet points regularly, especially after storms.

The inlet should be free of undercutting, and no water should be going around the point of entry. If there are problems, the headwall should be reinforced with compacted earth or sand bags.

- The outlet point should be free of erosion and installed with appropriate outlet protection.
- For permanent installations, inspect pipe periodically for vandalism and physical distress such as slides and wind-throw.
- Normally the pipe slope is so steep that clogging is not a problem with smooth wall pipe, however, debris may become lodged in the pipe.

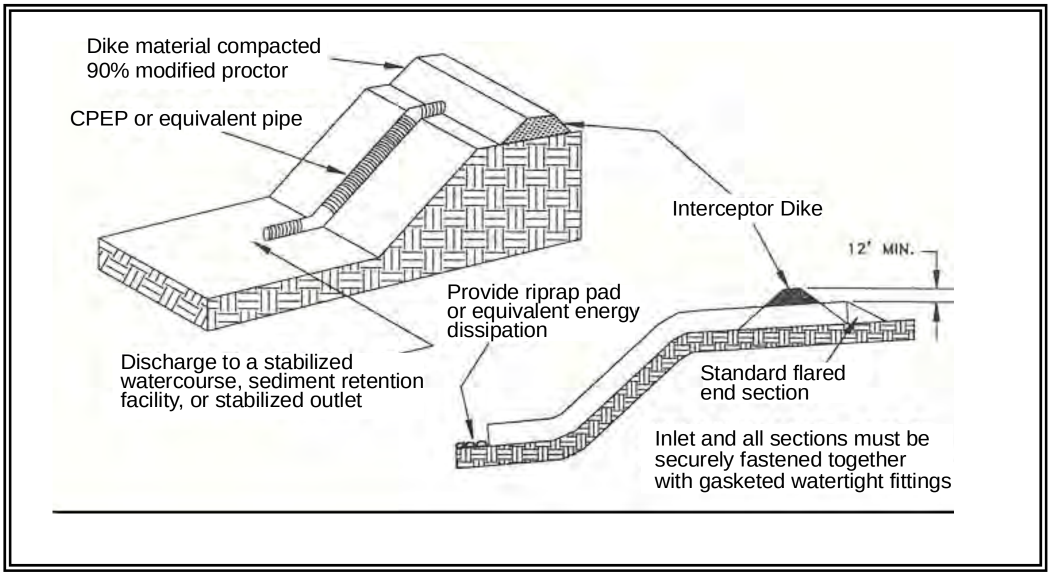


Figure 4.10 - Pipe Slope Drain

BMP C209: Outlet Protection

Purpose

Outlet protection prevents scour at conveyance outlets and minimizes the potential for downstream erosion by reducing the velocity of concentrated stormwater flows.

Conditions of use

Outlet protection is required at the outlets of all ponds, pipes, ditches, or other conveyances, and where runoff is conveyed to a natural or manmade drainage feature such as a stream, wetland, lake, or ditch.

Design and Installation Specifications

The receiving channel at the outlet of a culvert shall be protected from erosion by rock lining a minimum of 6 feet downstream and extending up the channel sides a minimum of 1–foot above the maximum tailwater elevation or 1-foot above the crown, whichever is higher. For large pipes (more than 18 inches in diameter), the outlet protection lining of the channel is lengthened to four times the diameter of the culvert.

- Standard wingwalls, and tapered outlets and paved channels should also be considered when appropriate for permanent culvert outlet protection. (See WSDOT Hydraulic Manual, available through WSDOT Engineering Publications).
- Organic or synthetic erosion blankets, with or without vegetation, are usually more effective than rock, cheaper, and easier to install. Materials can be chosen using manufacturer product specifications. ASTM test results are available for most products and the designer can choose the correct material for the expected flow.
- With low flows, vegetation (including sod) can be effective.
- The following guidelines shall be used for riprap outlet protection:
  1. If the discharge velocity at the outlet is less than 5 fps (pipe slope less than 1 percent), use 2-inch to 8-inch riprap. Minimum thickness is 1-foot.
  2. For 5 to 10 fps discharge velocity at the outlet (pipe slope less than 3 percent), use 24-inch to 4-foot riprap. Minimum thickness is 2 feet.
  3. For outlets at the base of steep slope pipes (pipe slope greater than 10 percent), an engineered energy dissipater shall be used.
- Filter fabric or erosion control blankets should always be used under riprap to prevent scour and channel erosion.
- New pipe outfalls can provide an opportunity for low-cost fish habitat improvements. For example, an alcove of low-velocity water can be created by constructing the pipe outfall and associated energy dissipater back from the stream edge and digging a channel, over-widened to the upstream side, from the outfall. Overwintering juvenile and migrating adult salmonids may use the alcove as shelter during

high flows. Bank stabilization, bioengineering, and habitat features may be required for disturbed areas. See Volume V for more information on outfall system design.

Maintenance Standards

- Inspect and repair as needed.
- Add rock as needed to maintain the intended function.
- Clean energy dissipater if sediment builds up.

BMP C233: Silt Fence

Purpose

Use of a silt fence reduces the transport of coarse sediment from a construction site by providing a temporary physical barrier to sediment and reducing the runoff velocities of overland flow. See Figure 4.19 for details on silt fence construction.

Conditions of Use

Silt fence may be used downslope of all disturbed areas.

- Silt fence is not intended to treat concentrated flows, nor is it intended to treat substantial amounts of overland flow. Any concentrated flows must be conveyed through the drainage system to a sediment pond. The only circumstance in which overland flow can be treated solely by a silt fence, rather than by a sediment pond, is when the area draining to the fence is one acre or less and flow rates are less than 0.5 cfs.
- Silt fences should not be constructed in streams or used in V-shaped ditches. They are not an adequate method of silt control for anything deeper than sheet or overland flow.

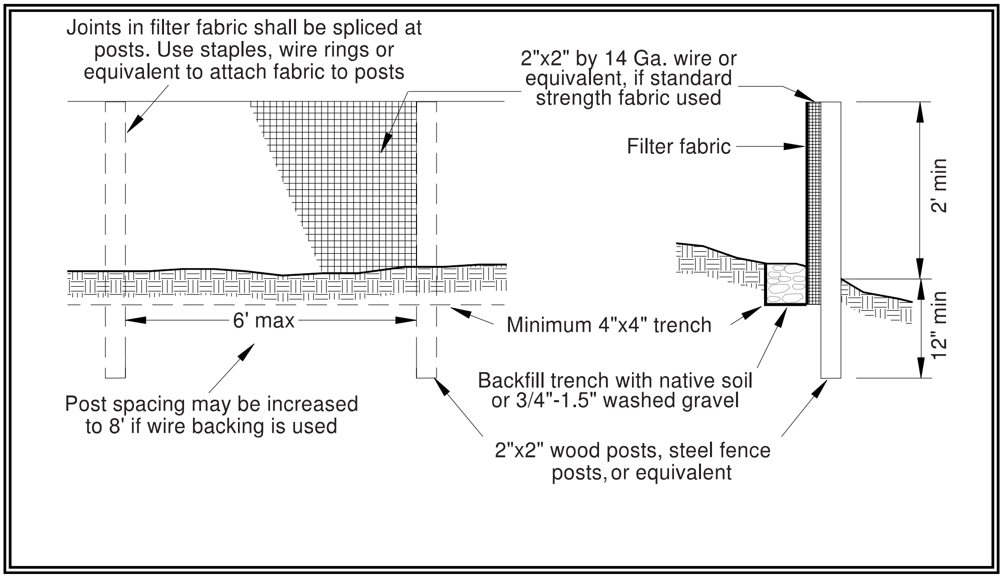


Figure 4.19 – Silt Fence

Design and Installation Specifications

- Drainage area of 1 acre or less or in combination with sediment basin in a larger site.
- Maximum slope steepness (normal (perpendicular) to fence line) 1:1.
- Maximum sheet or overland flow path length to the fence of 100 feet.
- No flows greater than 0.5 cfs.
- The geotextile used shall meet the following standards. All geotextile properties listed below are minimum average roll values (i.e., the test result for any sampled roll in a lot shall meet or exceed the values shown in Table 4.10):

Table 4.10 **Geotextile Standards**	
Polymeric Mesh AOS (ASTM D4751)	0.60 mm maximum for slit film wovens (#30 sieve). 0.30 mm maximum for all other geotextile types (#50 sieve). 0.15 mm minimum for all fabric types (#100 sieve).
Water Permittivity (ASTM D4491)	0.02 sec^{-1} minimum
Grab Tensile Strength (ASTM D4632)	180 lbs. Minimum for extra strength fabric. 100 lbs minimum for standard strength fabric.
Grab Tensile Strength (ASTM D4632)	30% maximum
Ultraviolet Resistance (ASTM D4355)	70% minimum

- Standard strength fabrics shall be supported with wire mesh, chicken wire, 2-inch x 2-inch wire, safety fence, or jute mesh to increase the strength of the fabric. Silt fence materials are available that have synthetic mesh backing attached.
- Filter fabric material shall contain ultraviolet ray inhibitors and stabilizers to provide a minimum of six months of expected usable construction life at a temperature range of 0°F. to 120°F.
- 100 percent biodegradable silt fence is available that is strong, long lasting, and can be left in place after the project is completed, if permitted by local regulations.
- Standard Notes for construction plans and specifications follow. Refer to Figure 4.19 for standard silt fence details.

  The contractor shall install and maintain temporary silt fences at the locations shown in the Plans. The silt fences shall be constructed in the areas of clearing, grading, or drainage prior to starting those activities. A silt fence shall not be considered temporary if the silt fence must function beyond the life of the contract. The silt fence shall prevent soil carried by runoff water from going beneath, through, or over the top of the silt fence, but shall allow the water to pass through the fence.

  The minimum height of the top of silt fence shall be 2 feet and the maximum height shall be 2½ feet above the original ground surface.

  The geotextile shall be sewn together at the point of manufacture, or at an approved location as determined by the Engineer, to form geotextile lengths as required. All sewn seams shall be located at a support post. Alternatively, two sections of silt fence can be overlapped, provided the Contractor can demonstrate, to the satisfaction of the Engineer, that the overlap is long enough and that the adjacent fence sections are close enough together to prevent silt laden water from escaping through the fence at the overlap.

The geotextile shall be attached on the up-slope side of the posts and support system with staples, wire, or in accordance with the manufacturer's recommendations. The geotextile shall be attached to the posts in a manner that reduces the potential for geotextile tearing at the staples, wire, or other connection device. Silt fence back-up support for the geotextile in the form of a wire or plastic mesh is dependent on the properties of the geotextile selected for use. If wire or plastic back-up mesh is used, the mesh shall be fastened securely to the up-slope of the posts with the geotextile being up-slope of the mesh back-up support.

The geotextile at the bottom of the fence shall be buried in a trench to a minimum depth of 4 inches below the ground surface. The trench shall be backfilled and the soil tamped in place over the buried portion of the geotextile, such that no flow can pass beneath the fence and scouring can not occur. When wire or polymeric back-up support mesh is used, the wire or polymeric mesh shall extend into the trench a minimum of 3 inches.

The fence posts shall be placed or driven a minimum of 18 inches. A minimum depth of 12 inches is allowed if topsoil or other soft subgrade soil is not present and a minimum depth of 18 inches cannot be reached. Fence post depths shall be increased by 6 inches if the fence is located on slopes of 3:1 or steeper and the slope is perpendicular to the fence. If required post depths cannot be obtained, the posts shall be adequately secured by bracing or guying to prevent overturning of the fence due to sediment loading.

Silt fences shall be located on contour as much as possible, except at the ends of the fence, where the fence shall be turned uphill such that the silt fence captures the runoff water and prevents water from flowing around the end of the fence.

If the fence must cross contours, with the exception of the ends of the fence, gravel check dams placed perpendicular to the back of the fence shall be used to minimize concentrated flow and erosion along the back of the fence. The gravel check dams shall be approximately 1-foot deep at the back of the fence. It shall be continued perpendicular to the fence at the same elevation until the top of the check dam intercepts the ground surface behind the fence. The gravel check dams shall consist of crushed surfacing base course, gravel backfill for walls, or shoulder ballast. The gravel check dams shall be located every 10 feet along the fence where the fence must cross contours. The slope of the fence line where contours must be crossed shall not be steeper than 3:1.

Wood, steel or equivalent posts shall be used. Wood posts shall have minimum dimensions of 2 inches by 2 inches by 3 feet minimum length, and shall be free of defects such as knots, splits, or gouges.

Steel posts shall consist of either size No. 6 rebar or larger, ASTM A 120 steel pipe with a minimum diameter of 1-inch, U, T, L, or C shape steel posts with a minimum weight of 1.35 lbs./ft. or other steel posts having equivalent strength and bending resistance to the post sizes listed. The spacing of the support posts shall be a maximum of 6 feet.

Fence back-up support, if used, shall consist of steel wire with a maximum mesh spacing of 2 inches, or a prefabricated polymeric mesh. The strength of the wire or polymeric mesh shall be equivalent to or greater than 180 lbs. grab tensile strength. The polymeric mesh must be as resistant to ultraviolet radiation as the geotextile it supports.

- Silt fence installation using the slicing method specification details follow. Refer to Figure 4.20 for slicing method details.

  The base of both end posts must be at least 2 to 4 inches above the top of the silt fence fabric on the middle posts for ditch checks to drain properly. Use a hand level or string level, if necessary, to mark base points before installation.

  Install posts 3 to 4 feet apart in critical retention areas and 6 to 7 feet apart in standard applications.

  Install posts 24 inches deep on the downstream side of the silt fence, and as close as possible to the fabric, enabling posts to support the fabric from upstream water pressure.

  Install posts with the nipples facing away from the silt fence fabric.

  Attach the fabric to each post with three ties, all spaced within the top 8 inches of the fabric. Attach each tie diagonally 45 degrees through the fabric, with each puncture at least 1 inch vertically apart. In addition, each tie should be positioned to hang on a post nipple when tightening to prevent sagging.

  Wrap approximately 6 inches of fabric around the end posts and secure with 3 ties.

  No more than 24 inches of a 36-inch fabric is allowed above ground level.

  The rope lock system must be used in all ditch check applications.

  The installation should be checked and corrected for any deviation before compaction. Use a flat-bladed shovel to tuck fabric deeper into the ground if necessary.

  Compaction is vitally important for effective results. Compact the soil immediately next to the silt fence fabric with the front wheel of the tractor, skid steer, or roller exerting at least 60 pounds per square inch. Compact the upstream side first and then each side twice for a total of four trips.

Maintenance Standards

- Any damage shall be repaired immediately.
- If concentrated flows are evident uphill of the fence, they must be intercepted and conveyed to a sediment pond.
- It is important to check the uphill side of the fence for signs of the fence clogging and acting as a barrier to flow and then causing channelization of flows parallel to the fence. If this occurs, replace the fence or remove the trapped sediment.
- Sediment deposits shall either be removed when the deposit reaches approximately one-third the height of the silt fence, or a second silt fence shall be installed.
- If the filter fabric (geotextile) has deteriorated due to ultraviolet breakdown, it shall be replaced.

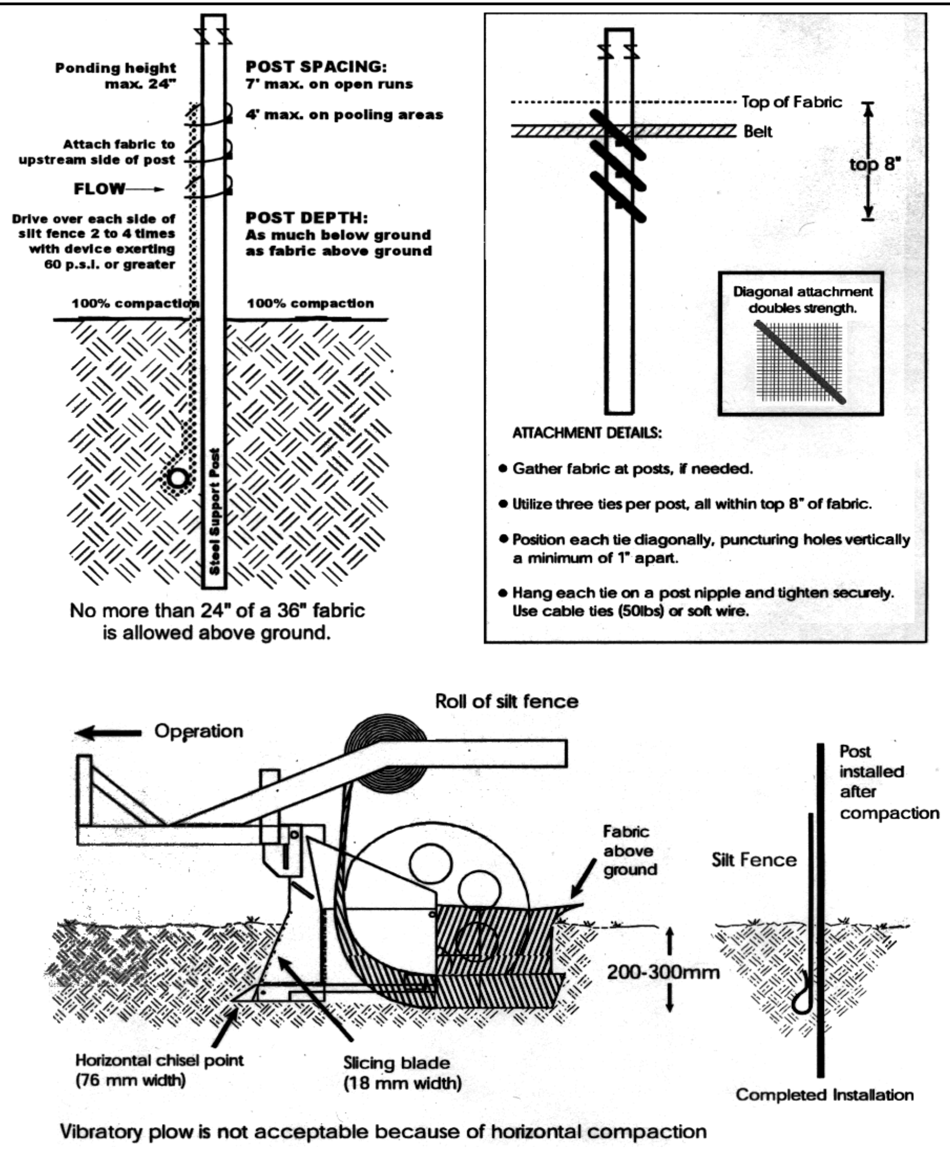


Figure 4.20 – Silt Fence Installation by Slicing Method

B&L Woodwaste Site
Pierce County, Washington

Engineering Design Report (EDR) Addendum 3

Phase 2 Part 1 Remediation Design Report

Groundwater Recovery and Treatment System

Attachment 3E.3
Site Inspection Form

FINAL

Attachment 3E.3
Construction Stormwater Pollution Prevention Plan (SWPPP)
Site Inspection Form

The site inspection form shall be completely filled out and attached to the site log book. The SWPPP and the site inspection forms shall be kept on site at all times during construction, and inspections will be performed and documented as outlined below.

At a minimum, each inspection form shall include the following:

a. Inspection date/times.

b. Weather information: general conditions during inspection, approximate amount of precipitation since the last inspection, and approximate amount of precipitation within the last 24 hours.

c. A summary or list of all BMPs that have been implemented, including observations of all erosion/sediment control structures or practices.

d. The following shall be noted:

    i. Locations of BMPs inspected.

    ii. Locations of BMPs that need maintenance.

    iii. The reason maintenance is needed.

    iv. Locations of BMPs that failed to operate as designed or intended.

    v. Locations where additional or different BMPs are needed, and the reason(s) why.

e. A description of any stormwater discharged from the site. The presence of suspended sediment, turbid water, discoloration, and/or oil sheen shall be noted, as applicable.

f. General comments and notes, including a brief description of any BMP repairs, maintenance, or installations made as a result of the inspection.

When the site inspection indicates that the BMPs are insufficient to maintain zero discharge from the work area, the inspector shall take immediate action(s) to: stop, contain, and clean up the discharges; correct the problem(s); implement appropriate BMPs, and/or conduct maintenance of existing BMPs; and achieve zero discharge. In addition, if the discharge causes a threat to human health or the environment, the inspector shall comply with the Notification of Discharge requirements in the SWPPP.

General Information					
Project Name:	B&L Woodwaste Site Phase 1 Part 1 Cleanup Action				
Inspector Name:			**Title:** **CESCL #:**		
Date:			**Time:**		
Inspection Type:		Implementation			
		Weekly			
		After a rain event			
		Other			
Weather:					
Precipitation:	Since last inspection:			In last 24 hours:	

Description of General Site Conditions		**Yes**	**No**	**Comments**
	Stormwater Discharge from Site?			
	Photo Taken?			
	Ecology Notified?			
	Date, Time, and Ecology Contact Name	--	--	

Inspection of BMPs						
BMP Element	**Inspected**		**Functioning**			**Problem/Corrective Action**
	Yes	**No**	**Yes**	**No**	**NIP**	
1. Preserve Natural Vegetation						
2. High Visibility Fencing						
3. Entrance and Construction Road Stabilization						
4. Wheel Wash						
5. Soils - Plastic Covering						
6. Dust Control						
7. Interceptor Dike and Swale and Pipe Slope Drains						

<table>
<tr><th colspan="7">Inspection of BMPs</th></tr>
<tr><th rowspan="2">BMP Element</th><th colspan="2">Inspected</th><th colspan="3">Functioning</th><th rowspan="2">Problem/Corrective Action</th></tr>
<tr><th>Yes</th><th>No</th><th>Yes</th><th>No</th><th>NIP</th></tr>
<tr><td>8. Outlet Protection</td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>9. Materials on Hand</td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>10. Material Delivery, Storage, and Containment</td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
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B&L Woodwaste Site
Pierce County, Washington

Engineering Design Report (EDR)
Addendum 3

Phase 2 Part 1 Remediation Design Report

Groundwater Recovery and
Treatment System

Appendix 3F
Construction Drawings
and Specifications

(Specifications provided on CD-ROM)

Note: Drawings from Appendix 3F are saved as two separate files due to electronic document size constraints

FINAL

B&L Woodwaste Site
Pierce County, Washington

Technical Specifications

Phase 2 Part 1 Groundwater Recovery and Treatment System

General Contract

Reference: SE10160010

Prepared for
B&L Custodial Trust
606 Columbia Street NW, Suite 212
Olympia, Washington 98501

Project Design Manager
AMEC Environment & Infrastructure
600 University Street, Suite 1020
Seattle, Washington 98101

Engineering Design
AMEC Environment & Infrastructure
900 Maple Grove Road, Unit 10
Cambridge, Ontario N3H 4R7

May 2011

DIVISION 1
GENERAL REQUIREMENTS

Section 01000 – General Requirements
Section 01010 – Scope of Work
Section 01040 – Coordination
Section 01300 – Submittals
Section 01400 – Quality Control
Section 01430 – Operation and Maintenance Data
Section 01600 – Material and Equipment
Section 01610 – Installation of Owner Furnished Equipment
Section 01640 – Manufacturer’s Services
Section 01650 – Facility Start-up
Section 01700 – Contract Closeout

SECTION 01000
GENERAL REQUIREMENTS

PART 1 GENERAL

1.1 ADMINISTRATIVE REQUIREMENTS

A. Correspondence

1. All forms of correspondence between OWNER, OWNER'S REPRESENTATIVE, and CONTRACTOR shall be under the signature of the respective Project Manager.
2. All letters are to be generally limited to a single subject, insofar as possible.
3. Letter headings shall include reference to the subject and a numerical sequence.
4. A log of letters is to be maintained at each originating location.
5. Copies of all letters are to go to CONTRACTOR, OWNER, and OWNER'S REPRESENTATIVE.
6. FAX and EMAIL correspondence shall be treated the same as letters.

B. Telephone Conversations

1. All telephone conversations resulting in agreements will be confirmed in writing by CONTRACTOR, and sent to OWNER'S REPRESENTATIVE for review and approval.
2. Confirmations of telephone conversations are to be sent to each participant and to CONTRACTOR, OWNER'S REPRESENTATIVE, and OWNER.

C. Precommencement Conferences: General review between CONTRACTORS, Contractor's Engineers (Professional Engineers representing Civil, Architectural/Structural, Mechanical, Electrical, Instrumentation, Geotechnical, etc.), OWNER, and OWNER'S REPRESENTATIVE before CONTRACTOR commences design work.

D. Progress Meetings

1. Detailed review of project activities shall be held on a weekly basis.
2. First meeting to take place within one week of award of contract.
3. CONTRACTOR will be required to make any subcontractor representatives available for participation in progress meetings as appropriate to agenda topics for each meeting.

E. Meeting Minutes

1. OWNER’S REPRESENTATIVE will issue minutes of all project meetings, detailing items discussed, decisions reached, and action items with responsible parties.
2. All attendees and OWNER and DESIGN BUILD CONTRACTOR will receive copies of meeting minutes.

F. Progress Reports

1. CONTRACTOR shall maintain, currently update and forward to OWNER and OWNER’S REPRESENTATIVE on a bi-weekly basis copies of:
    a. CONTRACTOR's construction schedule showing design, shop drawing approval, procurement, fabrication, and construction efforts; and if Work falls behind schedule, a recovery plan to regain and maintain schedule.
    b. Material Status Report indicating major procurement items, vendor purchase orders and date of placement, shop drawing requirements, status of submittals and approvals, and fabrication and delivery dates.
    c. Shop Drawing Log indicating dates of transmittal, date of receipt, disposition, action and/or comments specified by OWNER’S REPRESENTATIVE.
    d. Status of permits and regulatory items.
    e. Manning levels by craft and other functions. List onsite and offsite levels.
    f. Status of Subcontractor's activities including general activities, manning and percent complete.
    g. Summary of equipment received on site and equipment installed.
    h. Summary of drawings in progress, submitted for review and returned certified for construction.
    i. Line list items:
        1) Work started.
        2) Installed.
        3) Tested.
        4) Painted.
        5) Insulated.
        6) Accepted.
    j. An explanation of any changes made to the Progress Schedule.
2. On or before the tenth of each month, CONTRACTOR will be required to submit four copies of a monthly progress report to the OWNER of the previous month's activities, including as a minimum:
    a. Discussion of major accomplishments and major items scheduled.
    b. Identification of critical items list and schedule critical paths.

c. Updated project schedule showing actual versus scheduled progress.
d. Cost and cash flow analysis.
e. Manpower loading curves.
f. Material Status Report.
g. The reports shall contain photographs in color showing the construction progress.

1.2 SEQUENCE OF OPERATIONS

A. Coordination

1. CONTRACTORS shall cooperate in the coordination of their separate activities in a manner that will provide the least interference with the OWNER's operations and other CONTRACTORS and utility companies working in the area, and in the interfacing and connection of the separate elements of the overall project work.
2. If any difficulty or dispute should arise in the accomplishment of the above, the problem shall be brought immediately to the attention of the OWNER’S REPRESENTATIVE.

B. Compliance With OWNER's Business Operations

1. All CONTRACTORS working on this site are subject to this requirement for cooperation, and all shall abide by the OWNER's decision in resolving project coordination problems without additional cost to the OWNER.
2. During the performance of the Work, CONTRACTOR is responsible for adapting its means, methods, techniques, sequences and procedures of construction to allow OWNER to maintain existing facilities in their present condition and for compliance with applicable permit requirements, and Laws and Regulations. In performing such Work and in cooperating with the OWNER, it may be necessary for the CONTRACTOR to plan, design, and provide various temporary services, utilities, connections, temporary piping and heating, access, and similar items which will be included within the Contract Price.

1.3 SCHEDULING

A. Overall Project Schedule

1. The CONTRACTOR shall submit to OWNER’S REPRESENTATIVE for review an Overall Project Schedule within fifteen working days after execution of the Contract. The schedule shall submitted in a file format that can be read by MS Project and display the schedule using critical path method (CPM) format and shall use time scaled precedence diagramming methods. The schedule shall be time-scaled in calendar

days from the notice to proceed or actual date. The schedule shall contain but not be limited to the following items:

   a. Mobilization, move in, and permits from public agencies.
   b. Construction start date.
   c. Excavation, dredging, backfill, grading, paving, seeding, etc.
   d. Details for completing portions of the WORK performed by the CONTRACTOR and others not retained by CONTRACTOR and that requires coordination of the different parties (e.g., drilling contractors installing wells and CONTRACTOR installation of groundwater collection piping).
   e. Submittal preparation by the CONTRACTOR and review by the OWNER'S REPRESENTATIVE, including shop drawings, technical manuals, and all other submittals.
   f. Order, manufacture, delivery, installation, and checkout of critical material and major equipment.
   g. Concrete placement sequence.
   h. Structural steel, miscellaneous metal, masonry, precast, roofing, glazing, equipment installation, piping work.
   i. Plumbing.
   j. Heating, ventilation, and air conditioning.
   k. Electrical and control systems.
   l. Construction of various facilities.
   m. All other major construction activities.
   n. Subcontractor's items of work.
   o. Site-specific items such as holidays, inclement weather, etc.
   p. Performance and acceptance tests.
   q. Delivery, installation, and checkout of equipment and material.
   r. Start-up and balancing all systems.
   s. Punch-out and acceptance of all facilities.
   t. Operator and maintenance personnel training.
   u. All Contract-stipulated milestone dates, Substantial Completion date, and final completion date.
   v. Final cleanup.
   w. Move offsite.

2. The project completion date shall, unless otherwise approved, be the same as that submitted with the Bid.

B. Schedule Reports

1. The CONTRACTOR shall prepare reports with the following minimum information:
   a. Activity identification code keyed to Overall Project Schedule activities.
   b. Activity description.
   c. From the date of the report, remaining working days until early finish of each activity.

        d. Activity percent complete.
        e. Activity duration.
        f. Early start/finish and late start/finish.
        g. Total float.
        h. Free float.
        i. The predecessor and successor activities for each individual activity, including the precedence logic relationships.
        j. A critical item list of activities with fifteen working days or less total float.
        k. Scheduled and actual manpower loading for each activity.
        l. Scheduled and actual progress payment for each activity.
        m. Description of problem areas and corrective action required.
    2. Float or slack time is not for the exclusive use or benefit of either the OWNER or the CONTRACTOR but is a resource available, at no additional cost, to all parties as a whole.
    3. The CONTRACTOR shall maintain, update, and submit to the OWNER'S REPRESENTATIVE for review twice each month the Overall Project Schedule with current critical path logic changes, actual start dates, percent complete, remaining durations of activities, actual finish dates, actual progress payment, actual manpower, remaining progress payment, and remaining manpower.

C. Short Interval Schedule

1. The CONTRACTOR shall submit each week a Short-Interval Schedule for the following two weeks of planned work, along with the results of the previous week. The schedule shall be time-scaled in calendar days and shall use bar chart diagramming methods. The activity descriptions shall be consistent with the Overall Project Schedule activities. The level of detail must show the following activities as a minimum:
    a. Labor effort by trade.
    b. Subcontractors.
    c. Geographic areas.
    d. Coordination required with the OWNER and other companies.
    e. Expected delivery of major equipment and materials.
    f. Performance and acceptance tests.
2. The Short-Interval Schedule shall be submitted weekly starting one week after notice to proceed and continuing until move offsite.

D. Delays and Recovery

1. If at any time during the project, the CONTRACTOR fails to complete any activity by its latest scheduled completion date, the CONTRACTOR shall, within five working days, submit to the OWNER'S REPRESENTATIVE a written statement as to how and when he will reorganize his work force to return to the overall project schedule.

2. Whenever it becomes apparent to the OWNER from the current monthly progress evaluation and updated schedule data that any milestone interface completion dates and/or contract completion dates will not be met, the CONTRACTOR shall take some or all of the following actions:
    a. Increase construction manpower in such quantities and crafts as shall substantially eliminate the backlog of work.
    b. Increase the number of working hours per shift, shifts per work day, work days per work week, the amount of construction equipment, or any combination of the foregoing sufficient to substantially eliminate the backlog of work.
3. The addition of equipment or construction forces, increasing the working hours or any other method, manner, or procedure to return to the current CONTRACTOR's Overall Project Schedule shall not be considered justification for Contract modification or treatment as an acceleration unless the OWNER is notified and approves the modification before beginning the Work.

1.4 SITE CONDITIONS

A. Site Investigation and Representation

1. The CONTRACTOR acknowledges satisfaction as to the nature and location of the Work, the general and local conditions, particularly those bearing upon availability of transportation, access to the site, disposal, handling and storage of materials, availability of labor, water, electric power, roads, and uncertainties of weather, or similar physical conditions at the site, the conformation and conditions of the ground, the character of equipment and facilities needed preliminary to and during the prosecution of the Work and all other matters which can in any way affect the Work or the cost thereof under this Contract.
2. The CONTRACTOR further acknowledges satisfaction as to character, quality, and quantity of surface and subsurface materials to be encountered from his inspection of the site and from reviewing any available records of exploratory work furnished by the OWNER or included in these Documents. Failure by the CONTRACTOR to become acquainted with the physical conditions of the site and all the available information will not relieve the CONTRACTOR from responsibility for properly estimating the difficulty or cost of successfully performing the Work.
3. The CONTRACTOR warrants that as a result of examination and investigation of all the aforesaid data, the CONTRACTOR can perform the Work in a good and workmanlike manner and to the satisfaction of the OWNER. The OWNER assumes no responsibility for any representations made by any of its officers or agents during or prior to the execution of this Contract, unless:
    a. Such representations are expressly stated in the Contract.

b. The Contract expressly provides that the responsibility therefore is assumed by the CONTRACTOR.

B. CONTRACTOR's Responsibility for Utility Properties and Service

1. Where the CONTRACTOR's operations could cause damage or inconvenience to telecommunications, television, power, oil, gas, water, sewer, or irrigation systems, the operations shall be suspended until all arrangements necessary for the protection of these utilities and services have been made by the CONTRACTOR.
2. Notify all utility offices which are affected by the construction operation at least 48 hours in advance. Under no circumstances expose any utility without first obtaining permission from the appropriate agency. Once permission has been granted, locate, expose, and provide temporary support for all existing underground utilities.
3. Neither the OWNER nor its officers or agents shall be responsible to the CONTRACTOR for damages as a result of the CONTRACTOR's failure to protect utilities encountered in the Work.
4. Maintain in continuous service all existing oil and gas pipelines, underground power, telephone or communication cable, water mains, irrigation lines, sewers, poles and overhead power, and all other utilities encountered along the line of work, unless other arrangements satisfactory to OWNERs of said utilities have been made.
5. Where completion of Work requires temporary or permanent removal and/or relocation of an existing utility, coordinate all activities with OWNER of said utility and perform all work to their satisfaction.
6. Protect, shore, brace, support, and maintain underground pipes, conduits, drains, and other underground utility construction uncovered or otherwise affected by construction operations.
7. Keep fire hydrants and water control valves free from obstruction and available for use at all times.
8. In areas where the CONTRACTOR's operations are adjacent to or near a utility such as gas, telephone, television, electric power, water, sewer, or irrigation system and such operations may cause damage or inconvenience, suspend operations until arrangements necessary for protection thereof have been made by the CONTRACTOR.
9. Notify property OWNERs and utility offices which may be affected by the construction operation at least 2 days in advance.
10. Before exposing a utility, obtain utility OWNER's permission. Should service of utility be interrupted due to the CONTRACTOR's operation, notify proper authority immediately. Cooperate with said authority in restoring service as promptly as possible and bear costs incurred.
11. Do not impair operation of existing sewer systems. Prevent construction material, pavement, concrete, earth, volatile and corrosive wastes, and other debris from entering sewers, pump stations, or other sewer structures. Maintain original site drainage wherever possible.

C. Field Relocation: During the progress of construction, it is expected that minor relocations of the Work will be necessary. Such relocations shall be made only by direction of the OWNER’S REPRESENTATIVE. If the CONTRACTOR shall fail to so notify the OWNER’S REPRESENTATIVE and shall proceed with the construction despite this interference, he shall do so at his own risk.

D. Existing Structures: Where CONTRACTOR contemplates removal of small structures such as signposts, and culverts that interfere with CONTRACTOR's operations, obtain approval of property OWNER and OWNER. Replace those removed in a condition equal to or better than original.

E. Finished Construction: Protect finished floors and concrete floors exposed as well as those covered with composition tile or other applied surfacing.

F. Differing Subsurface Conditions:

1. In the event subsurface or latent physical conditions are found materially different from those indicated in these Documents, and differing materially from those ordinarily encountered and generally recognized as inherent in the character of work covered in these Contract Documents, the CONTRACTOR shall promptly, and before such conditions are disturbed, notify the OWNER’S REPRESENTATIVE in writing of such changed conditions.
2. The OWNER’S REPRESENTATIVE will investigate such conditions promptly and following this investigation, the CONTRACTOR shall proceed with the Work, unless otherwise instructed by the OWNER’S REPRESENTATIVE. If the OWNER’S REPRESENTATIVE finds that such conditions do so materially differ and cause an increase or decrease in the cost of, or in the time required for performing the Work, the OWNER’S REPRESENTATIVE will recommend the amount of adjustment in cost and time he considers reasonable. The OWNER will make the final decision on all Change Orders to the Contract regarding any adjustment in cost or time for completion.

G. Underground Utilities

1. Utilities and structures adjacent to or encountered in the Work are not shown on the Drawings. It is the DESIGN/BUILD CONTRACTOR’S sole responsibility to locate all subsurface items affecting the work and to relocate, protect or incorporate these items into their design as required. The OWNER has no reliable drawings of subsurface items. Any drawings are for the convenience of the CONTRACTOR only, and no responsibility is assumed by either the OWNER or the OWNER’S REPRESENTATIVE for their accuracy or completeness.

H. Cleaning During Construction

1. General:
    a. Wet down exterior surfaces prior to sweeping to prevent blowing of dust and debris. At least weekly, sweep all floors (basins, tunnels, platforms, walkways, roof surfaces), and pick up all debris and dispose.
    b. Provide approved containers for collection and disposal of waste materials, debris, and rubbish. At least at weekly intervals, dispose of such waste materials, debris, and rubbish offsite.
    c. At least weekly, brush sweep the entry drive and roadways, and all other streets and walkways affected by Work and where adjacent to Work.

1.5 TEMPORARY CONSTRUCTION FACILITIES

A. Site Layout: Before moving onto the site, the CONTRACTOR shall submit to the OWNER for approval, a layout of the site showing location of security fence, office areas, temporary washrooms, storage areas, workshops, designated parking for construction workers, and other temporary facilities.

B. Construction Meetings Field Office

1. The CONTRACTOR shall provide adequately lighted and heated/air conditioned space for a construction field office for use by the OWNER.
2. The CONTRACT provide a meeting area sufficient to accommodate up to 9 people, and shall be equipped with meeting table, chairs, and white board.
3. The use of OWNER’s temporary office for construction meetings shall not be acceptable, unless approved in advance by OWNER or OWNER’S REPRESENTATIVE.

C. Temporary Washrooms

1. CONTRACTOR shall provide sanitary facilities for use by all construction workers at the site.

D. Electricity and Lighting

1. CONTRACTOR is responsible for all electrical connections necessary to obtain electricity for the electrical distribution system and for all construction activities, including field offices. OWNER will be responsible for utility bills during construction.
2. CONTRACTOR is responsible for providing all lighting necessary for construction activities and to satisfy safety and security requirements.

E. Heat and Ventilation

1. Provide as required to maintain specified conditions for construction operations, to protect materials and finishes from damage due to temperature or humidity.
2. Provide ventilation of enclosed areas to cure materials, to disperse humidity, and to prevent accumulations of dust, fumes, vapors, or gases.
3. Provide heat and air conditioning for OWNER's temporary office.
4. All associated costs are to be paid by the CONTRACTOR.

F. Telephone Service: There is no existing telephone service on site. Temporary telephone service required by the CONTRACTOR shall be solely the CONTRACTOR’s responsibility. Installation arrangements for this service shall be by the CONTRACTOR, at the CONTRACTOR’s own expense.

G. Water: Water service does not exist onsite. CONTRACTOR shall provide drinking water for use by all site personnel.

H. Sanitary Facilities: Provide and maintain temporary sanitary facilities and enclosures for CONTRACTOR and OWNER personnel. Pay all fees to maintain service. The CONTRACTOR shall provide and maintain sanitary facilities for employees of the CONTRACTOR, his subcontractors and representatives of the equipment vendors. These facilities shall comply with the regulations of the local and state health codes.

I. Barriers

1. Provide as required to prevent public entry to construction areas and to protect existing facilities and adjacent properties from damage from construction operations.
2. Provide barriers around trees and plants designated to remain. Protect against vehicular traffic, stored materials, dumping, chemically injurious materials, and puddling or continuous running water.

J. Enclosures: Provide temporary weathertight closures of openings in exterior surfaces to provide acceptable working conditions and protection for materials, to allow for temporary heating, and to prevent entry of unauthorized persons.

1. Provide environmental control systems that meet recommendations of manufacturers of equipment and materials stored.
2. Arrange or partition to provide security of contents and ready access for inspection and inventory.
3. Store combustible materials (paints, solvents, fuels, etc.) in a well-ventilated and remote building meeting safety standards.

K. Protection of Installed Work

  1. Provide temporary protection for installed products. Control traffic in immediate area to minimize damage.
  2. Provide protection coverings at walls, projections, jambs, sills, and soffits of openings. Protect finished floors and stairs from traffic, movement of heavy objects, and storage.
  3. Prohibit traffic and storage on waterproofed and roofed surfaces, on lawn and landscaped areas.

L. Security: Provide security program and facilities to protect work from unauthorized entry, vandalism, and theft. Security is the responsibility of the CONTRACTOR until the acceptance of the facility by the OWNER.

M. Water Control

  1. Provide methods to control surface water to prevent damage to the project, the site or adjoining properties.
     a. Control fill, grading and ditching to direct surface drainage away from excavations, other construction areas, and to direct drainage to proper drainage facilities.
  2. Provide, operate, and maintain hydraulic equipment of adequate capacity to control surface water.
  3. Dispose of drainage water in a manner to prevent flooding, erosion, or other damage to any portion of the site or to adjoining areas.

N. Erosion Control

  1. Plan and execute construction earth work methods to control surface drainage from cuts and fills and prevent erosion and sedimentation in accordance with all plans and requirements included in project documents provided to CONTRACTOR during and after the bid process.
     a. Rough grade site to prevent standing water and to direct surface drainage away from excavations, adjoining properties and public right-of-way.
     b. Hold the areas of bare soil exposed at one time to a minimum.
  2. Construct fill areas by selective placement to eliminate surfaces which will erode.

O. Dust Control: Provide positive methods and apply dust control materials to minimize raising dust from construction operations and provide positive means to prevent air-borne dust from dispersing into the atmosphere.

P. Pollution Control

1. Provide methods, means and facilities required to prevent contamination of soil, water, or the atmosphere by the discharge of noxious substances from construction operations. This will be performed in accordance with project documents provided to CONTRACTOR during or after the bid process and in accordance with applicable local, State or Federal regulatory requirement.
2. Burning: Of waste materials, rubbish, or other debris will not be permitted on or adjacent to the site.
3. Conduct operations of spoil and soil movement by trucks in such a manner as to cause a minimum of dust. Give unpaved streets, roads, detours, or haul roads used in the construction area a dust-preventive treatment or periodically water to prevent dust. Strictly adhere to applicable environmental regulations for dust prevention.
4. Provide and maintain temporary dust-tight partitions, bulkheads, or other protective devices during construction to permit normal operation of existing facilities. Construct partitions of plywood, insulating board, plastic sheets, or similar material. Construct partitions in such a manner that dust and dirt from demolition and cutting will not enter other parts of existing building or facilities. Remove temporary partitions as soon as the need no longer exists.
5. Provide equipment and personnel, perform emergency measures required to contain any spillages and to remove contaminated soils or liquids.
    a. Excavate and dispose of any contaminated earth offsite and replace with suitable compacted fill and topsoil.
6. Take special measures to prevent harmful substances from entering public waters.
    a. Prevent disposal of wastes, effluents, chemicals, or other such substances adjacent to ponds, or in sanitary or storm sewers.
7. Divert sanitary sewage flow interfering with construction and requiring diversion to sanitary sewers. Do not cause or permit action to occur which would cause an overflow to an existing waterway.
8. Prior to commencing excavation and construction, CONTRACTOR to prepare detailed plans showing procedures intended to handle and dispose of sewage, groundwater, and stormwater flow, including dewatering pump discharges. Present these plans as a Shop Drawing for review by OWNER.
9. Comply with procedures outlined in project documents provided to CONTRACTOR during or after the bid process and in accordance with applicable local, State, or Federal regulations.
10. Do not dispose of volatile wastes such as mineral spirits, oil, chemicals, or paint thinner in storm or sanitary drains. Disposal of wastes into streams or waterways is prohibited. Provide acceptable containers for collection and disposal of waste materials, debris, and rubbish.
11. Provide acoustical barriers so noise emanating from tools or equipment will not exceed legal noise levels.

12. Noise Control Plans: Proposed plan to mitigate construction noise impacts and to comply with noise control ordinances including method of construction, equipment to be used, and acoustical treatments.

Q. Preservation, Restoration, and Cleanup

1. The construction site shall be kept orderly and neat on a daily basis. No rubbish shall be allowed to accumulate anywhere on the site.
2. The paved streets bordering the site shall be kept clean from material tracked offsite. The streets shall be washed and/or swept daily if material begins to accumulate.
3. Smoking and eating will be allowed onsite only in designated areas. The areas will be coordinated between the OWNER and CONTRACTOR after award of the Contract. However, no smoking or eating will be allowed on or inside any of the permanent structures at anytime.
4. Remove temporary materials, equipment, services, and construction prior to Substantial Completion inspection.
5. Clean and repair damage caused by installation or use of temporary facilities. Remove temporary underground installations. Grade site to drain.
6. If permanent air handling support equipment is used prior to acceptance by OWNER, filters must be replaced and the system internals cleaned.

R. CONTRACTOR is responsible for providing parking facilities necessary for the entire construction work force.

S. CONTRACTOR shall provide and maintain vehicular access to and within the site to provide uninterrupted access.

1. To temporary construction facilities, storage and work areas.
2. For use by persons and equipment involved in construction of the project.
3. For use by emergency vehicles.

T. CONTRACTOR shall provide, operate and maintain equipment, services and personnel, with traffic control and protective devices, as required to expedite vehicular traffic flow on haul routes, at site entrances, onsite access roads and parking areas.

U. Finishing of Site, Borrow, and Storage Areas: Upon completion of the project, all areas used by the CONTRACTOR shall be properly cleared of all temporary structures, rubbish, and waste materials, and properly graded to drain and blend in with the abutting property. Areas used for the deposit of waste materials shall be finished to properly drain and blend with the surrounding terrain.

1.6 SAFETY AND CONVENIENCE

A. Construction Safety Program

1. The CONTRACTOR shall develop and maintain for the duration of the Work a safety program that will effectively incorporate and implement all required safety provisions. The CONTRACTOR shall appoint an employee who is qualified and authorized to supervise and enforce compliance with the safety program. The CONTRACTOR shall prepare and submit to the OWNER or OWNER’S REPRESENTATIVE a Health and Safety Plan (HASP) that covers all aspects of the work to be performed by the CONTRACTOR. This plan shall specifically address potential hazards associated with subsurface work that may encounter groundwater. Any groundwater encountered during performance of the Work must be assumed to be contaminated with Arsenic at levels potentially hazardous to human health and the environment.
2. The duties of the OWNER or the OWNER’S REPRESENTATIVE do not include a review or approval of the adequacy of the CONTRACTOR's safety supervisor, the safety program, or any safety measures taken in, on, or near the construction site.
3. The safety program shall include weekly safety meetings with documented minutes of each meeting distributed to attendees within 2 days of meeting. OWNER and OWNER’S REPRESENTATIVE shall be provided a copy of all safety meeting minutes.

B. Safety Equipment

1. The CONTRACTOR, as part of his safety program, shall maintain at his office or other well-known place at the jobsite, safety equipment applicable to the Work as prescribed by the governing safety authorities, all articles necessary for giving first-aid to the injured, and shall establish the procedure for the immediate removal to a hospital or a doctor's care of any person who may be injured on the jobsite.
2. The CONTRACTOR shall do all work necessary to protect the general public from hazards, including, but not limited to, surface irregularities or unramped grade changes in pedestrian sidewalk or walkway, and trenches or excavations in roadway. Barricades, lanterns, and proper signs shall be furnished in sufficient amount to safeguard the public and the Work.
3. The performance of all work and all complete construction, particularly with respect to ladders, platforms, structure openings, scaffolding, shoring, lagging, machinery guards and the like, shall be in accordance with the applicable governing safety authorities.
4. During construction, the CONTRACTOR shall construct and at all times maintain satisfactory and substantial temporary chain link fencing, solid fencing, railing, barricades or steel plates, as applicable, at all

openings, obstructions, or other hazards in streets, sidewalks, floors, roofs, and walkways. All such barriers shall have adequate warning lights as necessary, or required, for safety.

C. Pre-Approval of Materials Brought On Site

1. OWNER and OWNER’S REPRESENTATIVE shall be provided a copy of all MSDS’s for all materials to be brought on site, for approval, prior to any materials being brought on site.

D. Accident Reports

1. If death or serious injuries or serious damages are caused, the accident shall be reported immediately by telephone or messenger to the OWNER. In addition, the CONTRACTOR must promptly report in writing to the OWNER all accidents whatsoever arising out of, or in connection with, the performance of the Work whether on, or adjacent to, the site, giving full details and statements of witnesses.
2. If a claim is made by anyone against the CONTRACTOR or any subcontractor on account of any accident, the CONTRACTOR shall promptly report the facts in writing to the OWNER, giving full details of the claim.

E. Verification of Qualifications of Construction Personnel

1. CONTRACTOR shall verify qualifications of all personnel performing work and or operating equipment prior to work activities taking place.

F. Fire Prevention and Protection

1. The CONTRACTOR shall perform all work in a fire-safe manner. He shall supply and maintain on the site adequate fire-fighting equipment capable of extinguishing incipient fires. The CONTRACTOR shall comply with applicable Federal, state, and local fire-prevention regulations. Where these regulations do not apply, applicable parts of the National Fire Prevention Standard for Safeguarding Building Construction Operations (NFPA No. 241), shall be followed.

G. Traffic Maintenance and Safety

1. Comply with all rules and regulations of the City, State, and County authorities regarding closing or restricting the use of public streets or highways. No public or private road shall be closed, except by express permission of the OWNER. Conduct the Work so as to assure the least possible obstruction to traffic and normal commercial pursuits. Protect all obstructions within traveled roadways by installing approved signs, barricades, and lights where necessary for the safety of the public.

2. When flagmen and guards are required by regulation or when deemed necessary for safety, they shall be furnished with approved orange wearing apparel and other regulation traffic-control devices.
3. Whenever it is necessary to cross, close, or obstruct roads, driveways, and walks, whether public or private, provide and maintain suitable and safe bridges, detours, or other temporary expedients for accommodation of public and private travel.
4. Road Closures: Maintain satisfactory means of exit for persons having occasion to transact business along the route of the Work. If it is necessary to close off roadway or alley providing sole vehicular access to property for periods greater than 2 hours, provide written notice for approval to OWNER 3 days prior to such closure.
5. Maintenance of traffic is not required if CONTRACTOR obtains written permission from OWNER or from the authority having jurisdiction over public property involved, to obstruct traffic at the designated point.
6. In making street crossings, do not block more than one-half the street at a time. Whenever possible, widen the shoulder on the opposite side to facilitate traffic flow. Provide temporary surfacing on shoulders as necessary.

H. Traffic Control: Traffic control on all county and State highway rights-of-way shall meet the requirements of the current edition (including all amendments) of the Manual on Uniform Traffic Control Devices for Streets and Highways published by the U.S. Department of Transportation Federal Highway and Administration as adopted by the State of Washington and all State of Washington Supplements.

I. Access for Police, Fire, and Postal Service

1. Notify the Fire Department and Police Department before closing any street or portion thereof. No closing shall be made without the OWNER's approval. Notify said departments when the streets are again passable for emergency vehicles. Do not block off emergency vehicle access to consecutive arterial crossings of dead-end streets, in excess of 300 linear feet, without special written permission from the Fire Department. Conduct operations with the least interference to fire equipment access, and at no time prevent such access.
2. The CONTRACTOR shall leave his night emergency telephone number or numbers with the Police Department, so that contact may be made easily at all times in case of barricade and flare trouble or other emergencies.

1.7 QUALITY CONTROL

A. General: Maintain quality control over suppliers, manufacturers, products, services, site conditions, and workmanship, to produce work of specified quality.

B. Workmanship

   1. Comply with industry standards except when more restrictive tolerances or specified requirements indicate more rigid standards or more precise workmanship.
   2. Perform Work by persons qualified to produce workmanship of specified quality.

C. MANUFACTURER’S Instructions: Comply with instructions in full detail, including each step in sequence. Should instructions conflict with Contract Documents, request clarification from the CONTRACTOR’s Engineer before proceeding.

D. MANUFACTURER’S Certificates: When required by individual sections, submit MANUFACTURER'S certificate, that products meet or exceed specified requirements.

E. Testing Laboratory Services

   1. Services will be performed in accordance with requirements of governing authorities and with specified standards.
   2. Reports will be submitted to OWNER’S REPRESENTATIVE giving observations and results of tests, indicating compliance or non-compliance with specified standards, CONTRACTOR’s design, and with Contract Documents. Tests or results which indicate noncompliance shall be followed by corrective action and appropriate tests to show compliance as specified.
   3. CONTRACTOR shall cooperate with Testing Laboratory personnel; furnish tools, samples of materials, design mix, equipment, storage and assistance as requested.
      a. Notify OWNER’S REPRESENTATIVE and Testing Laboratory 24 hours prior to expected time for operations requiring testing services.
      b. Make arrangements with Testing Laboratory and pay for additional samples and tests for CONTRACTOR's convenience.
   4. Reexamination of questioned Work may be ordered by the OWNER’S REPRESENTATIVE, and, if so ordered, the Work shall be uncovered by the CONTRACTOR. If such work is found to be in accordance with the Contract Documents, the OWNER will pay the cost of reexamination and replacement. If such Work is found to be not in accordance with the Contract Documents, the CONTRACTOR shall correct the defective Work, and the cost of reexamination and correction of the defective Work shall be paid by the CONTRACTOR.

1.8 PERMITS AND FEES

A. CONTRACTOR shall secure and pay for all permits needed to complete the Work that are not obtained by the OWNER as descrbied below. This will include governmental fees, licenses and inspections necessary for the proper execution and completion of the Work and as required to meet all applicable codes and standards and retain on-site.

B. OWNER will obtain and pay for the building permit all air, storm water and wastewater discharge permits required.

1.9 LAYOUT OF THE WORK

A. The design/build CONTRACTOR shall establish the Survey Control Baseline and place Bench Marks. Coordinate location of these items with the OWNER.

B. Layout the limits of clearing and grubbing for excavation, haul, and spreading. Notify the OWNER’S REPRESENTATIVE for review and acceptance of the line location and identification of trees to be protected prior to clearing and grubbing.

C. The OWNER’S REPRESENTATIVE may perform checks to verify the accuracy of the CONTRACTOR's layout work and ensure the completed Work complies with the Contract Documents.

END OF SECTION

SECTION 01010
SUMMARY OF WORK

PART 1 GENERAL

1.1 WORK COVERED BY CONTRACT DOCUMENTS

A. In general, the completed Work will provide the OWNER with a complete and fully operational groundwater recovery and treatment facility. The treatment system shall generally conform to these contract documents consisting of Specifications and Drawings, Work Plans, Engineering Design Report Addendum 3 (including all appendices) and other Addenda and Clarifications as may be issued throughout the bidding and award periods.

   1. The successful bidder (CONTRACTOR) shall be responsible for the design and construction of the complete system in accordance with all applicable codes and the project documents provided to the CONTRACTOR by the OWNER, as included in the Bid Documents.
   2. The facility to be designed and constructed should have a minimum 20-year design life under the identified operating conditions.
   3. The work consists of the Design/Build engineering, construction and commissioning services.

B. The work includes but is not limited to the following:

   1. Complete detailed design drawings, stamped by a professional engineer in the State of Washington.
   2. Complete detailed submittals as required in individual specification sections, in addition to the following, provided to the OWNER'S REPRESENTATIVE for approval before starting the relevant work, including, but not limited to:
      a. Detailed design drawings for all civil, structural, mechanical, and electrical works.
      b. Cutsheets for all system components (pipe, tanks, process equipment, valves, doors, windows, plumbing fixtures, grating, coatings, vaults, electrical enclosures, instrumentation, cable, conduit, etc). Include drawings and performance data where appropriate.
      c. Building and room layout, showing all details such as lighting, electrical outlets, lab furnishings, HVAC, receptacles etc.
      d. Building elevations showing aesthetic features, and building color samples.
      e. Control system screenshots and functional description.
   3. Record drawings upon completion of the construction activities.
   4. All necessary permits relating to all construction activities that are not being obtained by the OWNER, as described in the Project

Specifications. Permits to be obtained by the CONTRACTOR include but are not limited to temporary water use permit and City of Milton Street Work Permit. Contractor shall provide detailed building drawings and other submittals needed to obtain a Pierce County Building Permit and an NPDES discharge permit for treated groundwater. Permits listed as completed by others in Subsection C below are excluded from the Contractor's scope of work.

5. All yard piping for groundwater collection system, treatment system discharge piping, and electrical conduit, including trenching, backfill, compaction, surface restoration, fittings, valves, cleanouts, and accessories as required. This work will include coordination with the drilling contractor as appropriate to ensure the wells are completed and piped in accordance with project documents.
6. Supply and install well vaults for wells R-1 through R-11. This work will include coordination with the drilling contractor as appropriate to ensure the wells are completed and piped in accordance with project documents.
7. Supply and install all well pumps, complete with controllers as required. This work will include coordination with the drilling contractor as appropriate to ensure the wells are completed and piped in accordance with project documents.
8. All piping, insulation, fittings, valves, and accessories for all wells. This work will include coordination with the drilling contractor as appropriate to ensure the wells are completed and piped in accordance with project documents.
9. All electrical and control connections for well pumps and piezometers, including control kiosks, conduit, electrical vaults, trenching, and any necessary additional components required to send control signal from existing piezometers to central PLC as shown on P&IDs. This work will include coordination with the drilling contractor as appropriate to ensure the wells are completed and piped in accordance with project documents.
10. Design, supply, fabricate concrete foundation and floor for treatment building, including truck unloading area, roll-off bin receiving area, chemical containment area, building containment curb, sumps, superstructure foundations, and trenches.
11. Final grading for building pad area, including additional fill to account for settling, and surfacing with crushed rock.
12. Design and construct stormwater ditch around building to direct stormwater to natural drainage area to the north of the building.
13. Design, supply, fabricate treatment building, complete; including doors, windows, interior rooms, office, lab area, and restroom.
14. Design, supply, install complete building HVAC system, including heating and ventilation for office, laboratory, and restroom facilities.

15. Design, supply, install all interior building lighting and yard lighting to meet International Building Code (IBC) and WISHA/OSHA requirements.
16. Design, supply, install complete fire sprinkler system, complete with alarms, detectors, and fire extinguishers as per IBC, NFPA, local codes, and all applicable regulations.
17. Design, supply, and construct all piping and accessories necessary for potable water, fire water, and sewer services for the treatment building.
18. Design, supply, fabricate all stairs, catwalks, handrails and access platforms as per WISHA, OHSA, IBC, and NFPA requirements.
19. Select, procure and deliver all equipment other than OWNER Supplied Equipment.
20. Receive all equipment including owner supplied equipment, and handle as per manufacturer's recommendations.
21. Provide secure storage for all equipment and materials procured by CONTRACTOR or supplied by OWNER
22. Mechanical and electrical installation of all CONTRACTOR procured and Owner Supplied Equipment.
23. Design, supply, and install electrical connections to public utility grid to supply all equipment and building as required.
24. Design, supply, and install all motor control centers, starters, variable frequency drives for all equipment.
25. Design, supply, and install all electrical and control wiring for all equipment and building components.
26. Design, supply, install, and program new central treatment system PLC and SCADA control system, including data logging, call-out functionality, and remote monitoring capability over internet protocol.
27. Tie in existing stormwater PLC to new SCADA system to allow full functionality of existing PLC to be monitored, logged and controlled through the new SCADA.
28. Internet connection for SCADA and/or PLC via new telephone service line to be installed by Contractor.
29. All work required to install new equipment and modify existing works to produce a complete, functional system.
30. Quality control and quality assurance responsibilities as defined in the Contract Documents.
31. Health and Safety responsibilities including complete health and safety plan, as defined in the Contract Documents
32. Start-up and commissioning, including rented tanks to hold effluent which does not meet discharge requirements.
33. Landscaping to include a row of trees along south and east sides of the building.
34. Demobilization and site cleanup.

C. The following work will be completed by others, and is outside the scope of these specifications:

1. The following permits will be completed by others:
    a. Building permit (with assistance by Contractor for detailed building drawings and plans)
    b. National Pollutant Discharge Elimination System (NPDES) permits (with assistance by CONTRACTOR for drawings and plans needed to complete the permitting process)
    c. Stormwater permit (as needed)
    d. City of Milton Water Service Connection Permit
    e. Wetland Permits
    f. Land access agreements for adjacent properties
2. Drilling of all recovery wells and installation of well screens and casings.
3. Supply and installation of well vaults for wells R-12 through R-21.
4. Installation of geo-piers to support building foundation.
5. Placement and compaction of imported fill, to raise elevation of area surrounding building. The CONTRACTOR is responsible for additional fill to account for settling which may occur, and final crushed rock surfacing for the building pad area.
6. Owner Supplied Equipment:
    a. Flash Mix/Flocculation/Clarifier.
    b. Process Tanks
        1) Lime Storage Tank
        2) $KMnO_4$ Tank
        3) Oxidation Tank
        4) Sludge Tank
        5) Precipitation Tank
        6) pH Adjust Tank
    c. Filter Press
    d. $KMnO_4$ Drum Handling and Conveying System

D. The following materials, left over from previous work, are on site, and are available for use by the DESIGN-BUILD CONTRACTOR

1. Qty 18, 20 ft sections of 1 inch sched 40 rigid PVC conduit
2. Qty 35, 20 ft sections of 2 inch IPS HDPE pipe, DR 11
3. Qty 2, 50 ft sections of 2 inch ribbed flex hose
4. Qty 2, 50 ft sections of 1.5 inch ribbed flex hose

1.2 ORGANIZATION AND INTERPRETATION OF CONTRACT DOCUMENTS

A. Specifications and Drawings included in these Contract Documents establish the performance, quality requirements, location, and general arrangement of materials and equipment, and establish the minimum standards for quality of workmanship and appearance.

B. Specification sections have not been divided into groups for work of separate Contractors, Subcontractors, or various trades. Should there be questions concerning the applicability or interpretation of a particular section or part of a section or Drawing, direct questions to the OWNER'S REPRESENTATIVE.

C. Piping work shown on the Drawings is intended to be depictive and is not intended to be an exact and complete representation of the actual finished work required. The CONTRACTOR is responsible for the design of all works. Include fittings, joints, supports, nuts, bolts, and other accessories required to provide complete and satisfactory piping systems, even though some items may not be specifically shown on the Drawings.

D. All work that is necessary or required to make each installation satisfactory and operable for its intended purpose, even though it is not specifically included in the Specifications or on the Drawings, shall be performed as incidental work as if it were described in the Specifications and shown on the Drawings.

E. Any conflicts that arise between Contract Documents shall be brought to the attention of the OWNER'S REPRESENTATIVE for clarification. In general the precedence of Contract Documents shall be as follows, from highest precedence to lowest:

1. Construction Contract
2. Project Drawings
3. Engineering Design Report Addendum 3 (including all appendices)
4. Specifications

1.3 RESPONSIBILITY

A. The OWNER and OWNER's REPRESENTATIVE are not responsible for the health and safety of the CONTRACTOR's workers.

B. CONTRACTOR will keep OWNER informed of the probable delivery dates and will give timely confirmation of final delivery.

C. The OWNER's REPRESENTATIVE Responsibilities:

1. Timely review of Shop Drawings, testing data, CONTRACTOR'S submittals, and product data.
2. Confirm delivery date with CONTRACTOR.
3. On delivery of equipment, inspect jointly with CONTRACTOR.
4. Site observation.

5. Acceptance of Work.

D. The DESIGN/BUILD CONTRACTOR’s Responsibilities:

1. Design, review, and distribute Shop Drawings, testing data, submittals, and product data.
2. Receive and unload products at site; inspect for completeness or damage jointly with OWNER’S REPRESENTATIVE. Provide all labor and equipment for unloading.
3. Handle, store, and maintain products, equipment, and materials.
4. Repair or replace items damaged after receipt.
5. Indicate signed acceptance of delivery on a copy of the invoice.
6. Install, connect, and startup in accordance with MANUFACTURER’s instructions unless otherwise specified.
7. Maintain inventory of products.
8. Obtain MANUFACTURER’s certificate of proper installation.
9. Compile and prepare record drawings of all works.

1.4 DESIGN/BUILD CONTRACTOR'S USE OF THE PROJECT SITE

A. The CONTRACTOR's use of the project site shall be limited to its construction operations, including onsite storage of materials, equipment, onsite fabrication facilities, and field offices. The CONTRACTOR shall limit major construction activities to the work area shown on the drawings. Work by this CONTRACTOR outside the above limits shall be coordinated with the OWNER/OWNER’S REPRESENTATIVE, particularly when working on property other than the B&L Property. In addition to the area described above, the CONTRACTOR will determine the requirements for a field trailer location and laydown area or areas which will then be assigned by the OWNER/OWNER’S REPRESENTATIVE to the CONTRACTOR. The laydown area(s) may be revised by the OWNER/OWNER’S REPRESENTATIVE.

1.5 MISCELLANEOUS CONTRACTOR’S RESPONSIBILITIES

A. Environmental Controls

1. General:
   a. The CONTRACTOR in executing the work shall maintain affected areas within and outside project boundaries free from environmental pollution that would be in violation of federal, state, or local regulations.
   b. Do not impair operation or performance of existing sewer systems. Prevent construction material, pavement, concrete, earth, volatile, and corrosive wastes, and other debris from entering sewers, pump stations, or other sewer structures. Maintain original site drainage wherever possible.

2. Water Pollution Control: Comply with laws, rules, and regulations of the State of Washington and agencies of the United States Government prohibiting the pollution of lakes, wetlands, streams, or river waters from the dumping of refuse, rubbish, or debris.
3. Waste Material Disposal: Dispose of all waste materials including but not limited to excess excavated materials and demolished building materials off site in accordance with state and local and state codes and regulations. Costs for disposal of waste materials shall be borne by CONTRACTOR.
4. Noise Control: Minimize noise by executing work using appropriate construction methods and equipment. Provide acoustical barriers so noise emanating from tools or equipment will not exceed legal noise levels.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION (NOT USED)

END OF SECTION

SECTION 01040
COORDINATION

PART 1 GENERAL

1.1 SUBMITTALS

A. Photographs and other records of examination, as required herein.

1.2 OTHER WORK

A. Coordination of OWNER's Work: Reference Section 01000 for OWNER's work or worth by others, if any. The CONTRACTOR is responsible for coordinating CONTRACTOR's Work with all other contractors.

B. Other work may be performed at site by others during scheduled performance of Work under these Contract Documents. CONTRACTOR to coordinate work under these Contract Documents with others.

1.3 UTILITIES

A. Coordinate Work with various utilities within Project limits as required. Notify applicable utilities and obtain all necessary utility locates prior to commencing Work. CONTRACTOR shall notify OWNER and public utilities 3 working days before CONTRACTOR starts excavating. Notify applicable utilities immediately if damage occurs or if conflicts or emergencies arise during work.

1.4 PROJECT MEETINGS

A. General:

1. CONTRACTOR: Allow for project meetings in schedule throughout progress of Work as required but no less than weekly.
2. OWNER'S REPRESENTATIVE will schedule meetings, prepare meeting agenda and distribute with notification of each meeting, preside at meetings, record minutes to include significant proceedings and decisions, and distribute copies of minutes within 10 days after each meeting to participants and parties affected by meeting decisions.
3. Representatives of OWNER, CONTRACTOR, and Subcontractors shall attend meetings, as needed.

B. Precommencement Conference:

1. Unless deemed otherwise by OWNER or OWNER’S REPRESENTATIVE, the pre-commencement conference shall be held at site.
2. Attendees shall include but not be limited to:
    a. OWNER
    b. OWNER's REPRESENTATIVES.
    c. CONTRACTOR’s design engineering staff, all disciplines.
    d. CONTRACTOR's office representative.
    e. CONTRACTOR's resident superintendent.
    f. CONTRACTOR's quality control representative and safety representative.
    g. Subcontractors' representatives whom CONTRACTOR may desire or OWNER may request to attend.
    h. Others as appropriate.

C. Preliminary Schedules Review Meeting: A detailed project schedule shall be submitted by the CONTRACTOR within 15 days after award as stated in Item 1.3 of Section 01000 General Requirements, and presented at the Preliminary Schedules Review Meeting at the project site. The project schedule shall be consistent with general schedule submitted with CONTRACTOR’s bid (ref. Section 00408), unless authorized in writing by OWNER.

D. Progress Meetings:

1. OWNER’S REPRESENTATIVE will schedule regular progress meetings at site, conducted weekly to review Work progress, progress schedule, Submittals submissions schedule, Application for Payment, contract modifications, and other matters needing discussion and resolution.
2. Attendees will include:
    a. OWNER, as appropriate.
    b. OWNER's REPRESENTATIVE, as appropriate.
    c. CONTRACTOR’s Design Engineer, as appropriate.
    d. CONTRACTOR, Subcontractors, and Suppliers, as appropriate.
    e. Others as appropriate.

E. Quality Control and Coordination Meeting(s):

1. Scheduled by CONTRACTOR on regular basis and as necessary to review test and inspection reports, and other matters relating to quality control of Work and work of other contractors.
2. Attendees will include CONTRACTOR, CONTRACTOR's designated quality control representative, selected Subcontractors and Suppliers,

and CONTRACTOR’s Design Engineers, OWNER’S REPRESENTATIVE, and OWNER.

F. Pre-installation Meetings:

1. When required in individual Specification sections, convene at site prior to commencing Work of that section.
2. Require attendance of entities directly affecting, or affected by, Work of that section.
3. Notify OWNER’S REPRESENTATIVE 4 days in advance of meeting date.
4. Provide suggested agenda to OWNER’S REPRESENTATIVE to include reviewing conditions of installation, preparation and installation or application procedures, and coordination with related Work and work of others.

G. CONTRACTOR's Meetings:

1. Hold Subcontractor coordination meetings as required.

H. Other Meetings: In accordance with Contract Documents and as may be required by OWNER and OWNER’S REPRESENTATIVE.

1.5 SEQUENCE OF WORK

A. The following constraints apply to construction of the Work. The CONTRACTOR shall incorporate these constraints when developing his construction schedule.

B. Include the Milestones and sequences of Work specified herein as a part of the progress schedule required. The CONTRACTOR must sequence his design, shop-drawing review, equipment purchase construction, debug, startup, and testing activities to ensure these completion dates are met. The OWNER intends to place the processes in continuous, full-time service on the dates as listed in Section 00408 of the Bid Documents.

C. No buried service may be interrupted without the OWNER’s written permission. No buried service may be interrupted for more than 24 hours.

D. Coordinate proposed Work with the OWNER before effecting unit shutdowns. Under no circumstances cease Work at the end of a normal working day if such actions may inadvertently cause a cessation of any OWNER’S operating process, in which case, remain onsite until necessary repairs are complete.

E. Do not close lines, open valves, or take other action which would affect the operation of existing systems, except as specifically required by the Contract

Documents and after approval by the OWNER. Such actions will be considered by OWNER upon 48 hours written notice.

F. Provide all necessary provisions and construction approaches to ensure vehicle and pedestrian access requirements by the OWNER are not disrupted.

1.6 OWNER’S OCCUPANCY

A. OWNER will occupy the premises during the entire period of construction for the conduct of its normal operations. Cooperate with OWNER in all construction operations to minimize conflict and to facilitate OWNER usage.

1.7 OWNER FACILITIES

A. Operation and Shutdown of Existing Facilities:

1. Conduct Work outside regular working hours on prior written consent of OWNER to meet Project schedule and avoid undesirable conditions.
2. Do not proceed with Work affecting a facility's operation without obtaining OWNER's advance approval of the need for and duration of such Work.
3. Provide 7 days advance request for approval to OWNER of need to shut down a process or facility.

1.8 PHYSICAL CONDITIONS

A. It is the CONTRACTOR’s sole responsibility to locate all subsurface items affecting the work.

B. Thoroughly check immediate and adjacent areas subject to excavation by visual examination (and by electronic metal and pipe detection equipment, as necessary) for indications of subsurface structures and Underground Facilities.

C. Make exploratory excavations where existing Underground Facilities or structures may potentially conflict with proposed Underground Facilities or structures. Conduct exploratory excavations in presence of OWNER's Representative and sufficiently ahead of construction to avoid possible delays to CONTRACTOR's Work.

D. Any information obtained by the OWNER stating field or soil conditions, subsurface conditions, groundwater levels or similar data will be provided to all bidders. This information is offered as supplementary information and the OWNER does not assume any responsibility for the completeness or interpretation of such information.

E. Any information obtained by the OWNER regarding site conditions, subsurface item information, groundwater elevations, existing construction of site facilities as applicable, and similar data will be available for inspection at the production facility upon request. Such information is offered as supplementary information only. Neither the OWNER'S REPRESENTATIVE nor the OWNER assumes any responsibility for the completeness or interpretation of such supplementary information.

1.9 REFERENCE POINTS AND SURVEYS

A. CONTRACTOR's Responsibilities:

1. Provide complete survey layout for the works and establish bench marks convenient to Work. Work shall be performed by, and field notes stamped by a registered surveyor.
2. Establish horizontal reference points or coordinate system with bench marks and reference points for CONTRACTOR's use as necessary to lay out Work.
3. Provide additional survey and layout as required.
4. Locate and protect reference points prior to starting Work at site.
5. The CONTRACTOR shall provide a competent surveyor in his employ to provide all control points, surveying and staking and to assist OWNER, or OWNER'S REPRESENTATIVE, when required, in checking lines and elevations.
6. Check and establish exact location of existing facilities prior to construction of new facilities and any connections thereto.
7. In event of discrepancy in data or staking, determine the appropriate resolution and notify the OWNER'S REPRESENTATIVE before proceeding with Work.
8. Preserve and leave undisturbed control staking until OWNER's Representative has completed checks it deems necessary.
9. Re-establish reference points resulting from destruction by CONTRACTOR's operations.
10. Provide competent employee(s), tools, stakes, and other equipment and materials as OWNER may require to:
    a. Establish control points, lines, and easement boundaries.
    b. Check layout, survey, and measurement Work performed by others.
    c. Measure quantities for payment purposes.
11. Cooperate with OWNER's Representative so that checking and measuring may be accomplished with least interference to CONTRACTOR's operations.

1.10 REFERENCE STANDARDS

A. The design and construction of the groundwater recovery and treatment system and associated work components under this contract must comply with the following standards even if not specifically noted on the drawings or in the specifications hereafter.

1. International Building Code (IBC), International Code Council
2. International Mechanical Code, International Conference of Building Officials International Code Council
3. Uniform Plumbing Code (UPC, International Association of Plumbing and Mechanical Officials
4. International Fire Code (IFC), International Code Council
5. State Building Code (Washington, SBC)
6. Washington State Energy Code, State Building Code Council
7. Pierce County Code
8. American Concrete Institute (ACI 318)
9. AISC – American Institute for Steel Construction
10. ANSI – American National Standards Institute
11. API – American Petroleum Institute
12. ASA - American Standard Code for Pressure Piping
13. Minimum Design Loads for Buildings and Other Structures (ASCE 7) by ASCE (American Society of Civil Engineers)
14. ASHRAE Applications Handbook – American Society of Heating, Refrigerating and Air Conditioning Engineers
15. ASME – American Society of Mechanical Engineers
16. ASTM – American Society for Testing and Materials
17. AWS – American Welding Society
18. AWWA - American Water Works Association
19. EPA – U.S. Environmental Protection Agency
20. FM – Factory Mutual Systems Loss Prevention Standards
21. Hydraulic Institute Standards
22. IEEE – Institution of Electrical and Electronic Engineers
23. MBMA – Metal Building Manufacturer's Association
24. NAAMM – National Association of Architectural Metal Manufacturers
25. NACE – National Association of Corrosion Engineers
26. NEC – National Electrical Code
27. NEMA – National Electrical Manufacturers Association.
28. NFPA – National Fire Protection Agency
29. NSF - National Sanitation Foundation
30. North American Specification for the Design of Cold-Formed Steel Structural Members by AISI and CSA
31. OSHA – Occupational Safety & Health Administration
32. PPI – Plastics Pipe Institute
33. SSPC – Steel Structures Painting Council
34. UL – Underwriters Laboratories Inc.

35. Local laws and ordinances
36. State of Washington laws and regulations
37. Local fire marshall
38. State and/or federal safety regulations

B. It is the CONTRACTOR's responsibility to obtain the above standards as required.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION

3.1 CUTTING, FITTING, AND PATCHING

A. General: Reference paragraph GC3.13 of the General Conditions.

1. Cut, fit, adjust, or patch Work and work of others, including excavation and backfill as required, to make Work complete.
2. Obtain prior written authorization of OWNER before commencing Work to cut or otherwise alter:
   a. Structural or reinforcing steel, structural columns or beams, elevated slabs, trusses, or any other structural member.
   b. Weather- or moisture-resistant elements.
   c. Landfill cap.
   d. Efficiency, maintenance, or safety of element.
   e. Mechanical, electrical, I&C systems.
   f. Work of others.
3. Refinish surfaces to provide an even finish:
   a. Refinish continuous surfaces to nearest intersection.
   b. Refinish entire assemblies.
   c. Finish restored surfaces to such planes, shapes, and textures that no transition between existing work and Work is evident in finished surfaces.
4. Restore existing work, Underground Facilities, and surfaces that are to remain in completed Work including concrete-embedded piping, conduit, and other utilities as specified and as shown.
5. Make restorations with new materials and appropriate methods as specified for new Work of similar nature; if not specified, use best recommended practice of MANUFACTURER or appropriate trade association.
6. Fit Work airtight to pipes, sleeves, ducts, conduit, and other penetrations through surfaces and fill voids.
7. Remove specimens of installed Work for testing when requested by OWNER’S REPRESENTATIVE.

END OF SECTION

SECTION 01300
SUBMITTALS

PART 1 GENERAL

1.1 GENERAL

A. Inquiries: Direct to OWNER’S REPRESENTATIVE regarding procedure, purpose, or extent of Submittal.

B. Submittal policies are as follows in this section unless otherwise stated in the specific equipment specification section and as may otherwise be established during the pre-commencement conference.

C. OWNER's Authorization: At any time, OWNER may authorize changes to procedures and requirements for Submittals, as necessary to accomplish specific purpose of each Submittal. Such authorization will be by Field Order or Work Change Directive.

D. It is the CONTRACTOR’s sole responsibility to coordinate with the Vendors, Manufacturers, Subcontractors, and Suppliers of CONTRACTOR-furnished items for the submission of submittals, scheduling, procurement, shipping, handling and storage on-site. The CONTRACTOR will be required to coordinate shop drawings, submittals, delivery, and inspection of OWNER-supplied equipment.

E. Timeliness: Make submissions in accordance with requirements of individual Specification sections, as shown on the current accepted schedule of Submittals submissions, and in such sequence as to cause no delay in Work or in work of other contractors.

F. Identification of Submittals:

1. Prior to contract award, the CONTRACTOR shall prepare and submit a detailed list and schedule of submittals submissions to the OWNER’S REPRESENTATIVE. The schedule will identify preliminary submittal dates for all submittals. Submissions will be grouped and referenced as noted hereafter (i.e. see also administrative submittals hereafter). Where applicable, shop drawing submittals shall be sealed and signed by the CONTRACTOR’S professional engineer, licensed in the State of Washington, as identified in the bid documents.
2. Complete, sign, and transmit with each Submittal package, one Transmittal of CONTRACTOR’s Submittal Form attached at the end of this section.

3. Submittal Number Format: SSSSS-NN-V.
    a. SSSSS: Representing specification section number.
    b. NN: Submittal number (01 through 99).
    c. V: Resubmission version with sequential alphabetic suffix.
4. Format: Orderly, indexed with labeled tab dividers.
5. Show date of submission and dates of previous submissions.
6. Show Project title and OWNER's contract identification and contract number.
7. Show names of Designer, Vendor, Subcontractor or Supplier, and MANUFACTURER as appropriate.
8. Identify, as applicable, Contract Document section and paragraph to which Submittal applies.
9. Clearly identify revisions from previous submissions.

G. Incomplete Submittal Submissions:

1. At OWNER REPRESENTATIVE’s sole discretion, OWNER’S REPRESENTATIVE will either (i) return the entire Submittal for CONTRACTOR’S revision/correction and resubmission, or (ii) retain portions of the Submittal and request submission/resubmission of specified items or as noted thereon.
2. Submittals which do not clearly bear the CONTRACTOR’s Design Engineer’s seal and signature and the CONTRACTOR’S specific written indication of CONTRACTOR review and approval of Submittal or which are transmitted with an unsigned or uncertified submission form or as may otherwise be required under Contract Documents, will be returned to CONTRACTOR unreviewed for resubmission in accordance with Contract Documents.
3. Delays, resequencing or other impact to Work resulting from CONTRACTOR’S submission of unchecked or unreviewed, incomplete, inaccurate or erroneous, or nonconforming Submittals, which will require CONTRACTOR’S resubmission of a Submittal for OWNER’s review, shall not constitute a basis of claim for adjustment in Contract Price or Contract Times.

H. Non-specified Submissions: Submissions not required under these Contract Documents and not shown on schedule of Submittals submissions established by the CONTRACTOR and OWNER’S REPRESENTATIVE will not be reviewed and will be returned to CONTRACTOR.

I. Transmit Submittals in accordance with current accepted schedule of Submittals submissions, and deliver as follows:

1. Submittals to OWNER:

   B&L Custodial Trust
   C/O
   Mr. Dan Silver
   606 Columbia Street NW, Suite 212
   Olympia, Washington 98501
   danieljsilver@msn.com

2. Submittals to OWNER'S REPRESENTATIVE:

   Len de Vlaming
   AMEC Earth and Environmental
   900 Maple Grove Road, Unit 10
   Cambridge, ON N3H 4R7
   len.devlaming@amec.com

J. Disposition of Submittals, Except Shop Drawings and Samples: OWNER'S REPRESENTATIVE will review, stamp, and indicate requirements for resubmission or acceptance on Submittal as follows:

   1. Accepted:
      a. CONTRACTOR may proceed to perform Submittal related Work.
      b. Two copies filed by OWNER'S REPRESENTATIVE.
      c. One copy for OWNER's file.
      d. Two copies returned to CONTRACTOR, one for onsite records.
   2. Rejected as Noted (Revise/Correct or Develop Replacement and Re-submit):
      a. Revise/correct in accordance with OWNER'S REPRESENTATIVE's comments and resubmit.
      b. One copy to OWNER'S REPRESENTATIVE's file.
      c. One copy returned to CONTRACTOR appropriately annotated.
      d. Remaining copy will be destroyed.

K. OWNER's Review: OWNER'S REPRESENTATIVE will act upon CONTRACTOR'S Submittal and transmit response to CONTRACTOR not later than 14 calendar days after receipt, unless: (i) specified otherwise or (ii) accepted by OWNER'S REPRESENTATIVE as set forth in Paragraph OWNER'S REPRESENTATIVE'S Duties below and identified on current accepted schedule of Submittals submissions. Resubmittals will be subject to the same review time.

L. OWNER'S REPRESENTATIVE'S Duties:

   1. Review Submittals with reasonable promptness and in accordance with current accepted schedule of Submittals submissions.

    a. No extension of Contract Times will be allowed due to OWNER’S REPRESENTATIVE’S review of Submittals, unless all of following criteria are met:
        1) CONTRACTOR has notified OWNER’S REPRESENTATIVE in writing that timely review of Submittal in question is critical to progress of Work, and has received OWNER’S REPRESENTATIVE’S written acceptance to reflect such on schedule of Submittals submissions and progress schedule. Written agreement by the OWNER’S REPRESENTATIVE to reduce the Submittal review time will be made only for unusual and CONTRACTOR-justified reasons. Acceptance of a progress schedule containing Submittal review times less than specified or less than agreed to in writing by OWNER’S REPRESENTATIVE will not constitute OWNER’s REPRESENTATIVE’S acceptance of the review times.
        2) OWNER’S REPRESENTATIVE has failed to review and return first submission of a Submittal within agreed time indicated on current accepted schedule of Submittal submissions or, if no time is indicated thereon, within 14 days.
        3) CONTRACTOR demonstrates that delay in progress of Work is directly attributable to OWNER’s REPRESENTATIVE’S failure to return Submittal within time indicated and accepted by OWNER’S REPRESENTATIVE.
    b. No extension of Contract Times will be allowed due to delays in progress of Work caused by rejection and subsequent resubmission of Submittals, including multiple re-submissions.
2. Review, return for correction, reject, accept or approve Submittals submissions only as set forth in applicable paragraphs of General Conditions.
3. Stamp and indicate requirements for resubmission and acceptance or approval of Submittal submission.
4. Return Submittals to CONTRACTOR for distribution or revision and resubmission.
5. Transmit to CONTRACTOR without review Submittal submissions received directly from Subcontractors, Suppliers, manufacturers, and non-required submissions from CONTRACTOR.

1.2 ADMINISTRATIVE SUBMITTALS

A. Description: Submittals required by Contract Documents that are not Shop Drawings or Samples, or that do not reflect quality of product or method of construction. Administrative Submittals may include, but will not be limited to those Submittals identified below.

B. Copies: Submit five.

C. Schedules:

1. Schedule of Submittals Submissions:
   a. Prepare and submit as required, preliminary Submittals submissions list grouped by Contract Document article/paragraph number or Specification section number, with identification, numbering and tracking system as specified under Paragraph Identification of Submittals (pg. 01300-2) and as approved by OWNER'S REPRESENTATIVE.
   b. Include in Submittal list only the following required submissions:
      1) Shop Drawings and Samples.
      2) Certificates of inspection.
      3) Test reports.
      4) Operation and maintenance manuals.
      5) Record documents.
      6) Specifically required certificates, warranties, and service agreements.
      7) Listing of Specifications and products for which substitutes or "or-equals" will be proposed.
   c. Identify items for which CONTRACTOR, Subcontractor, etc., anticipate proposing substitute or "or-equal" products or methods.
   d. Coordinate with progress schedule and, utilizing Submittals list, prepare schedule of Submittals submissions to show for each clearly identified Submittal, at a minimum, the following:
      1) Estimated submission date to OWNER'S REPRESENTATIVE.
      2) Specifically requested and clearly identified review time if shorter than that set forth herein for OWNER'S REPRESENTATIVE, with justification for such request and critical dates Submittals will be needed from OWNER'S REPRESENTATIVE.

1.3 SHOP DRAWINGS

A. Excessive Shop Drawing Review: Review of the first submission and <u>one</u> resubmission of Shop Drawings will be performed by OWNER'S REPRESENTATIVE as appropriate, at no cost to CONTRACTOR. Subsequent additional re-submissions of that Shop Drawing will be reviewed by OWNER'S REPRESENTATIVE, however OWNER'S REPRESENTATIVE will document work hours and other expenses required to perform such additional review(s) and these costs shall be deducted from CONTRACTOR'S progress payments.

B. Substitute and "Or-Equal" Items: The CONTRACTOR must base his bid price on items specified in these specifications. Substitute and "or equal" items will only be considered during the bid period.

C. Copies: Submit five (5) hard copies. Final approved shop drawing versions shall also be submitted in PDF and in AutoCAD format.

D. Submit Shop Drawings to OWNER’S REPRESENTATIVE in accordance with Specification sections for equipment and materials to be furnished under these Contract Documents.

E. Identify and Indicate:

1. Pertinent Drawing sheet(s) and detail number(s), products, units and assemblies, and system or equipment identification or tag numbers.
2. Critical field dimensions and relationships to other critical features of Work.
    a. Each deviation or variation from Contract Documents.

F. Re-submissions: Clearly identify each correction or change made.

G. Foreign Manufacturers: When proposed, include following additional information:

1. Names and addresses of at least two companies closest to Project that maintain technical service representatives.
2. Complete inventory of spare parts and accessories for each piece of equipment.

H. Preparation:

1. Format: Whenever possible, schedule for and combine Shop Drawings required for submission in each Specification section into a single Submittal package.
2. Present in a clear and thorough manner and of sufficient detail to show kind, size, arrangement, and function of components, materials, and devices and compliance with Contract Documents. Identify details by reference to sheet and detail, and schedule or room numbers shown on Drawings.
3. Piping Systems: Drawn to scale.
4. Product Data: Clearly mark each copy to identify pertinent products or models and show performance characteristics and capacities, dimensions and clearances required, wiring or piping diagrams and controls, and external connections, anchorages, and supports required.
5. Equipment and Component Titles: Identical to title shown on Drawings.
6. MANUFACTURER's standard schematic drawings and diagrams as follows:

        a. Modify to delete information that is not applicable to Work.
        b. Supplement standard information to provide information specifically applicable to Work.

I. Design Data:

    1. Provide an appropriately licensed professional engineer to perform design, oversee preparation of Shop Drawings, manufacturing, and installation, as appropriate, and to stamp and certify Shop Drawings conform with design requirements and requirements of Laws and Regulations and governing agencies.
    2. When specified, provide Project-specific information as required and as necessary to clearly show calculations, dimensions, logic and assumptions, and referenced standards and codes upon which design is based.

J. Disposition: OWNER'S REPRESENTATIVE will review, mark, and stamp Shop Drawings as appropriate and distribute marked-up copies as noted.

    1. Approved as Submitted (for incorporation in Work):
        a. One copy for OWNER'S file.
        b. Two copies filed by OWNER'S REPRESENTATIVE.
        c. Two copies will be returned to CONTRACTOR appropriately annotated.
            1) One copy to be kept on file as record document at CONTRACTOR'S office.
            2) Remaining copies for CONTRACTOR'S office file, Subcontractors, or Suppliers.
        d. CONTRACTOR may begin to implement (i) activities to incorporate specific product(s) or (ii) Work covered by Shop Drawing as shown on approved Shop Drawing.
    2. Approved as Noted (for incorporation in Work):
        a. One copy for OWNER'S file.
        b. Two copies filed by OWNER'S REPRESENTATIVE.
        c. Two copies will be returned to CONTRACTOR appropriately annotated.
            1) Remaining copies for CONTRACTOR'S office file, Subcontractors, or Suppliers.
        d. CONTRACTOR may begin to implement (i) activities to incorporate product(s) or (ii) Work covered by Shop Drawing and in accordance with OWNER'S REPRESENTATIVE'S notations on Shop Drawing.
        e. Copies of Submittal data in operation and maintenance manuals shall be revised according to exceptions as noted.
    3. Disapproved:

        - a. Revise/Correct and Resubmit or Develop Replacement and Submit:
            - 1) Two copies filed by OWNER’S REPRESENTATIVE.
            - 2) Two copies will be returned to CONTRACTOR appropriately annotated.
            - 3) Remaining copies, if any, will be destroyed.
            - 4) CONTRACTOR is responsible to revise, correct, and to resubmit Shop Drawing (in same manner and quantity as specified for original submission).
        - b. Shop Drawing is not approved.
    - 4. Incomplete:
        - a. Complete and Submit or Resubmit Missing Portion(s):
            - 1) OWNER’S REPRESENTATIVE will retain copies of incomplete Submittal and transmit a written list of deficiencies.
            - 2) CONTRACTOR shall submit specified item(s) to correct the incomplete Submittal.
        - b. Shop Drawing is not approved.

1.4 QUALITY CONTROL SUBMITTALS

A. Certificates:

- 1. MANUFACTURER's Certificate of Compliance:
    - a. When specified in individual Specification sections or where products are specified to a recognized standard or code, submit prior to shipment of product or material to the site.
    - b. OWNER’S REPRESENTATIVE may permit use of certain materials or assemblies prior to sampling and testing if accompanied by accepted certification of compliance.
    - c. Signed by product manufacturer certifying that materials, manufacture, and product specified conforms to or exceeds specified requirements and intent for which product will be used. Submit supporting reference data, affidavits, and certifications as appropriate.
    - d. May reflect recent or previous test results on material or product, but must be acceptable to OWNER’S REPRESENTATIVE.
- 2. Certificates of Successful Testing or Inspection: Submit when testing or inspection is required by Laws and Regulations or governing agency or specified in the individual Specification sections.
- 3. MANUFACTURER's Certificate of Proper Installation: As required in Section 01640 Manufacturers’ Services.

B. Operation and Maintenance Manual: As required in Section 01430 OPERATION AND MAINTENANCE DATA.

C. Statements of Qualification: Evidence of qualification, certification, or registration. As required in these Contract Documents to verify qualifications of professional land surveyors, engineers, materials testing laboratories, specialty Subcontractors, trades, specialists, consultants, installers, and other professionals.

D. Field Samples: Provide as required by individual Specifications and as may be required by OWNER'S REPRESENTATIVE during progress of Work.

E. Written Test Reports of Each Test and Inspection: As a minimum, include the following:

1. Date of test and date issued, Project title and number, testing laboratory name, address, and telephone number, and name and signature of laboratory inspector.
2. Date and time of sampling or inspection and record of temperature and weather conditions.
3. Identification of product and Specification section, location of Sample, test or inspection in the Project, type of inspection or test with referenced standard or code, certified results of test.
4. Compliance with Contract Documents, and identifying corrective action necessary to bring materials and equipment into compliance.
5. Provide an interpretation of test results, when requested by OWNER'S REPRESENTATIVE.

1.5 SUPPLEMENTS

A. Supplement listed below follows "END OF SECTION" and is part of this Specification.

1. Transmittal of CONTRACTOR'S Submittal Form.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION (NOT USED)

END OF SECTION

AMEC GEOMATRIX

TRANSMITTAL OF CONTRACTOR'S SUBMITTAL

(ATTACH TO EACH SUBMITTAL) Date:____________________

TO:____
____
____
____
____

Submittal No.:________________________________
☐ New Submittal ☐ Resubmittal
Previous Submittal No.:________________________
Project:______________________________________
Project No.:__________________________________
Specification Section No.:______________________
(Cover only one section with each transmittal)
Schedule Date of Submittal:
____

FROM:______________________________________
VENDOR
____
____
____

SUBMITTAL TYPE: ☐ Shop Drawing ☐ Administrative ☐ "Or-Equal"/Substitute

The following items are hereby submitted:

Number of Copies	Description of Item Submitted (Type, Size, Model Number, Etc.)	Spec. Para. No.	Drawing or Brochure Number	Contains Variation to Contract	
				No	Yes

VENDOR hereby certifies that (i) VENDOR has complied with the requirements of Contract Documents in preparation, review, and submission of designated Submittal and (ii) the Submittal is complete and in accordance with the Contract Documents and requirements of laws and regulations and governing agencies.

By:____
VENDOR (Authorized Signature)

SECTION 01400
QUALITY CONTROL

PART 1 GENERAL

1.1 REQUIREMENTS INCLUDED

A. General Quality Control.

B. Workmanship.

C. Manufacturer's Instructions.

D. Manufacturer's Certificates.

E. Mockups.

F. Manufacturers' Field Services.

G. Testing Laboratory Services.

1.2 QUALITY CONTROL, GENERAL

A. Maintain quality control over suppliers, manufacturers, products, services, site conditions, and workmanship, to produce work of specified quality and industry best practices.

1.3 WORKMANSHIP

A. Comply with industry standards except when more restrictive tolerances or specified requirements indicate more rigid standards or more precise workmanship.

B. Perform work by persons qualified to produce workmanship of specified quality.

1.4 MANUFACTURERS' INSTRUCTIONS

A. Comply with instructions in full detail, including each step in sequence. Should instructions conflict with Contract Documents, request clarification from OWNER’S REPRESENTATIVE before proceeding.

1.5 MANUFACTURERS' CERTIFICATES

A. When required by individual sections, submit manufacturer's certificate, in duplicate, that products meet or exceed specified requirements.

1.6 MOCKUPS

A. When required by individual Sections, erect complete, full-scale mockup of assembly at designated location.

1.7 MANUFACTURER'S FIELD SERVICES

A. When specified in respective Specification Sections, require manufacturer to provide qualified personnel to observe field conditions, conditions of surfaces and installation, quality of workmanship, start-up of equipment, test, adjust and balance of equipment as applicable, and to make appropriate recommendations.

B. Representative shall submit written report to OWNER’S REPRESENTATIVE listing observations and recommendations.

1.8 FIELD AND LABORATORY TESTING SERVICES

A. Services will be performed in accordance with requirements of governing authorities and with specified standards.

B. Reports will be submitted to OWNER’S REPRESENTATIVE giving observations and results of tests, indicating compliance or non- compliance with specified standards and with Contract Documents. Tests or results which indicate noncompliance shall be followed by corrective action and appropriate tests to show compliance as specified.

C. CONTRACTOR shall cooperate with Field and Laboratory Testing personnel; furnish tools, samples of materials, design mix, equipment, storage and assistance as requested.

  1. Notify OWNER’S REPRESENTATIVE and Field and Laboratory Testing Services 24 hours prior to expected time for operations requiring testing services.
  2. Make arrangements with Field and Laboratory Testing Services and pay for additional samples and tests for CONTRACTOR'S convenience.

D. Reexamination of questioned work may be ordered by the OWNER’S REPRESENTATIVE, and, if so ordered, the work shall be uncovered by the CONTRACTOR. If such work is found to be in accordance with the Contract Documents, the OWNER will pay the cost of reexamination and replacement. If such work is found to be not in accordance with the Contract Documents, the CONTRACTOR shall correct the defective work, and the cost of reexamination and correction of the defective work shall be paid by the CONTRACTOR.

END OF SECTION

SECTION 01430
OPERATION AND MAINTENANCE DATA

PART 1 GENERAL

1.1 DEFINITIONS

A. Maintenance Operation: Maintenance is defined to mean any routine operation required to ensure satisfactory performance and longevity of equipment. Examples of typical maintenance operations are lubrication, belt tensioning, adjustment of pump packing glands, and routine adjustments.

B. System and Subsystem: Refer to Section FACILITY STARTUP, Section 1.1, Definitions.

1.2 QUALITY CONTROL SUBMITTALS

A. Operation and Maintenance Manuals: As required in this section and as may be required in the individual Specification sections.

1.3 QUALITY ASSURANCE

A. Manuals for equipment and systems shall be prepared by equipment manufacturer or system Supplier.

1.4 OPERATION AND MAINTENANCE MANUAL-GENERAL

A. Prepare data in the form and format of an instructional manual for use by OWNER'S personnel and on electronic media: Adobe PDF or Microsoft Word, for Windows most current version.

B. Manual Format:

1. Size: 8-1/2 inches by 11 inches.
2. Paper: 20-pound minimum, white for typed pages.
3. Text: Manufacturer's printed data, or neatly typewritten.
4. Drawings:
    a. Provide reinforced punched binder tab, bind in with text.
    b. Reduced to 8-1/2 inches by 11 inches, or 11 inches by 17 inches folded to 8-1/2 inches by 11 inches.
    c. Where reduction is impractical, fold and place in 8-1/2-inch by 11-inch envelopes bound in text.
    d. Suitably identify Specification section and product on Drawings and envelopes.
5. Three-hole punch data for binding and composition; arrange printing so that punched holes do not obliterate data.

6. Provide fly-leaf for each separate product, or each piece of operating equipment, with typed description of product and major component parts of equipment and provide with heavy section dividers with numbered plastic index tabs.
7. Provide each manual with title page, and typed table of contents with consecutive page numbers. Place contents of entire set, identified by volume number, in each binder.
8. Cover: Identify each volume with typed or printed title "OPERATION AND MAINTENANCE MANUAL, VOLUME NO.", if applicable, and list:
   a. Project title.
   b. Designate the system or equipment for which it is intended.
   c. Identity of separate structure as applicable.
   d. Identity of general subject matter covered in manual.
9. Assemble and bind material in same order as specified, as much as possible.
10. Prepare material in manuals suitable for reproduction, copy clarity, and quality equal to original. Photocopying of material will be acceptable, except for material containing photographs.

C. Binders:

1. Preliminary Manuals: Electronic version only (MS Word or Adobe PDF)
2. Final Manuals: Electronic (MS Word or Adobe PDF) and commercial quality, substantial, permanent, three-ring binders with durable, cleanable, plastic binders.

D. Table of contents neatly typewritten, arranged in a systematic order:

1. CONTRACTOR, name of responsible principal, address, and telephone number.
2. List of each product required to be included, indexed to content of each volume.
3. List with Each Product: Name, address, and telephone number of Subcontractor, Supplier, installer, and maintenance Contractor, as appropriate.
   a. Identify area of responsibility of each.
   b. Provide local source of supply for parts and replacement.
4. Identify each product by product name and other identifying numbers or symbols as set forth in Contract Documents.

E. Product Data:

1. Include only those sheets that are pertinent to specific product.
2. Clearly annotate each sheet to:

    - a. Identify specific product or part installed.
    - b. Identify data applicable to installation.
    - c. Delete references to inapplicable information.

F. Drawings: Supplement product data with drawings as necessary to clearly illustrate:

  1. Relations of component parts of equipment and systems.
  2. Control and flow diagrams.
  3. Coordinate drawings with Project record documents to assure correct illustration of completed installation.
  4. Do not use Project record documents as maintenance manual drawings.

G. Instructions and Procedures: Within text, as required to supplement product data.

  1. Handling, storage, maintenance during storage, assembly, erection, installation, adjusting, testing, operating, shutdown in emergency, troubleshooting, maintenance, interface, and as may otherwise be required.
  2. Organize in a consistent format under separate heading for each different procedure.
  3. Provide a logical sequence of instructions for each procedure.
  4. Provide information sheet for OWNER'S personnel, including:
     - a. Proper procedures in the event of failure.
     - b. Instances that might affect the validity of warranties or Bonds.

H. Warranties, Bonds, and Service Agreements: In accordance with Section CONTRACT CLOSEOUT.

1.5 MANUALS FOR EQUIPMENT AND SYSTEMS

A. Provide an operation and maintenance manual for each item of equipment or system specified in the individual Specification sections in the quantity listed in Article MANUAL SUBMISSION REQUIREMENTS hereinafter.

B. Assemble operation and maintenance manuals into one set for entire Project prior to final Application for Payment.

C. Content for each unit (or common units) and system, as appropriate, complete including controls, accessories, and appurtenances.

  1. Description of Unit and Component Parts:
     - a. Function, normal operating characteristics, and limiting conditions.
     - b. Performance curves, engineering data, nameplate data, and tests.

    c. Complete nomenclature and commercial number of replaceable parts.
2. Operating Procedures:
    a. Startup, break-in, routine, and normal operating instructions.
    b. Test procedures and results of factory tests where required.
    c. Regulation, control, stopping, and emergency instructions.
    d. Shutdown instructions for both short and extended durations.
    e. Summer and winter operating instructions, as applicable.
    f. Safety precautions.
    g. Special operating instructions.
    h. Installation instructions.
3. Maintenance and Overhaul Procedures:
    a. Routine operations.
    b. Guide to troubleshooting.
    c. Disassembly, removal, repair, reinstallation, and reassembly.
4. Installation Instructions: Including alignment, adjusting, calibrating, and checking.
5. Original manufacturer's parts list, illustrations, detailed assembly drawings showing each part with part numbers and sequentially numbered parts list, and diagrams required for maintenance.
    a. Preventive maintenance and overhaul instructions.
    b. Predicted life of parts subject to wear.
    c. Items recommended to be stocked as spare parts and ordering instructions.
    d. Identify installed spares and other provisions for future work (e.g. reserved panel space, unused components, wiring, terminals).
6. Grease/Oil Points: Instructions and diagrams.
7. Manufacturer's printed operating and maintenance instructions.
8. Description of operation sequence by control manufacturer.
9. List of electrical relay settings, and control and alarm contact settings.
10. Electrical interconnection wiring diagram, including control and lighting systems.
11. As-installed control diagrams by control manufacturer.
12. Results of field functional and performance tests as required.
13. CONTRACTOR'S coordination drawings and as-installed, color-coded piping diagrams.
14. Charts of valve tag numbers, with the location and function of each valve.
15. Original equipment manufacturer's (OEM) recommended spare parts list, including commercial part numbers, manufacturer's current prices, and recommended quantities to be maintained in storage.
16. Other data as required under individual Specification sections.

D. Content for each electric or electronic item or system, as appropriate:

1. Description of Unit and Component Parts:
    a. Function, normal operating characteristics, and limiting conditions.
    b. Performance curves, engineering data, nameplate data, and tests.
    c. Complete nomenclature and commercial number of replaceable parts.
    d. Interconnection wiring diagrams, including all control and lighting systems.
2. Circuit Directories of Panelboards:
    a. Electrical service.
    b. Controls.
    c. Communications.
3. As-installed, color-coded, wiring diagrams.
4. Operating Procedures:
    a. Routine and normal operating instructions.
    b. Sequences required.
    c. Safety precautions.
    d. Special operating instructions.
5. Maintenance Procedures:
    a. Routine operations.
    b. Guide to troubleshooting.
    c. Adjustment and checking.
    d. List of relay settings, control and alarm contact settings.
6. Manufacturer's printed operating and maintenance instructions.
7. List of original manufacturer's spare parts, manufacturer's current prices, and recommended quantities to be maintained in storage.
8. Other data as required under pertinent sections of the Specifications.

E. Prepare and include additional data when the need for such data becomes apparent during instruction of OWNER'S personnel.

F. Additional Requirements for Operating and Maintenance Data: See individual Specification sections.

1.6 MANUALS FOR MATERIALS AND FINISHES

A. Provide an operation and maintenance manual for materials and finishes as specified in the individual Specification sections in quantity listed in Article MANUAL SUBMISSION REQUIREMENTS hereinafter.

B. Content for Architectural Products, Applied Materials, and Finishes:

1. Manufacturer's data, giving full information on products:
    a. Catalog number, size, and composition.

        - b. Color and texture designations.
        - c. Information required for reordering special-manufactured products.
    - 2. Instruction for Care and Maintenance:
        - a. Manufacturer's recommendation for types of cleaning agents and methods.
        - b. Cautions against cleaning agents and methods that are detrimental to product.
        - c. Recommended schedule for cleaning and maintenance.

C. Content for Moisture Protection and Weather Exposed Products:

- 1. Manufacturer's data, giving full information on products:
    - a. Applicable standards.
    - b. Chemical composition.
    - c. Details of installation.
- 2. Instructions for inspections, maintenance, and repair.

D. Additional Requirements for Maintenance Data: As provided in individual Specification sections.

1.7 MANUAL SUBMISSION REQUIREMENTS

A. Manuals for Equipment and Systems:

- 1. Preliminary Manuals: Deliver two (2) preliminary copies prior to the shipment date for equipment, system, subsystem, or component. Include copy of warranties, Bonds, and service agreements if specified. No partial payments will be made for equipment or systems on hand or installed until preliminary manuals have been submitted.
    - a. OWNER’S REPRESENTATIVE will review and determine adequacy of content, organization, quality, and fulfilment of requirements of the Contract Documents.
    - b. Disposition: In accordance with Section SUBMITTALS.
    - c. If Acceptable:
        - 1) One copy will be returned to CONTRACTOR.
        - 2) One copy sent to Resident Project Representative.
        - 3) One copy will be retained in OWNER’S REPRESENTATIVE’S file.
        - 4) One copy will be retained in OWNER'S file.
    - d. If unacceptable:
        - 1) Two copies will be returned to CONTRACTOR with OWNER’S REPRESENTATIVE’S comments for revision.
        - 2) One copy will be retained in OWNER’S REPRESENTATIVE'S file.

        3) Resubmit three revised preliminary copies for OWNER’S REPRESENTATIVE’S review.

2. Final Manuals: Submit five (5) final copies not less than 30 days prior to equipment or system field testing or startup or at the 75 percent completion date. Failure to submit final manuals at the project 75 percent completion date will result in a stop of progress payments until manuals are submitted.
    a. If final manuals differ from accepted preliminary manuals, submit copies of any necessary supplemental material, with instructions for insertion, for conforming OWNER’S REPRESENTATIVE'S and Resident Project Representative's copies of preliminary manuals to final manuals.
    b. OWNER’S REPRESENTATIVE will compare final manuals with accepted preliminary manuals.
    c. If identical, or otherwise acceptable, CONTRACTOR will be so notified.
    d. If rejected, all final copies will be returned to CONTRACTOR for revision; or all copies will be retained by OWNER’S REPRESENTATIVE and the necessary revision data will be requested from CONTRACTOR, at OWNER’S REPRESENTATIVE’S option.
    e. Submit copies, with instructions for insertion and for revising final manuals of:
        1) Field functional and performance test results, if required, signed by manufacturer's authorized representative.
        2) Final Maintenance Summary Forms as accepted by OWNER’S REPRESENTATIVE.
        3) Any revisions found desirable during instruction of OWNER’S personnel.
        4) Revised table of contents, as applicable.

B. Manuals for Materials and Finishes:

1. Submit three preliminary copies at least 15 days prior to request for final inspection.
    a. Disposition: In accordance with Section SUBMITTALS.
    b. OWNER’S REPRESENTATIVE will review.
        1) One copy will be returned to CONTRACTOR with comments.
        2) One copy will be transmitted to Resident Project Representative.
        3) One copy will be retained for OWNER’S REPRESENTATIVE’S file.
    c. No final inspection will be conducted until preliminary manuals have been submitted.

2. Submit five final copies, revised in accordance with OWNER’S REPRESENTATIVE’S comments, within 10 days after final inspection.
    a. OWNER’S REPRESENTATIVE will compare final copies with preliminary copies and OWNER’S REPRESENTATIVE’S comments thereto.
    b. If acceptable, CONTRACTOR will be so notified.
        1) One copy will be transmitted to OWNER.
        2) Five copies will be held for later transmittal to OWNER.
    c. If rejected, all six copies will be returned to CONTRACTOR for revision; or all copies will be retained by OWNER’S REPRESENTATIVE and the necessary revision data will be requested from CONTRACTOR, at OWNER’S REPRESENTATIVE’S option.

1.8 MAINTENANCE SUMMARY

A. Fill out and complete in the order and format of the Maintenance Summary Form bound at the end of this section and described below.

1. Each Maintenance Summary may take as many pages as required.
2. Use only 8-1/2-inch by 11-inch size paper.
3. Handwritten summaries are not acceptable.

B. Compile an individual Maintenance Summary for each equipment item, respective unit or system, and for components or subunits.

1. Include detailed lubrication instructions and diagrams showing points to be greased or oiled; recommend type, grade, and temperature range of lubricants and frequency of lubrication.
2. All spare parts data to be consistent with manufacturer's Bill of Materials/Parts List furnished in O&M manuals. "Unit" is the unit of measure for ordering the part, e.g., each, lot of 3, box of 100, etc. The term "Quantity" is the number of units recommended. The term "Unit Cost" is the purchase price of a unit at the time the Equipment Data Form is completed.

C. Preliminary Summaries: Submit six copies with, but as a separate submission from, respective operation and maintenance manual.

1. OWNER’S REPRESENTATIVE will review:
    a. One copy will be returned to CONTRACTOR with comments.
    b. One copy will be transmitted to Resident Project Representative.
    c. Four copies will be retained for OWNER’S REPRESENTATIVE’S and OWNER’S file.

    d. No partial payments will be made for equipment or systems on hand or installed until preliminary Maintenance Summaries have been submitted to OWNER’S REPRESENTATIVE.

  2. The manufacturer's standard form will not be an acceptable substitute.

D. Final Summaries: Submit eight final copies not less than 30 days prior to equipment or system field testing or startup with instructions for insertion into the respective final operations and maintenance manual.

1.9 SUPPLEMENTS

A. Supplement listed below follows "END OF SECTION" and is part of this Specification.

  1. Maintenance Summary Form.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION (NOT USED)

END OF SECTION

MAINTENANCE SUMMARY FORM

PROJECT:________________________________ CONTRACT NO._________________

1. EQUIPMENT ITEM____

2. MANUFACTURER____

3. EQUIPMENT/TAG NUMBER(S)____________________________________

4. WEIGHT OF INDIVIDUAL COMPONENTS (OVER 100 POUNDS)__________

5. NAMEPLATE DATA (hp, voltage, speed, etc.)__________________________

6. MANUFACTURER'S LOCAL REPRESENTATIVE

   a. Name___________________________________Telephone No.____________

   b. Address____

7. MAINTENANCE REQUIREMENTS

Maintenance Operation Comments	**Lubricant Frequency**	**(If Applicable)**
List briefly each maintenance operation required and refer to specific information in manufacturer's standard maintenance manual, if applicable. (Reference to manufacturer's catalogue or sales literature is not acceptable.)	List required frequency of each maintenance operation.	Refer by symbol to lubricant list required.

8. LUBRICANT TEST

Reference Symbol	**Shell**	**Standard Oil**	**Gulf**	**Arco**	**Or Equal**
List symbols used in No. 7 above.	List equivalent lubricants, as distributed by each manufacturer for the specific use recommended.				

9. RECOMMENDED SPARE PARTS FOR OWNER'S INVENTORY

Part No.	**Description**	**Unit**	**Quantity**	**Unit Cost**
Indicate non shelf items with an asterisk. Identify parts provided by this contract with two asterisks.				

SECTION 01600
MATERIAL AND EQUIPMENT

PART 1 GENERAL

1.1 PRODUCTS

A. Products include material, equipment, and packaged systems.

B. All products shall comply with the CONTRACTOR’s Engineer’s shop drawings and specifications, project specifications, Vendor recommendations, referenced standards and all applicable regulatory requirements.

C. Like items of equipment and distinct materials provided shall be from one manufacturer in order to achieve standardization of appearance, maintenance and replacement.

D. Unless otherwise indicated, provide materials and equipment which are the standard products of manufacturers regularly engaged in the production of such materials and equipment. Provide the MANUFACTURER's latest standard design that conforms to these Specifications.

E. Provide materials and equipment with the MANUFACTURER's standard finish, unless otherwise required.

F. All materials and equipment shall be new, non-surplus and suitable for the intended use.

G. Any non-domestic materials and equipment must be clearly identified and listed.

H. Do not use materials and equipment removed from existing structures, except as specifically required, or allowed, by Contract Documents.

1.2 TRANSPORTATION AND HANDLING

A. Transport products by methods to avoid product damage; deliver in undamaged condition in MANUFACTURER's unopened containers or packaging, in a dry and clean condition.

B. Handle materials as recommended by the MANUFACTURER, with approved equipment in a manner that will prevent damage.

C. Promptly inspect shipments received to assure that products comply with requirements, quantities are correct, and products are undamaged. Notify the OWNER’S REPRESENTATIVE of any discrepancies or damage noted.

1.3 STORAGE AND PROTECTION

A. Store products in accordance with the MANUFACTURER's instructions, with seals and labels intact and legible.

B. Store sensitive products in weathertight enclosures. Maintain within temperature and humidity ranges required by the MANUFACTURER.

C. For exterior storage of fabricated products, place on sloped supports above ground.

D. Cover products subject to deterioration with impervious sheet covering. Provide ventilation to avoid condensation.

E. Store loose granular materials on solid surfaces in a well- drained area; prevent mixing with foreign matter.

F. Arrange storage to provide access for inspection and inventory. Periodically inspect to assure that products are undamaged and are maintained under required conditions.

1.4 PRODUCT OPTIONS

A. Products specified by reference standards or by description only: Any product meeting those standards and all applicable requirements of the Contract Documents.

B. Products specified by naming one or more manufacturers as acceptable but not listing as "Sole Source" may be considered for substitution. Submit a written request in accordance with the requirements of Article 1.5 below for the substitution of an alternate manufacturer.

C. Products specified by naming one or more manufacturers and stating "Sole Source" will not be considered for substitution except during the bid period. If such a case does develop, submit a written request in accordance with the requirements of Article 1.5 below for the substitution of an alternate manufacturer.

1.5 SUBSTITUTIONS

A. Each request shall be submitted in writing to OWNER’S REPRESENTATIVE with complete data substantiating compliance of proposed substitution with Contract Documents.

B. Request constitutes a representation that CONTRACTOR:

1. Has investigated proposed product and determined that it meets or exceeds in all respects the specified product.
2. Will provide the same warranty for substitution as for specified product.
3. Will coordinate installation and make other changes which may be required for work to be complete in all respects.
4. Waives claims for additional costs which may subsequently become apparent.

C. Each request must clearly state why the substitution is being requested and what benefit will be received by the project by the acceptance of the substitution.

D. OWNER'S REPRESENTATIVE will determine acceptability of proposed substitution and will notify CONTRACTOR of acceptance or rejection in writing within 15 working days of receipt of the written request.

E. The use of alternate materials will not be allowed under any condition without the prior written approval of OWNER'S REPRESENTATIVE.

END OF SECTION

SECTION 01610
INSTALLATION OF OWNER FURNISHED EQUIPMENT

PART 1 GENERAL

1.1 WORK INCLUDED

A. This Section covers the work necessary to coordinate delivery, receive, unload, inspect, protect, store, install, pre-operationally test, and commission the Owner-furnished equipment. Specifications and Drawings for owner-furnished items will be provided to the successful bidder.

B. The OWNER is purchasing some equipment early, to allow for long delivery items to be received on the job in accordance with the schedule requirements. The OWNER will make all payments directly to the suppliers of the prepurchased equipment. However, the Owner will require approval and acceptance by the CONTRACTOR, prior to making progress payments for the equipment.

1.2 RELATED WORK

A. Section 15010 - Basic Mechanical Requirements.

B. Related electrical sections contained in the project specifications.

1.3 MAINTENANCE SERVICE

A. Equipment shall be maintained in a new and operational condition. Provide maintenance service on the equipment listed herein for the period after installation until final acceptance by the Owner.

1.4 OWNER-FURNISHED EQUIPMENT SCHEDULE

A. The equipment to be installed is listed in the Owner- Furnished Equipment Schedule at the end of this Section.

B. Equipment delivery schedule information will be made available to the CONTRACTOR as soon as these dates have been established by the OWNER’S REPRESENTATIVE. Such information will include approximate shipping weights of separate components, method of shipment, destination point, date of shipment, approximate date of delivery, and methods for handling, storage, and protection as specified in the equipment specifications.

1.5 SHOP DRAWINGS FURNISHED BY THE OWNER

A. Final shop drawings, including installation instructions from the equipment supplier, will be made available for the CONTRACTOR’S use in performing the work under this section. The CONTRACTOR shall coordinate with the equipment supplier for scheduling the suppliers' work.

1.6 FIELD SERVICES FURNISHED BY THE MANUFACTURER

A. The manufacturer of the equipment has contracted to provide field service and instruction manuals as specified in the equipment specifications appended at the end of this Section. Any additional information and services that the CONTRACTOR needs to provide a complete and operable system as specified by the Contract Documents shall be arranged through the OWNER’S REPRESENTATIVE.

1.7 RESPONSIBILITY FOR COMPLETE SYSTEM

A. The CONTRACTOR shall have complete responsibility for receiving, storing, handling, installing, leveling and aligning, adjusting, lubricating, maintaining, testing, and operational startup of Owner-furnished equipment under this Section. The CONTRACTOR shall coordinate the construction of interconnecting structures, equipment, piping, electrical and instrumentation work, and appurtenances to effect installation and operation of the Owner-furnished equipment.

B. Electrical hook-up shall be by the CONTRACTOR.

1.8 INSURANCE

A. The CONTRACTOR shall include in his insurance coverage for the work under this Contract sufficient coverage to protect the Owner-furnished equipment and material items against all losses during unloading, storage, handling, and installation and until final acceptance of the work by the OWNER’S REPRESENTATIVE.

PART 2 PRODUCTS

2.1 GENERAL

A. Except where specifically specified as "Owner-furnished", all materials required to complete the work under this Section shall be provided by the CONTRACTOR. Such materials to be provided by the CONTRACTOR include, but are not limited to: concrete piers, base wells, inserts, anchor bolts, connecting piping and valves, hangers and supports, motor starters and wiring, piping accessories, specialties, finish painting, and expendable materials, all as necessary to provide a complete and properly functioning system.

B. All materials provided by the CONTRACTOR are subject to review by the OWNER’S REPRESENTATIVE prior to their installation into the work. The CONTRACTOR shall submit a complete list of all materials he proposes to furnish, and include such complete submittal data to the OWNER’S REPRESENTATIVE for review.

PART 3 EXECUTION

3.1 GENERAL

A. All work shall be in conformance with the manufacturer's recommended procedures, instructions, and shop drawings, as accepted by the OWNER. The CONTRACTOR shall receive, unload, inspect, and maintain an inventory on all Owner-furnished equipment and materials.

3.2 INSPECTION

A. Upon transferral of the Owner-furnished equipment to the CONTRACTOR, the CONTRACTOR and the OWNER’S REPRESENTATIVE shall make a joint inspection of the condition of each item and shall record in writing the items transferred to the CONTRACTOR's care and any defects in said equipment. Damage to or loss of equipment and materials after the transfer to the CONTRACTOR shall be repaired to original condition, or replaced with new equipment and materials, at the CONTRACTOR's sole expense.

3.3 STORAGE AND PROTECTION

A. Following delivery of Owner-furnished items, and until final acceptance of the completed work, the CONTRACTOR shall protect and maintain the items in a condition that will prevent damage in accordance with the manufacturer's instructions. The CONTRACTOR shall replace items that become corroded, damaged, or deteriorated prior to installation and acceptance of the work.

3.4 PREPARATION

A. All items will have been cleaned for their applicable service and protected for shipment. The CONTRACTOR shall maintain cleanliness throughout erection. Any component which has been contaminated shall be called to the attention of the OWNER and recleaned by the CONTRACTOR under the OWNER's direction.

3.5 SAFETY CONSIDERATIONS

A. All mechanical equipment shall be installed with approved WISHA and OSHA safety guards and suitable access clearances for maintenance or removal of replaceable parts and components, and with necessary couplings or flanges to perform the maintenance or removal without removing the connecting appurtenances.

3.6 INSTALLATION

A. The CONTRACTOR shall provide all supervision, labor, tools, construction equipment, incidental materials, and necessary services required to install and test the Owner-furnished equipment and materials.

3.7 SUPPLIER VERIFICATION

A. All owner supplied equipment start-up is subject to verification of proper installation by the equipment supplier as outlined in Section 01610. The CONTRACTOR is responsible for coordinating with the supplier for this inspection.

3.8 FIELD TESTING

A. Startup Preparation: The CONTRACTOR shall prepare all Owner-furnished equipment for startup, including cleanup, lubrication, motor phasing, motor test running, and equipment tolerance adjusting. Furnish all incidental materials required for this preparation.

B. Functional Test: Following installation, a functional (or run) test on all Owner-furnished equipment shall be performed by the CONTRACTOR in the presence of the OWNER.

3.9 PERFORMANCE TEST

A. Prior to plant startup, all equipment shall be performance tested under actual or simulated operating conditions and as specified in the applicable equipment specifications. Such testing shall be performed by the CONTRACTOR and scheduled in cooperation with the OWNER and the manufacturer's representative.

3.10 CLEANING, STARTUP, AND ADJUSTING

A. The CONTRACTOR shall be responsible for proper operation of all systems, minor subsystems, and services provided under this Section. He shall coordinate start-up procedures, calibration, and system check-out with all subcontractors involved. Any system operational problems shall be diagnosed; all correctional procedures shall be initiated with the various subcontractors as required to bring the system into compliance with the design, and the problem then shall be rechecked to verify that the system operates normally. Any remaining difficulties shall be reported to the OWNER.

B. Thoroughly clean all parts of the installation at the completion of the work. The CONTRACTOR shall clean up and remove from the premises all refuse material, crates, and rubbish arising from his work. Insert quantities and equipment items below. Include any separate components to be furnished by the equipment manufacturer.

END OF SECTION

Table 01610-1
LIST OF OWNER SUPPLIED EQUIPMENT

Owner Tag Number	Quantity	Service	Equipment Detail	Estimated Approximate Cost Value	Vendor	Date of Delivery (preliminary)
TH-130	1	Inclined plate clarifier	LGS 200/55 – integral floc tank and rapid mix tank	$95,000	Parkson	Sept 16, 2011
FP-240	1	Plate and frame filter press	Semi-automatic	$100,000	TBD	Sept 28, 2011
TK-110	1	Oxidation tank	FRP, vertical, cylindrical	$20,000	TBD	Sept 9, 2011
TK-120	1	Co-precipitation tank	FRP, vertical, cylindrical	$20,000	TBD	Sept 9, 2011
TK-220	1	Sludge tank	FRP, vertical, cylindrical	$25,000	TBD	Sept 9, 2011
TK-320	1	Lime slurry tank	FRP, vertical, cylindrical	$25,000	TBD	Sept 9, 2011
TK-420	1	pH adjust tank	FRP, vertical, cylindrical	$20,000	TBD	Sept 9, 2011
TK-310	1	$KMnO_4$ tank	FRP, vertical, cylindrical	$15,000	TBD	Sept 9, 2011
	1	KMnO4 drum handling and conveying system	Automated drum dumper, hopper, screw conveyor	$40,000	TBD	Oct 13, 2011

SECTION 01640
MANUFACTURERS' SERVICES

PART 1 GENERAL

1.1 DEFINITIONS

A. Person-Day: One person for 8 hours within regular CONTRACTOR working hours.

1.2 SUBMITTALS

A. Quality Control Submittals: When specified in the individual Specifications, submit:

1. Manufacturer's Certificate of Proper Installation: On form appended to this section.

1.3 QUALIFICATION OF MANUFACTURER'S REPRESENTATIVE

A. Authorized representative of the manufacturer, factory trained, and experienced in the technical applications, installation, operation, and maintenance of respective equipment, subsystem, or system. Representative subject to acceptance by OWNER and OWNER’S REPRESENTATIVE. No substitute representatives will be allowed unless prior written approval by OWNER has been given.

1.4 FULFILMENT OF SPECIFIED MINIMUM SERVICES

A. Where manufacturer’s services are specified, furnish manufacturer's representative qualified to provide these services. Where time is necessary in excess of that stated in the Specifications for manufacturers' services, additional time required to perform the specified services shall be considered incidental work and shall be at the CONTRACTOR's expense.

B. Schedule manufacturer's on-site services to avoid conflicting with other on-site testing or other manufacturer's on-site services.

1. Determine that all conditions necessary to allow successful testing have been met before scheduling services.

C. Manufacturer's non-training services shall include as a minimum:

1. Assistance during installation to include observation, guidance, instruction of CONTRACTOR's assembly, erection, installation or application procedures.

2. Inspection, checking, and adjustment as required for equipment to function as warranted by manufacturer and necessary to provide written approval of installation.
3. Revisiting the site as required to correct problems and until installation and operation are acceptable to OWNER’S REPRESENTATIVE.
4. Resolution of assembly or installation problems attributable to, or associated with, respective manufacturer's products and systems.
5. Assistance during functional and performance testing and startup demonstration, and until product acceptance by the OWNER.
6. Completion of Manufacturer's Certificate of Proper Installation (form enclosed at end of this section) with applicable certificates for proper installation and initial, interim, and final test or service.

1.5 SUPPLEMENTS

A. Supplement listed below follows "END OF SECTION" and is part of this Specification.

1. Manufacturer's Certificate of Proper Installation Form.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION (NOT USED)

END OF SECTION

MANUFACTURER'S CERTIFICATE OF PROPER INSTALLATION

OWNER ______________________________________ EQPT SERIAL NO.:_____________________________

EQPT TAG NO.: ________________________________ EQPT/SYSTEM:_________________________________

PROJECT NO.:_________________________________ SPEC. SECTION:_______________________________

I hereby certify that the above-referenced equipment/system has been:

(Check Applicable)

- ☐ Installed in accordance with Manufacturer's recommendations.
- ☐ Inspected, checked, and adjusted.
- ☐ Serviced with proper initial lubricants.
- ☐ Electrical and mechanical connections meet quality and safety standards.
- ☐ All applicable safety equipment has been properly installed.
- ☐ System has been performance tested, and meets or exceeds specified performance requirements. (When complete system of one manufacturer.)
- ☐ Full compliance with all code requirements.

Comments:____

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I, the undersigned Manufacturer's Representative, hereby certify that I am (i) a duly authorized representative of the manufacturer, (ii) empowered by the manufacturer to inspect, approve, and operate his equipment and (iii) authorized to make recommendations required to assure that the equipment furnished by the manufacturer is complete and operational, except as may be otherwise indicated herein. I further certify that all information contained herein is true and accurate.

Date:________________________, 20_____

Manufacturer:____

By Manufacturer's Authorized Representative:____

(Authorized Signature)

SECTION 01650
FACILITY START-UP

PART 1 GENERAL

1.1 DEFINITIONS

A. Reference Section 01640, MANUFACTURERS' SERVICES.

B. Facility Start-up: Includes putting Project in operating order, cleaning, adjusting and balancing equipment, initial operation (start-up) of equipment item, operating equipment, starting systems, operation of systems, testing of equipment and systems, and demonstration and verification of the completed facility as a unit.

C. Functional Test: A test or tests in the presence of the OWNER’S REPRESENTATIVE to demonstrate that the installed equipment or system meets MANUFACTURER's installation and adjustment requirements and other requirements specified including, but not limited to, noise vibration, alignment, speed, proper electrical and mechanical connections, thrust restraint, proper rotation, and initial servicing.

D. Operation Period: The operation period begins when the facility has been successfully started up as defined under Paragraph Start-up Test Period and has met all completion requirements.

E. Performance Test: A test performed in the presence of the OWNER’S REPRESENTATIVE and after any required functional test specified, to demonstrate and confirm that the equipment and/or system meets the specified performance requirements.

F. Facility Start-up Test Period:

1. Start-up of the entire facility or any portion thereof includes coordinated operation of the facilities by the CONTRACTOR, Subcontractors, OWNER operating personnel, and MANUFACTURER's representatives for equipment items and systems after all required functional tests have been completed and those performance tests deemed necessary for the safe operation of the entire facility have been completed.
2. Start-up of the entire facility or any portion thereof shall be considered complete when, in the opinion of the OWNER and OWNER’S REPRESENTATIVE, the facility or designated portion has operated in the manner intended and has met facility start-up performance objectives specified hereafter for 7 continuous days without interruption.

G. System: The overall process, or a portion thereof, that performs a specific function. A system may consist of two or more subsystems as well as two or more types of equipment.

1.2 SUBMITTALS

A. Administrative Submittals:

1. Start-up, functional and performance test schedules and plan for equipment, units, and systems at least 14 days prior to start of related testing. Include test plan, procedures, and log format.
2. Schedule and plan of facility start-up activities at least 21 days prior to commencement.

B. Quality Control Submittals:

1. MANUFACTURER's Certificate of Proper Installation as required.
2. Test Reports: Functional and performance testing, in format acceptable to OWNER and certification of functional and performance test for each piece of equipment or system specified.
3. Operation and maintenance data as specified in Section, OPERATION AND MAINTENANCE DATA.
4. Certifications of Calibration: Testing and measurement equipment.

1.3 CONTRACTOR FACILITY START-UP RESPONSIBILITIES

A. General:

1. Prepare full and complete start-up plan and functional testing program for each subsystem and system.
2. Perform Work for tests specified.
3. Demonstrate proper installation, adjustment, function, performance, and operation of equipment, systems, control devices, and required interfaces individually and in conjunction with process instrumentation and control system.
4. Provide water, power, chemicals, and other items as required for testing, unless otherwise indicated.

1.4 OWNER/OWNER’S REPRESENTATIVE FACILITY START-UP RESPONSIBILITIES

A. General:

1. Review CONTRACTOR's test plan and schedule.
2. Witness each functional or performance test.

B. Start-up Test Period:

1. Operate process units and devices, with support of CONTRACTOR.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION

3.1 GENERAL

A. The Facility Start-up will consist of, but not be limited to, the following steps:

1. Testing Preparation.
2. Functional Testing.
3. Facility Clean Water Testing.
4. Facility Dirty Water Testing.
5. Continuous Operations.

3.2 TESTING PREPARATION

A. General:

1. Complete Work associated with the unit and related processes before testing, including related MANUFACTURER's representative services.
2. Provide related operating and maintenance manuals, and spare parts and special tools as specified before testing any unit or system.
3. Furnish qualified MANUFACTURER's representatives when required to assist in testing.
4. Utilize the MANUFACTURER's Certificate of Proper Installation Form from Section, MANUFACTURERS' SERVICES, supplemented as necessary, to document functional and performance procedures, results, problems, and conclusions.
5. Schedule and attend pretest meetings related to test schedule, plan of test, materials, chemicals, and liquids required, facilities' operations interface, OWNER’S REPRESENTATIVE and OWNER involvement.
6. Designate and provide one or more persons to be responsible for coordinating and expediting CONTRACTOR's facility start-up duties. The person or persons shall be present during facility start-up meetings and shall be available at all times during the facility start-up period.
7. Provide temporary valves, gauges, piping, test equipment and other materials and equipment required to conduct testing.

B. Cleaning and Checking: Prior to starting functional testing:

1. Calibrate testing equipment for accurate results.

2. Inspect and clean equipment, devices, connected piping, and structures so they are free of foreign material.
3. Lubricate equipment in accordance with MANUFACTURER's instructions.
4. Turn rotating equipment by hand and check motor-driven equipment for correct rotation.
5. Open and close valves by hand and operate other devices to check for binding, interference, or improper functioning.
6. Check power supply to electric-powered equipment for correct voltage.
7. Adjust clearances and torques.
8. Test piping for leaks.
9. Balance HVAC systems, measuring airflow (cfm) static pressure, and component pressure losses. Provide typed report documenting results of balancing to OWNER’S REPRESENTATIVE.
10. Obtain completion of applicable portions of MANUFACTURER's Certificate of Proper Installation in accordance with Section MANUFACTURERS' SERVICES.

C. Ready-to-test determination will be by OWNER’S REPRESENTATIVE based at least on the following:

1. Notification by CONTRACTOR of equipment and system readiness for testing.
2. Acceptable testing plan.
3. Acceptable operation and maintenance manuals incorporating review comments.
4. Receipt of MANUFACTURER's Certificate of Proper Installation, if specified.
5. Adequate completion of Work adjacent to, or interfacing with, equipment to be tested.
6. Availability and acceptability of MANUFACTURER's representative, when specified, to assist in testing of respective equipment.
7. Equipment and electrical tagging complete.
8. All spare parts and special tools delivered to OWNER.

3.3 FUNCTIONAL TESTING

A. General:

1. Begin testing at a time mutually agreed upon by the OWNER, OWNER’S REPRESENTATIVE, MANUFACTURER'S representative(s), and CONTRACTOR.
2. Notify in writing OWNER, OWNER’S REPRESENTATIVE, and MANUFACTURER's representative at least 10 days prior to scheduled date of functional tests.

3. Separate items of equipment demonstrated to function properly during subsystem testing may require no further functional test if documentation of subsystem testing is acceptable to OWNER.
4. Conduct functional test until each individual component item or system has achieved one continuous hour of satisfactory operation. Demonstrate all operational features and controls function during this period while in automatic modes.
5. If, in OWNER’s opinion, each system meets the functional requirements specified, such system will be accepted as conforming for purposes of advancing to performance testing phase, if required. If, in OWNER’s opinion, functional test results do not meet requirements specified, the systems will be considered as non-conforming.
6. Performance testing shall not commence until the equipment or system meets functional tests specified.

3.4 FACILITY CLEAN WATER START-UP TEST PERIOD

A. Test Reports: As applicable to the equipment furnished, certify in writing that:

1. Necessary hydraulic structures, piping systems, and valves have been successfully tested.
2. Equipment systems and subsystems have been checked for proper installation, started, and successfully tested to indicate that they are operational.
3. Systems and subsystems are capable of performing their intended functions.
4. Facilities are ready for intended operation.

B. Attend planning meetings and arrange for attendants by key major equipment MANUFACTURER representatives as required by the Contract Documents.

C. Designate and provide one or more persons, other than the field superintendent, to be responsible for coordinating and expediting CONTRACTOR's facility start-up duties.

D. When facility start-up has commenced, schedule remaining Work so as not to interfere with or delay the completion of facility start-up. Support the facility start-up activities with adequate staff to prevent delays and process upsets. This staff shall include, but not be limited to, major equipment and system MANUFACTURER’S representatives, Subcontractors, electricians, instrumentation personnel, millwrights, pipefitters and plumbers.

E. Supply and coordinate specified MANUFACTURER's facility start-up services.

F. Make adjustments, repairs, and corrections necessary to complete facility start-up.

G. After the facility is operating, complete the testing of those items of equipment, systems, and subsystems which could not be or were not adequately or successfully tested, calibrated, or adjusted prior to start-up test periods.

3.5 FACILITY DIRTY WATER START-UP TEST PERIOD

A. Test Reports: As applicable to the equipment furnished, certify in writing that:

1. Necessary hydraulic structures, piping systems, and valves have been successfully tested.
2. Equipment systems and subsystems have been checked for proper installation, started, and successfully tested to indicate that they are operational.
3. Systems and subsystems are capable of performing their intended functions.
4. Facilities are ready for intended operation.

B. Attend planning meetings and arrange for attendants by key major equipment MANUFACTURER representatives as required by the Contract Documents.

C. Designate and provide one or more persons, other than the field superintendent, to be responsible for coordinating and expediting CONTRACTOR's facility start-up duties.

D. When facility start-up has commenced, schedule remaining Work so as not to interfere with or delay the completion of facility start-up. Support the facility start-up activities with adequate staff to prevent delays and process upsets. This staff shall include, but not be limited to, major equipment and system MANUFACTURER’S representatives, Subcontractors, electricians, instrumentation personnel, millwrights, pipefitters and plumbers.

E. Supply and coordinate specified MANUFACTURER's facility start-up services.

F. Make adjustments, repairs, and corrections necessary to complete facility start-up.

G. After the facility is operating, complete the testing of those items of equipment, systems, and subsystems which could not be or were not adequately or successfully tested, calibrated, or adjusted prior to start-up test periods.

3.6 CONTINUOUS OPERATIONS

A. OWNER may accept equipment and systems as complete and ready for continuous operation only after successful facility start-up is completed and documented, and reports submitted, and MANUFACTURER’S services completed for training of OWNER's personnel.

END OF SECTION

SECTION 01700
CONTRACT CLOSEOUT

PART 1 GENERAL

1.1 CONTRACT CLOSEOUT SUBMITTALS

A. Reference: In accordance with paragraph the provisions of the Construction Contract between OWNER and CONTRACTOR and as may be otherwise required in the Contract Documents.

B. Record Documents: The CONTRACTOR shall be responsible for maintaining a record of all materials, equipment, location and dimensions of the work. These items shall be recorded on a set of drawings. The record drawings shall be provided to the OWNER once per month to review progress and verify record of work. On the completion of the job the CONTRACTOR shall submit the final and complete record drawings to the OWNER.

C. Operations and Maintenance Manuals: In accordance with Section 01430 OPERATION AND MAINTENANCE DATA, and as required in the individual Specification sections.

D. Certificates of Testing and Inspection: As required in individual specification sections, General Conditions and contract documents.

E. Certificate of Completion.

F. Special Warranties, and Service Agreements:

1. Form of Submittals:
    a. Bind in commercial quality, 8-1/2 × 11 three-ring side binders with hardback, cleanable, plastic covers.
    b. Label cover of each binder with typed or printed title WARRANTIES, with title of Project; name, address, and telephone number of CONTRACTOR and equipment Supplier; and name of responsible principal.
    c. Table of Contents: Neatly typed, in the sequence of the Table of Contents of the Project Manual, with each item identified with the number and title of the Specification section in which specified, and the name of the product or Work item.
    d. Separate each warranty with index tab sheets keyed to the Table of Contents listing. Provide full information, using separate typed sheets as necessary. List Subcontractor, Supplier, and manufacturer, with name, address, and telephone number of responsible principal.
2. Preparation for Submission:

a. Obtain notarized warranties, executed in duplicate by responsible Subcontractors, Suppliers, and manufacturers, within 10 days after completion of the applicable item or Work. Except for items put into use with OWNER's permission, leave date of beginning of time of warranty until the date of completion is determined.
b. Retain warranties and service agreements until time specified for submission.

3. Time of Submission:
   a. For equipment or component parts of equipment put into service during construction to be utilized by OWNER, submit documents within 10 days after the date of completion for that part of the Work.
   b. Submit other Submittals within 10 days after the date of completion and prior to submission of final Application for Payment.
   c. For item of Work when acceptance is delayed beyond date of completion, submit within 10 days after OWNER’s written acceptance, listing the date of acceptance as the beginning of the warranty period.

G. Certificates or Evidence of Insurance: As required in the Construction Contract between OWNER and CONTRACTOR and other Contract Documents.

H. Written Releases from Agreements with Others:

1. Before final payment will be authorized, CONTRACTOR shall furnish the OWNER written releases from property OWNERS or public agencies, if applicable, where side agreements or special easements have been made, or where CONTRACTOR'S operations have not been kept within the OWNER'S construction right-of-way.

I. Spare parts and special tools.

J. Other Required Submittals: In accordance with the Contract Documents.

1.2 FINAL APPLICATION FOR PAYMENT

A. Submit the final Application for Payment in accordance with procedures and requirements stated in the Construction Contract between OWNER and CONTRACTOR and as may otherwise be specified herein.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION

3.1 FINAL CLEANING

A. At completion of Work or of a part thereof and immediately prior to CONTRACTOR's request for certificate of completion; or if no certificate is issued, immediately prior to CONTRACTOR's notice of completion, clean entire site or parts thereof, as applicable.

1. Leave the Work and adjacent areas affected in a cleaned condition satisfactory to OWNER.
2. Remove grease, dirt, dust, paint or plaster splatter, stains, labels, fingerprints, and other foreign materials from exposed surfaces.
3. Repair, patch, and touch up marred surfaces to specified finish and match adjacent surfaces.
4. Clean all windows.
5. Clean and wax wood, vinyl, or painted floors.
6. Broom clean exterior paved driveways and parking areas.
7. Hose clean sidewalks, loading areas, and others contiguous with principal structures.
8. Rake clean all other surfaces.
9. Remove snow and ice from access to buildings.
10. Replace air-handling filters and clean ducts, blowers, and coils of ventilation units operated during construction.
11. Leave water courses, gutters, and ditches open and in condition satisfactory to OWNER.

END OF SECTION

DIVISION 2
SITEWORK

Section 02010 – Site Geotechnical Investigation
Section 02200 – Earthwork
Section 02218 – Landscape Grading
Section 02434 – Yard Piping
Section 02936 – Hydroseeding

SECTION 02010
SITE GEOTECHNICAL INVESTIGATION REPORT

PART 1 GENERAL

1.1 EXISTING REPORT

A. A geotechnical report was prepared by AMEC Geomatrix in the spring of 2011, which can be provided upon request.

B. Reliance on this report is at the sole discretion of the Design Build CONTRACTOR. The OWNER does not warrant the accuracy or applicability of the existing report. The OWNER shall not be liable for any damages resulting from the use of the existing report.

1.2 ADDITIONAL GEOTECHNICAL INVESTIGATION

A. Any additional geotechnical investigation required for the design of the work shall be conducted at the Design Build CONTRACTOR's full expense.

B. The Design Build CONTRACTOR shall be solely responsible for determining, evaluating, making appropriate design considerations and field confirmations as required for a fully complete system.

END OF SECTION

SECTION 02200
EARTHWORK

PART 1 GENERAL

1.1 WORK INCLUDED

A. This Section covers the work necessary for the earthwork, complete, including but not limited to:

1. Detailed design of all earthworks and related items.
2. Site clearing.
3. Rough and finish grading.
4. Trench excavation and backfill for underground piping and utilities.
5. Excavating for footings and foundations.
6. Installation of granular fill under concrete slabs on grade and related site structures.

1.2 CONSTRUCTION STANDARDS

A. All work pertaining to this Section shall be in conformance, except as modified herein, with the current edition of Washington’s State Department of Transportation Standard Specifications for Road, Bridge, and Municipal Construction, hereinafter referred to as the Standard Specifications.

1.3 DEFINITIONS

A. Relative Compaction: The ratio, in percent, of the as-compacted field dry density to the laboratory maximum dry density as determined by ASTM D1557. Corrections for oversize material may be applied to either the as-compacted field dry density or the maximum dry density, as determined by the Engineer.

B. Optimum Moisture Content: Shall be determined by the ASTM standard specified to determine the maximum dry density for relative compaction. Field moisture content shall be determined on the basis of the fraction passing the ¾ inch sieve.

C. Prepared Ground Surface: The ground surface after clearing, grubbing, stripping, excavation, and scarification and/or compaction.

D. Completed Course: A course or layer that is ready for the next layer or next phase of the work.

E. Well-Graded: A mixture of particle sizes that has no specific concentration or lack thereof of one or more sizes. Well-graded does not define any numerical value that must be placed on the coefficient of uniformity, coefficient of curvature, or other specific grain size distribution parameters. Well-graded is used to define a material type that, when compacted, produces a strong and relatively incompressible soil mass free from detrimental voids.

F. Truck Measure: Wherever the term "truck measure" is used, the truck volume shall be determined by leveling off selected loads in the truck box after the material has been transported from the site of loading to the site of placement. The Engineer may call for such measurement at any time. The CONTRACTOR shall cooperate with the Engineer in the measurement, and they shall together determine and agree upon the volume of material in the truck box.

G. Influence Area: The area within planes sloped downward and outward at an angle of 60 degrees from the horizontal from (a) one foot outside the outermost edge at the base of foundations or slabs; or (b) one foot outside the outermost edge at the surface of roadways or shoulder; or (c) one-half foot outside the exterior edge at the spring line of pipes and culverts.

H. Unclassified Excavation: Unclassified excavation shall mean that the nature of materials to be encountered has not been identified or described herein.

I. Borrow: Borrow material shall be material excavated on the site or taken from designated borrow areas on or near the site.

J. Selected Backfill Material: Materials available on-site that the Engineer determines to be suitable for a specific use.

K. Imported Material: Imported materials shall be materials obtained by the CONTRACTOR from sources off the site.

L. Structural Fill: The fill materials as required under structures, paving, etc.

M. Embankment: Embankment material shall be the fill materials required to raise the existing grade in areas other than under structures.

N. Standard Proctor Density: As defined in ASTM D698.

O. Pea Gravel: Size number 89, ASTM D448, naturally rounded aggregate.

1.4 SUBMITTALS

A. Submittals shall be provided in accordance with Section 01300, Submittals, and the requirements of this Section.

B. Detailed design drawings, signed by a professional engineer licensed in the State of Washington, shall be submitted for all earthworks, trenching, and excavations.

C. Provide the following submittals:

1. Certification, test results, source, and samples for all imported material.
2. Catalog and MANUFACTURER's data sheets for compaction equipment.
3. Certification and mill certificates for geotextile.
4. Catalog and MANUFACTURER's data sheets, and samples for identification tape.
5. Copies of permits obtained for excavation, blasting, etc., that are required by State and local governing authorities.
6. Certified results of in-place density and moisture content tests.

1.5 PROTECTION

A. Excavation Safety: All excavations and trenching work shall be performed in accordance with current OSHA regulations on excavations, trenching, and shoring. CONTRACTOR shall be solely responsible for making all excavations in a safe manner. Provide appropriate measures to retain excavation sideslopes and prevent rock falls to ensure that persons working in or near the excavation are protected.

B. Protect wetlands and agricultural ditches from equipment, vehicular traffic, earth worksand from any adverse impact during the course of the project.

C. Protect trees, shrubs, lawns, rock outcropping, and other features remaining as a portion of final landscaping.

D. Protect bench marks, existing structures, fences, utilities, and paving from equipment and vehicular traffic.

E. Protect above and below grade utilities which are to remain.

F. Protect existing landfill cap from any damage, if cap is damaged contractor shall repair it following manufacturer specifications.

G. Notify Engineer of unexpected subsurface conditions and discontinue affected work in area until notified to resume work.

H. Grade excavation top perimeter to prevent surface water run-off into excavation.

PART 2 PRODUCTS

2.1 GENERAL

A. Provide all labor, materials, and equipment necessary to accomplish the work specified in this Section.

2.2 MATERIALS

A. Unclassified Excavation: Excavation is unclassified. Complete all excavation regardless of the type, nature, or condition of the materials encountered. The CONTRACTOR shall make its own estimate of the kind and extent of the various materials to be excavated in order to accomplish the work.

B. Earthfill: Excavated material free from roots, organic matter, trash, debris, rocks larger than three inches, and other deleterious materials.

C. Granular Fill: One inch minus crushed gravel or crushed rock, free from dirt, clay balls, and organic material, well graded from coarse to fine (maximum particle size 1/4 inches), containing sufficient finer material for proper compaction, and less than 8 percent by weight passing the No. 200 sieve.

D. Sand: Natural sand or sand produced from crushed gravel or crushed rock, maximum size ¼ inch, 95 percent shall pass a No. 4 sieve, free from clay and organic material, with a maximum of eight percent passing the No. 200 sieve when tested in accordance with ASTM C117.

E. Native Site Material: Any material obtained from excavating or grading under Contract.

F. Controlled Density Fill: A blend of Portland Cement, fly ash, aggregate, and water.

G. Trench Excavation: Trench excavation is unclassified. Remove all material regardless of the nature, type, or condition of the material encountered.

H. Trench Stabilization Material: Three inch minus river-run or pit-run gravel, crushed gravel, or crushed rock; free from clay balls, roots, and organic matter; well-graded from coarse to fine, with less than 8 percent by weight passing the ¼ inch sieve. Submit a one cubic yard sample for Engineer's review prior to delivery of the material to the site.

I. Granular Pipe Base: Three-fourth inch minus gravel, crushed gravel, or crushed rock. For plastic pipe, copper tubing and heating pipes use ¼ inch minus granular material or ¼ inch to 1/8 inch pea gravel.

J. Selected Backfill Material for Pipe Zone: Excavated material, free from stones, roots, and organic material, of suitable gradation for satisfactory compaction. If excavated material at a particular location is not satisfactory, use suitable material from other portions of the trench excavation. The maximum size of particles shall be:

Pipe Material	Max. Size of Backfill Particles
Concrete	1 inch
Welded steel with bituminous coating and felt wrapping	1 inch
Cast iron 12 inch and smaller	1-1/2 inch
Galvanized steel	1 inch
Electric conduit	¼ inch
Plastic (PVC, CPVC, PE, PP, HDPE, and PB), copper and other flexible tubing	¼ inch

K. Imported Granular Backfill Material for Pipe Zone: For concrete, cast iron, steel, and galvanized iron pipe, use ¾ inch minus well-graded granular material. For plastic pipe, use ¼ inch minus well-graded granular material.

L. Detectable Marking Tape: Detectable marking tape shall be placed directly over buried non-metallic water lines and conduit. Marking tape shall be positioned 1 foot above the top of the pipe or conduit and along its entire length. Tape shall meet the requirements of WSDOT Standard Specifications Section 9-15.18.Backfill Above the Pipe Zone: For trenches within the influence area of existing or proposed structures, and roads, use specified Granular Fill above the pipe zone. For other areas use Earthfill as specified if specified compaction can be obtained. If specified compaction cannot be obtained, use specified Granular Fill.

M. Imported Topsoil: Sandy loam, from a source reviewed by the Engineer, which possesses friability and a high degree of fertility, free of clods, roots, gravel, inert material, and noxious vegetation or seed. Should regenerative material be present in the soil, remove all such growth, both surface and root, which may appear in the imported material within one year following acceptance of the work.

N. Topsoil: Selected topsoil at the site, properly stored and protected, free from roots, sticks, hard clay, and stones which will not pass through a 1 inch square opening. Remove existing grass and overburden before topsoil is excavated. Provide imported topsoil of equal quality if required to accomplish the work.

O. Water for Compaction: Water for compaction will be furnished by the CONTRACTOR as required.

P. Riprap: Hard and durable quarry stone with not more than 35 percent wear when tested for resistance to abrasion in conformance to ASTM C535. Bulk density shall be not less than 160 pounds per dry cubic foot. Size of riprap shall be as shown.

2.3 EQUIPMENT

A. Compaction Equipment: Compaction equipment shall be of suitable type and adequate to obtain the densities specified, and shall provide satisfactory breakdown of materials to form a dense fill. Compaction equipment shall be operated in strict accordance with the MANUFACTURER's instructions and recommendations. Equipment shall be maintained in such condition that it will deliver the MANUFACTURER's rated compactive effort. If inadequate densities are obtained, larger and/or different types of additional equipment shall be provided by the CONTRACTOR. Hand-operated equipment shall be capable of achieving the specified densities.

B. Moisture Control Equipment: Equipment for applying water shall be of a type and quality adequate for the work, shall not leak, and shall be equipped with a distributor bar or other approved device to assure uniform application. Equipment for mixing and drying out material shall consist of blades, discs, or other approved equipment.

C. Other Materials and Equipment: All other materials and equipment, not specifically described but required for a complete and proper installation, shall be selected by the CONTRACTOR subject to review by the OWNER’S REPRESENTATIVE prior to use.

2.4 GEOTEXTILE

A. Geotextile shall be a pervious sheet of polyester, polyethylene, Nylon, or polypropylene filaments, woven or nonwoven, and formed into a uniform pattern. The geotextile shall have the following minimum properties when measured in accordance with the referenced standard:

Grab tensile strength, ASTM D1682 130 lbs
Trapezoidal tear, ASTM D2263 70 lbs

Mullen Burst, ASTM D751 120 psi

B. The geotextile shall be finished so that the filaments will retain their relative position with respect to each other. The edges of woven fabric shall be finished to prevent the outer material from pulling away from the fabric.

C. Provide MANUFACTURER's certificate of compliance attesting that the geotextile meets the requirements of these Specifications. Provide mill certificates stating the length and width of fabric contained on each roll.

2.5 LANDFILL CAP

The existing Landfill cap consists in three layers of the following material

A. Geosynthetic clay liner (GCL) shall be Claymax 200R or approved equivalent.

B. Geomembrane shall be 40 mil PVC and glue bonded per manufacturer’s recommendation.

C. Geonet shall be GSE Hypernet HF or approved equivalent, with a bonded layer of geotextile facing up.

PART 3 EXECUTION

3.1 INSPECTION

A. Imported Material Acceptance: All imported materials specified in this Section are subject to the following requirements:

1. All tests necessary for the CONTRACTOR to locate an acceptable source for each imported material shall be made by the CONTRACTOR. Certification that the material conforms to the Specification requirements along with copies of the test results from a qualified commercial testing laboratory shall be submitted to the OWNER’S REPRESENTATIVE for review at least 15 days before the material is required for use. All material samples shall be furnished by the CONTRACTOR at the CONTRACTOR's sole expense. Samples shall be representative and be clearly marked to show the source of the material and the intended use on the project. Sampling of the material source shall be done by the CONTRACTOR in accordance with ASTM D75. Notify the OWNER’S REPRESENTATIVE at least 24 hours prior to sampling. The OWNER’S REPRESENTATIVE may, at the OWNER’S REPRESENTATIVE’S option, observe the sampling procedures.

2. Tentative acceptance of the material source shall be based on observation of the source by the OWNER’S REPRESENTATIVE and/or the certified test results submitted by the CONTRACTOR to the OWNER’S REPRESENTATIVE, at the OWNER’S REPRESENTATIVE’S discretion.
3. No imported materials shall be delivered to the site until the proposed source and materials tests have been tentatively accepted in writing by the OWNER’S REPRESENTATIVE.
4. Final acceptance will be based on tests made on samples of material taken from the completed and compacted course. The completed course is defined as a course or layer that is ready for the next layer or the next phase of construction.
5. All testing for final acceptance shall be performed by the OWNER’S REPRESENTATIVE.
6. Gradation tests by the CONTRACTOR shall be made on samples taken at the place of production prior to shipment. Samples of the finished product for gradation testing shall be taken from each 1,500 tons of prepared materials or more often as determined by the OWNER’S REPRESENTATIVE, if variation in gradation is occurring, or if the material appears to depart from the Specifications. Test results shall be forwarded to the OWNER’S REPRESENTATIVE within 48 hours after sampling.
7. If tests conducted by the CONTRACTOR or the OWNER’S REPRESENTATIVE indicate that the material does not meet Specification requirements, material placement will be terminated until corrective measures are taken.
8. Material which does not conform to the Specification requirements and is placed in the work shall be removed and replaced with the specified material at the CONTRACTOR's sole expense.
9. Sampling and testing performed by the CONTRACTOR shall be done at the CONTRACTOR's sole expense.

3.2 PREPARATIONS

A. Clearing and Grubbing: Clear the site within the areas required for access and execution of work. Remove the existing trees, brush, stumps, and waste material on the site. Grub out stumps and roots. Prevent damage to surrounding wetlands, agricultural ditches, infiltrations ponds, and adjacent trees which are to remain. Dispose of waste off-site in accordance with all federal, State, and local laws relating to such disposal. After completion of clearing and grubbing, get Engineer's acceptance before commencing stripping.

B. Stripping: Prior to beginning any excavation or fill, strip the topsoil to a depth sufficient to remove all organic material and stockpile for future use.

In general, topsoil shall be removed where structures are to be built, trenches dug, and roads, parking lots, walks and similar improvements constructed within the areas presently covered with topsoil. Topsoil shall be stored clear of the construction area. Take reasonable care to prevent the topsoil from becoming mixed with subsoil.

3.3 INSTALLATION/APPLICATION/ERECTION

A. General Excavation: Perform all excavation of every description, regardless of the type, nature, or condition of material encountered, as specified, shown, or required to accomplish the construction.

B. Shoring, Sheeting, Bracing, and Sloping: Install and maintain shoring, sheeting, bracing, and sloping necessary to support the sides of the excavation, to keep and to prevent any movement which may damage adjacent pavements, utilities, or structures, damage or delay the work, or endanger life and health. Install and maintain shoring, sheeting, bracing, and sloping as required by OSHA and other applicable governmental regulations and agencies.

C. Excavation for Road, Parking Area, and Building Pad: Work by others.

D. Excavation in Landfill Area: Remove topsoil as specified hereinbefore in paragraph “Stripping”. Excavate carefully to the lines and grades shown. Design-Build Contractor will determine the final depth of the excavation inside the landfill to avoid damaging the Landfill cap. The method of excavation used is optional; however, no equipment shall be operated within 1 foot of the existing Landfill cap. Excavation that cannot be accomplished without endangering the existing layers of the landfill cap shall be performed with hand tools

E. Structural Excavation:

1. Excavation is unclassified. Excavate for structures to the lines and grades shown or as required to accomplish the construction. Perform all excavation regardless of the type, nature, or condition of the material encountered.
2. The method of excavation used is optional; however, no equipment shall be operated within 5 feet of existing structures or newly completed construction without prior review by the CONTRACTOR’s Engineer. Excavation that cannot be accomplished without endangering the present or new structures shall be done with hand tools.

F. Limits of Excavation:

1. Excavate to the depths and widths, as shown. Allow for forms, working space, granular base, and finish topsoil as shown or required. Do not carry excavation for footings and slabs deeper than the elevation shown.
2. Excavation carried below the grade lines shown or established by the Engineer shall be replaced with the same fill material as specified for the overlying fill or backfill, and compacted as required for such overlying fill or backfill. Where the overlying area is not to receive fill or backfill, replace the over excavated material and compact to a density not less than that of the underlying ground. Excavations under footings shall be filled with concrete of strength equal to that of the footing. Cuts below grade shall be corrected by similarly cutting adjoining areas and creating a smooth transition.
3. Correction of all over excavated areas shall be at the CONTRACTOR's sole expense.

G. Removal of Water:

1. Provide and operate equipment adequate to keep all excavations and trenches free of water. Remove all water during periods when concrete is being deposited, when pipe is being laid, during the placing of backfill, and at such other times as required for efficient and safe execution of the work.
2. Avoid settlement or damage to adjacent property. Discharge the water into a dedicated water container capable of storing the contaminated water until the treatment plant is able to treat it. When dewatering open excavations, dewater from outside the structural limits and from a point below the bottom of the excavation when possible. Design, install, and operate dewatering systems to prevent removal of fines from existing ground.

H. Foundation Preparation:

1. After completion of excavation, and prior to foundation or fill construction, proof-roll the excavation surface with a loaded dump truck or similar heavy-wheeled vehicle to detect soft or loose zones. Notify the OWNER’S REPRESENTATIVE prior to commencement of proof-rolling.
2. If soft or loose zones are found under foundations or structures, excavate the soft or loose material to a depth reviewed in advance by the OWNER’S REPRESENTATIVE, then fill with granular backfill under facilities, compacted as specified for such fill. If soft or loose zones are found under fills or roads, excavate the soft or loose material to a depth reviewed in advance by the OWNER’S REPRESENTATIVE, then fill and compact as specified for the overlying fills or roads.

3. Additional excavation and replacement filling beyond that stated in the Basis of Bid Documents, but found to be required during site work, will, when approved in advance by the OWNER, be paid for by the OWNER at the rate established by the CONTRACTOR for additional work in the CONTRACTOR's bid.

I. Preparations for Placing Backfill:

1. Backfill around concrete structures only after the concrete has attained the specified compressive strength indicated in Section 03310, Concrete. Remove all form materials and trash from the excavation before placing any backfill. Obtain the OWNER'S REPRESENTATIVE'S written acceptance of concrete work and attained strength prior to backfilling.
2. Do not operate earth-moving equipment within five feet of walls of concrete structures for the purpose of depositing or compacting backfill material without prior review by the CONTRACTOR's Engineer. Compact backfill adjacent to concrete walls with hand-operated tampers or similar equipment that will not damage the structure.
3. Backfill water-holding basins only after satisfactory leakage tests have been conducted as specified in Section 03310, Concrete.

J. Imported Granular Fill Under Facilities:

1. Place hereinbefore specified imported granular fill in previously excavated areas under piping, slabs, walks, curbs, structures, facilities, and other areas as shown. Do not exceed loose lifts of less than 12 inches. Compact each lift to not less than 95 percent relative compaction. Stop imported granular fill 6 inches below finished grade in all areas where topsoil is to be replaced. Moisten material as required to aid compaction. Place material in horizontal lifts and in a manner which avoids segregation.
2. Any subsequent damage to slabs, piping, concrete structures, facilities, or other structures caused by settlement of fill material shall be corrected and repaired by the CONTRACTOR at the CONTRACTOR's sole expense.

K. Granular Backfill Around Structures: Place hereinbefore specified Granular Fill in lifts not greater than 12 inches thick prior to compaction, and compact each lift to not less than 95 percent relative compaction.

L. Earthfill Under Facilities and Around Structures: Place hereinbefore specified Earthfill in areas under facilities and around structures where granular fill is not designated. Deposit material from the excavation in horizontal lifts of maximum 12 inch uncompacted depth and compact each lift to not less than 98 percent relative compaction. Maintain material at optimum moisture content, plus or minus two percentage points. Place backfill material free of roots, organic matter, trash, and rocks larger than 4 inch diameter. Stop backfill at specified grade. Make allowance for topsoil where required. Consolidation by flooring or jetting will not be permitted.

M. Fills Not Under Structures or Facilities: Place hereinbefore specified Earthfill to the lines and grades shown. Place fill material in lifts not greater than 12 inches thick prior to compaction, and compact each lift to not less than 95 percent relative compaction. Make proper allowance for topsoil where required.

N. Construction of Embankments:

1. Use selected materials from the excavation and borrow of type specified hereinbefore in paragraph Earthfill. Construct embankment to lines and cross sections shown. Deposit fill material in lifts not exceeding 12 inch depth prior to compaction across full width of embankment. Compact each lift to not less than 95 percent relative compaction.
2. Compact full width of the embankment. If pipelines are to be laid in embankment, construct embankment to an elevation 2 feet above the top of proposed pipeline prior to trench excavation for pipeline. Moisten fill material as necessary to produce specified compaction. If material is too wet for proper compaction, aerate by blading, discing, or other methods. Dress completed embankment to elevations and slopes shown. Make proper allowance for topsoil where required.

O. Compaction: Compact all materials by mechanical means. Flooding or jetting will not be permitted. If compaction tests indicate that compaction or moisture content is not as specified, material placement shall be terminated and corrective action shall be taken by the CONTRACTOR prior to continued placement.

P. Protection of Work: Use all means necessary to prevent erosion of freshly graded areas during construction and until such time as permanent drainage and erosion measures have been installed.

Q. Moisture Control:

1. During all compacting operations, maintain optimum practicable moisture content required for compaction purposes in each lift of fill. Maintain moisture content uniform throughout the lift. Insofar as practicable, add water to the material at the site of excavation. Supplement, if required, by sprinkling the fill. At the time of compaction, the water content of the material shall be at optimum moisture content, plus or minus two percentage points.

2. Do not attempt to compact fill material that contains excessive moisture. Aerate material by blading, discing, harrowing, or other methods, to hasten the drying process.

R. Trench Excavation and Backfill:

1. Excavation: Excavate for the installation of piping, utilities, and appurtenances. All obstructions, such as tree roots, stumps, abandoned concrete structures, and other material of any type shall be removed.
2. Trench Width: Minimum width of unsheeted trenches or the minimum clear width of sheeted trenches in which pipe is to be laid shall be 18 inches greater than the outside diameter of the pipe. Sheeting requirements shall be independent of trench width. The maximum clear width at the top of the pipe or above the pipe will not be limited, except in cases where excess width of excavation would cause damage to adjacent structures.
3. Grade: Carry the bottom of the trench to the line and grade shown, or as established by the CONTRACTOR’s Engineer. Allow for pipe thickness and for pipe base or special bedding when specified. Backfill any part of the trench excavated below grade with pipe base material and compact to not less than 90 percent relative compaction.
4. Shoring, Sheeting, and Bracing of Trenches: Erect, maintain, and remove shoring, sheeting, and bracing as required by all federal, state and local laws, codes, and ordinances.
5. Removal of Water: Removal of water shall be accomplished as specified hereinbefore.
6. Trench Stabilization: If, in the opinion of the CONTRACTOR’s Engineer or OWNER’S REPRESENTATIVE, the material in the bottom of the trench is unsuitable for supporting the pipe, excavate to remove the unsuitable material, and backfill to the required grade with Trench Stabilization Material as specified, compacted to not less than 90 percent relative compaction..
7. Pipe Base: Place a minimum 4 inch thickness of granular pipe base of the type hereinbefore specified. Place for the full width of the trench with the top of the granular base at flow line grade. Bed the pipe in the granular base so that the flow line is at the required grade and elevation. Place and finish the gravel base to grade ahead of the pipe laying operation. No granular pipe base will be required for cast iron pipe.
8. Pipe Zone Backfill:
    a. Backfill the pipe zone to 6 inches above the outside of the pipe for the full width of the trench with backfill material as specified hereinbefore. Place in the trench in horizontal lifts not exceeding 6 inches in uncompacted thickness on both sides of the pipe. Thoroughly tamp and supplement by "walking in" the material. Use particular attention in placing material on the underside of the

pipe to provide a solid backing and to prevent lateral movement during the final backfilling procedure.

b. Backfill at the pipe zone for plastic pipe must receive particular attention and care to prevent damage to the pipe. After placing material as specified herein to a point of 12 inches above the top outside surface of the barrel of the pipe, the material so placed will be compacted by at least three passes of a vibratory compactor over the area generally above the sides of the pipe. Impact compactors will not be used for compaction of backfill at the pipe zone. Impact compactors will not be used until 3 feet of cover has been placed over the top of the pipe.

9. Trench Backfill Above the Pipe Zone:

a. In trenches under all structures, sidewalks, roads, parking areas, piping, and similar facilities, except where specifically shown, deposit backfill material in horizontal lifts not exceeding 6 inches in uncompacted thickness. Compact to not less than 95 percent relative compaction. Repair any subsequent damage caused by settlement of trenches at the CONTRACTORS's sole expense.

b. In other areas the excavated trench material may be used for backfill. Push by mechanical means, first onto the slope of the backfill previously placed and allow to roll down into the trench. Do not allow free fall of the material into the open trench. Under no circumstances allow sharp, heavy pieces of material to drop directly onto the pipe or the material in the pipe zone. Backfill material shall not exceed one half cubic foot in size and shall be intermixed with finer material to produce completed fill that is free from detrimental voids and segregation. Neatly windrow the material over the trench to provide for future settlement. Any excess or deficiency of backfill material after settlement within the guarantee period shall be corrected by regrading and adding or removing material.

c. In other areas the excavated trench material may be used for backfill. Compact the backfill in suitable lifts with mechanical vibratory or impact tampers. Determine the type of compaction equipment, method to use, and amount of compaction required to prevent subsequent settlement. Remove all boulders and stones 2 inches in diameter and larger from material used for backfill in the upper 12 inches of backfilled trenches. In areas where topsoil conditions exist, replace topsoil in the top 12 inches of the trench. Compact and rake to match the ground surface adjacent to the trench. Maintain the surface of the backfilled trench level with the existing grade until the entire project is accepted by the OWNER. Any subsequent settlement of the finished surface during the guarantee period shall be considered to be a result of improper or insufficient compaction and shall be promptly repaired by the CONTRACTOR at no cost to the OWNER.

d. Identification Tape: Place identification tape 3 feet above the top of the pipe or culvert or 1 foot below finished grade, whichever is lower. Place identification tape over the center of the pipe or culvert.

S. Placing Topsoil: After rough grading is completed and reviewed by the OWNER'S REPRESENTATIVE, spread topsoil hereinbefore specified, over area shown to a minimum compacted depth of 6 inches with surface elevations as shown. Loosen the finished surface to a depth of 2 inches and leave in smooth condition, free from depressions or humps, ready for seeding.

T. Foundation Preparation for Riprap: The lines and grades for earth surfaces on which riprap is to be placed are shown. Trim surfaces above grade to the neat line. Fill areas below grade by increasing the thickness of the riprap. Place no material until foundation has been reviewed by the OWNER'S REPRESENTATIVE.

U. Placing Riprap: Depth of riprap shall be as shown. Intermix the sizes of riprap material to provide uniform gradation between small and large material. Prevent damage to pipe or other facilities. Repair damage to the pipe or coating at the CONTRACTOR'S sole expense.

V. Site Grading: Perform all earthwork to the lines and grades as shown and/or established by the Engineer, with proper allowance for topsoil where specified or shown. Shape, trim, and finish slopes of channels to conform with the lines, grades, and cross sections shown. Make slopes free of all exposed roots and stones exceeding 3 inch diameter which are loose and liable to fall. Round tops of banks to circular curves, in general, not less than a 6 foot radius. Rounded surfaces shall be neatly and smoothly trimmed. Neatly blend all new grading into surrounding, existing terrain. Over excavating and backfilling to the proper grade will not be acceptable. Finished site grading will be reviewed by the Engineer.

3.4 GEOTEXTILE PLACEMENT

A. Geotextile shall be placed as specified below and on Drawings:

1. Prevent exposure of geotextile to light until needed for construction. Geotextile laying and subsequent covering with succeeding courses (granular fill, for example) shall proceed in such a manner as to limit exposure to light to a maximum period of 48 hours.
2. The surface to receive the geotextile shall be smooth, free from obstructions, depressions, and sharp objects. Notify the OWNER'S

REPRESENTATIVE and the CONTRACTOR's Engineer prior to placing geotextile so that the OWNER'S REPRESENTATIVE and the CONTRACTOR's Engineer may observe the surface to receive the geotextile. Lay geotextile so as to minimize the number of joints and seams. Lay geotextile loosely, but without creases. Provide at least 2 foot overlap at joints.

3. Do not operate machinery directly on the geotextile. When placing material over joints, place in the direction from the overlying geotextile to the underlying geotextile. Prevent puncture, tear, or displacement of geotextile and protect from damage. Replace torn areas and holes by placing an overlay of geotextile having dimensions at least 2 feet greater than the tear or hole.

3.5 LANDFILL CAP RESTORATION

A. Any necessary landfill cap restoration or installation will be completed as specified here and in the Drawings:

1. Salvage and protect Geonet, PVC geomembrane and geosynthetic clay liner (GCK) over the mixing pad to the extent possible for reuse.
2. Where landfill cap restoration is necessary, restore cap in layers from bottom up to match the existing cap. Use manufacturer approved equipment and techniques to install all geosynthetic material.
3. Repairs to the GCL shall be made with dry GCL with 1 foot minimum overlap shingled toward the toe of the landfill.
4. Geomembrane overlaps shall be a minimum of 2 feet and be shingled toward the toe of the landfill. Test 100% of the bonds/welds in accordance with the manufacturer's recommendation. PVC Geomembrane shall be installed in a relaxed condition, free from stress, tension and wrinkles.
5. Any new Geonet shall be installed with a minimum overlap of 1 foot shingled toward the toe of the landfill.
6. The surface to receive any of the geosynthetic material shall be smooth, free from obstructions, depressions, and sharp objects. Notify the OWNER'S REPRESENTATIVE and the CONTRACTOR's Engineer prior to placing geosynthetic material so that the OWNER'S REPRESENTATIVE and the CONTRACTOR's Engineer may observe the surface.

3.6 TOLERANCES

A. All material limits shall be constructed within a tolerance of 0.1 foot except where dimensions or grades are shown or specified as minimum. All grading shall be performed to maintain slopes and drainage as shown. No reverse slopes will be permitted.

3.7 FIELD QUALITY CONTROL

A. The CONTRACTOR and the DESIGN BUILD CONTRACTOR’S Civil/Geotechnical Engineer shall inspect the site to ensure the workmanship is in accordance with the applicable codes and standards. As a minimum, the DESIGN BUILD CONTRACTOR’S Civil/Geotechnical Engineer shall provide weekly site visits for inspection during periods of earthworks, and monthly site visits for inspections thereafter.

B. Field Density and Moisture Tests: The Inspector will determine in-place density and moisture content by any one or combination of the following methods: ASTM D2922, D1556, D2216, D3017, or other methods selected by the Engineer. Cooperate with this testing work by leveling small test areas designated by the Inspector. Backfill test areas at CONTRACTOR's sole expense. The frequency and location of testing shall be determined solely by the Engineer.

3.8 ADJUSTING AND CLEANING

A. On-site Disposal of Excess Excavation: Dispose of all excess excavation, not required or suitable for backfill or filling, in the designated waste area. Uniformly grade waste area to conform to existing contours, leave with a neat appearance, and in free-draining condition.

B. Off-site Disposal of Excess Excavation: Dispose of all excess excavated materials, not required for backfill or fills, outside of the area of work. Make arrangements for the disposal of the excavated material and bear all costs or retain any profit incidental to such disposal.

END OF SECTION

SECTION 02218
LANDSCAPE GRADING

PART 1 GENERAL

1.1 WORK INCLUDED

A. Finish grade subsoil.

B. Place and level topsoil and soil amendments.

1.2 RELATED WORK

A. Section 02936 - Hydroseeding.

B. Section 02950 - Trees, Plants, and Ground Cover: Topsoil fill for trees, plants, and ground cover.

1.3 REFERENCES

A. AASHTO T88 - Particle Size Analysis of Soils.

B. ASTM C33 - Concrete Aggregates.

1.4 DEFINITIONS

A. Weeds: Includes Dandelion, Jimsonweed, Quackgrass, Horsetail, Morning Glory, Rush Grass, Mustard, Lambsquarter, Chickweed, Cress, Crabgrass, Canadian Thistle, Nutgrass, Poison Oak, Blackberry, Tansy Ragwort, Bermuda Grass, Johnson Grass, Poison Ivy, Nut Swedge, Nimble Will, Bindweed, Bent Grass, Wild Garlic, Perrenial Sorrel, and Brome Grass.

1.5 SAMPLES

A. Furnish the following samples in the quantities indicated:

1. Topsoil - 1-5 gallon bucket.
2. Organic Soil Amendment - 1-5 gallon bucket.
3. Textural Soil Amendment - 1-5 gallon bucket.

B. Have mechanical analysis of topsoil performed by a soils testing lab or engineer to determine conformance to specified physical properties in accordance with AASHTO T88 - Mechanical Analysis of Soils.

C. Submit 10 lb, 4.5 kg sample of imported fill to testing laboratory, in sealed containers. Submit one copy of the soils report to OWNER’S REPRESENTATIVE.

D. Disregard sample submission if recent test results are available for type of fill.

1.6 PROTECTION

A. Protect landscaping and other features remaining as final work.

B. Protect existing structures, fences, roads, sidewalks, paving, and curbs.

PART 2 PRODUCTS

2.1 MATERIALS

A. Topsoil: Imported, friable loam; free of subsoil clay, other foreign matter larger than 2-inch diameter, roots, grass, excessive amount of weeds, stone, and foreign matter; acidity range (pH) of 5.5 to 7.5; containing a minimum of 4 percent and a maximum of 25 percent organic matter.

B. Organic Soil Amendment: Barkdust; fine grind; fir, pine, or hemlock; minus 3/4-inch to plus 0-inch size.

C. Textural Soil Amendment: Sand; clean coarse ungraded, meeting the requirements of ASTM C33 for fine aggregate.

PART 3 EXECUTION

3.1 INSPECTION

A. Review site conditions, all finish grades, underground utilities and structures with the General Contractor before commencing work. CONTRACTOR must examine the subgrade, verify elevations, observe the conditions under which the work is to be performed, and notify the OWNER of unsatisfactory conditions.

B. Beginning work of this section means acceptance of existing conditions.

3.2 SUBSOIL PREPARATION

A. Eliminate uneven areas and low spots. Remove debris, roots, branches, stones, in excess of ½ inch in size. Remove subsoil contaminated with petroleum products.

B. Scarify subgrade to depth of 3 inches where topsoil is scheduled. Scarify in areas where equipment used for hauling and spreading topsoil has compacted subsoil.

3.3 PLACING TOPSOIL

A. Place topsoil in areas where seeding and planting are scheduled. Subgrade shall be substantially weed free at the time topsoil is spread.

B. Use topsoil in relatively dry state. Place during dry weather.

C. Spread topsoil and soil amendments over the prepared site grade in the following sequence:

1. Topsoil - 2 inches.
2. Organic Soil Amendment - 2 inches.
3. Textural Soil Amendment - 2 inches.

Thoroughly mix layers with rototiller or other means.

D. Fine grade topsoil eliminating rough or low areas. Maintain levels, profiles, and contours of subgrade.

E. Remove stone, roots, grass, weeds, debris, and foreign material while spreading.

F. Manually spread topsoil around trees, plants, building, and, sidewalk to prevent damage.

G. Lightly compact placed topsoil.

H. Remove surplus subsoil and topsoil from site.

I. Leave stockpile area and site clean and raked, ready to receive landscaping.

3.4 TOLERANCES

A. Top of Topsoil: Plus or minus 1/2 inch.

3.5 SCHEDULE OF LOCATIONS

A. The following paragraphs identify compacted topsoil mixture thicknesses for various locations.

B. Seeded Grass: 6 inches.

C. Shrub Beds: 6 inches.

D. Ground Cover Beds: 6 inches.

END OF SECTION

SECTION 02434
YARD PIPING

PART 1 GENERAL

1.1 WORK INCLUDED

A. This Section covers the work to design, supply and install the yard and internal piping required for this project as shown on the Drawings and includes, in general:

1. The design, supply and installation of all pipe support systems (concrete and SS), piping (HDPE, PVC and SS), pipe fittings (HDPE, PVC and SS) and appurtenances, including yard piping between all process structures, and clean outs.
2. Pressure testing and flushing of all piping.

1.2 RELATED WORK SPECIFIED IN OTHER SECTIONS

A. The following related areas are included for reference only. The Design/Build CONTRACTOR is responsible for all works described, shown, and referenced in the Contract Documents.

1. Section 02200 Earthwork
2. Section 15060 Pipe and Pipe Fittings – General
3. Section 15080 High Density Polyethylene Pipe

1.3 PERMITS, INSPECTIONS AND FEES

A. Obtain all permits required for installation of work immediately after notification of award of Contract. Arrange for inspections and tests and pay all costs for permits, test, inspections and fees.

B. Obtain copies of Drawings from OWNER or OWNER’S REPRESENTATIVE for submission with application for permits.

1.4 CODES, REGULATIONS AND STANDARDS

A. Work shall comply with the most recent version of the Uniform Plumbing Code (UPC) and all state, regional and/or municipal codes, regulations and standards. The most stringent requirements shall govern.

B. Codes, regulations, and standards referred to hereinafter are by inference, in each case, the latest issue, including all revisions and amendments thereto as adopted and published at date of invitation to tender.

PART 2 PRODUCTS

2.1 GENERAL

A. The material to be used for the yard piping systems shown on the Drawings is HDPE SDR11 except where specified otherwise.

2.2 PIPING MATERIALS

A. Yard piping materials shall be as specified as shown on the applicable Drawings.

PART 3 EXECUTION

3.1 GENERAL

A. Execution specifications for yard piping works including preparation, handling, installation, thrust blocking, and testing shall be specified in applicable sections of Section 02200 Earthwork, Section 15060 Pipe and Pipe Fittings – General, Section 15080 High Density Polyethylene Pipe and shown on Drawings.

B. All pipe to be installed according to the manufacturer’s instructions and the UPC.

END OF SECTION

SECTION 02936
HYDROSEEDING

PART 1 GENERAL

1.1 WORK INCLUDED

A. Hydroseeding.

B. Mulching.

C. Maintenance.

1.2 RELATED WORK

A. This Section shall be used in conjunction with the following other specifications and related Contract Documents to establish the total requirements for seeding.

1. Instructions to Bidders.
2. Division 1 sections included in the project specifications.
3. The Contract.
4. Contract Drawings.
5. Section 02218 - Landscape Grading: Preparation of subsoil and placement of topsoil in preparation for the work of this Section.

1.3 WARRANTY

A. If, at the end of the maintenance period, a satisfactory stand of grass has not been produced, the CONTRACTOR shall renovate and reseed the grass or unsatisfactory portions thereof immediately, or, if directed by the Engineer, during the next planting season. If a satisfactory stand of grass develops after replanting of the following year, it will be accepted. If it is not accepted, a complete replanting will be required during the planting season meeting all of the requirements specified under EXECUTION.

B. A satisfactory stand is defined as grass or section of grass of 10,000 square feet or larger that has:

1. No bare spots larger than 1/3 square metre.
2. Not more than 10 percent of total area with bare spots larger than 1/10 square metre.
3. Not more than 15 percent of total area with bare spots larger than 6 inches square.

1.4 DEFINITIONS

A. Objectionable vegetation as defined by the Engineer or appropriate regulatory or agriculture officials.

1.5 REGULATORY REQUIREMENTS

A. Comply with regulatory agencies for fertilizer and herbicide composition where used.

1.6 QUALITY ASSURANCE

A. Provide certified seed mixture in original containers showing percentage of seed mix, year of production, net weight, date of packaging, and location of packaging.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Deliver grass seed mixture in original, unopened sealed containers. Seed in damaged packaging is not acceptable.

B. Deliver fertilizer in original, unopened sealed showing weight, chemical analysis, and name of manufacturer.

1.8 SUBMITTALS

A. Submittals shall be provided in accordance with Section 01300, Submittals, and the requirements of this Section.

B. Provide proposed seed mixture to OWNER’S REPRESENTATIVE for review and approval.

C. Furnish the following samples in the quantities indicated:

1. Topsoil: One 20 L bucket
2. Sand: 10 kilograms
3. Erosion Control Fabric: 0.5 square metre
4. Mulch: 20 L
5. Edging: One length with stakes

D. Provide certified seed mixture in original containers showing percentage of seed mix, year of production, net weight, date of packaging, and location of packaging.

E. Within 20 calendar days of the date specified for commencement of work, submit to the OWNER’S REPRESENTATIVE a proposed time schedule indicating dates for beginning and completion of the following operations:

1. Delivery of materials
2. Preparation of seedbed
3. Planting grass
4. Maintenance

1.9 MAINTENANCE SERVICE

A. Begin maintenance immediately after each portion is seeded. Maintain seeded areas for one month from Date of Substantial Completion.

PART 2 PRODUCTS

2.1 SEED MIXTURE

A. Seed Mixture: (Percentages by weight)

   1. As approved by OWNER'S REPRESENTATIVE during submittal stage.

B. Guaranteed 95 percent pure and to have a minimum germination rate of 85 percent, within one year of test.

C. Inoculant: Pure culture of nitrogen-fixing bacteria prepared specifically for the legume species. A mixing medium as recommended by the manufacturer shall be used to bond the inoculant to the seed.

2.2 MULCH

A. Hydroseeding Mulch: Silva-fiber as manufactured by Weyerhaeuser Co., or approved equal. Mulch shall be a specially processed cellulose fiber containing no growth or germination-inhibiting factors. It shall be manufactured in such a manner that after addition and agitation in slurry tanks with water, the fibers in the material become uniformly suspended to form a homogeneous slurry. When sprayed on the ground, the material shall allow absorption and percolation of moisture. Each package of the cellulose fiber shall be marked by the manufacturer to show the air dry weight content.

2.3 WATER

A. Water: Clean, fresh and free of substances or matter which could inhibit vigorous growth of grass.

2.4 EROSION CONTROL FABRIC

A. Erosion Fabric: Jute matting, open weave, or paper or straw interwoven.

2.5 HERBICIDE

A. Herbicides shall NOT be used.

2.6 ACCESSORIES

A. Stakes: Softwood lumber, chisel pointed.

B. String: Inorganic fiber.

PART 3 EXECUTION

3.1 AREAS TO BE HYDROSEEDED

A. Areas to be hydroseeded shall include:

1. Any disturbed soil surface including trenching areas in landfill and wetlands.
2. Any areas indicated on the Drawings.

3.2 INSPECTIONS

A. Verify that prepared soil base is ready to receive the work of this Section.

B. Beginning of installation means acceptance of existing site conditions.

C. Notify Engineer and arrange for inspections when:

1. Subsoil is prepared and before topsoil is spread.
2. When topsoil has been spread, amendments incorporated and before seeding.
3. When seeding and mulching are being performed.
4. When seeding is complete to establish Date of Substantial Completion.
5. When maintenance service period is complete.

3.3 HYDROSEEDING

A. Apply slurry of seed, mulch, and water at a rate sufficient to apply a total average of 15 seeds per square inch, but not less than 6 lbs per 1,000 sq ft evenly in two intersecting directions, with a hydraulic seeder. Do not hydroseed area in excess of that which can be mulched on same day.

B. Immediately following seeding, apply mulch to a thickness of 4 mm.

C. Apply water with a fine spray immediately after each area has been mulched. Saturate soil. Avoid run-off and erosion.

3.4 MAINTENANCE

A. Mow grass at regular intervals (weekly) during the Maintenance Period to maintain at a maximum height of 75 mm. Do not cut more than 1/3 of grass blade at any one mowing.

B. Neatly trim edges and hand clip where necessary.

C. Water to prevent grass and soil from drying out. Repair washed out areas by filling with topsoil, fertilizing, and seeding. Add mulch and erosion control fabric when washed or blown away.

D. Immediately reseed areas which show bare spots.

E. Protect seeded areas with warning signs during maintenance period.

END OF SECTION

DIVISION 3
CONCRETE

Section 03100 – Concrete Formwork
Section 03210 – Reinforcing Steel
Section 03250 – Concrete Accessories
Section 03310 – Concrete
Section 03600 – Grout

SECTION 03100
CONCRETE FORMWORK

PART 1 GENERAL

1.1 WORK INCLUDED

A. This Section covers the work to design, supply and install the concrete formwork required for this project and includes, in general:

1. Designing, furnishing, and constructing all formwork for cast-in-place concrete, with shoring and bracing.
2. Forming all openings for other affected work.
3. Furnishing and installing all form accessories.
4. Furnishing and installing all formliners and rustication strips.
5. Furnishing and installing all box voids.
6. Formwork removal.
7. Formwork design.

1.2 RELATED WORK SPECIFIED IN OTHER SECTIONS

A. The following related areas are included for reference only. The Design/Build CONTRACTOR is responsible for all works described, shown, and referenced in the Contract Documents:

1. Section 03250 – Concrete Accessories: Embedded inserts, waterstops, and dowels.
2. Section 05500 – Metal Fabrications: Embedded miscellaneous metals, anchorages, and fasteners.

1.3 DESIGN REQUIREMENTS

A. Form and shoring design shall be the responsibility of the CONTRACTOR and shall be signed by a professional engineer licensed in the State of Washington.

B. Form and shoring design shall be in accordance with ACI SP-4 and ACI 347.

C. Forms and shoring shall be adequately designed so that all vertical and lateral loads can be carried properly and safely until such loads can be carried by the structure.

D. Vertical and lateral loads during and due to placement, vibration, and hardening of concrete and construction loading shall be in accordance with Section 2.2 of ACI 347.

E. Form and Shoring Design Factors:

1. Method and rate of concrete placement.
2. Ambient and concrete temperatures.
3. Type of vibration.
4. Type of admixtures.
5. Wind loading.
6. Lateral stability and other factors pertinent to the safety of the structure.
7. Preventing damage to previously placed concrete.
8. Requirements for special construction and/or finishes.

F. The CONTRACTOR is solely responsible for coordinating with equipment vendors for specific requirements for items related to the concrete.

1.4 QUALITY ASSURANCE

A. Plywood form panels shall be marked with an APA grade mark.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Formwork materials and accessories at the site shall be stored off the ground and stored/handled in such a manner as to prevent contamination, soiling, and/or damage.

1.6 SUBMITTALS

A. Submittals shall be provided in accordance with Section 01300 Submittals, and the requirements of this Section.

B. Product data showing compliance with these Specifications shall be submitted to the OWNER’S REPRESENTATIVE for review prior to installation.

PART 2 PRODUCTS

2.1 MATERIALS

A. Plywood Form Panels for General Forming: APA B-B Plyform Class I, Exterior, plywood.

B. Fiberglass Reinforced Plastic Forms: Reusable, segmental, matched and tight fitting, and, stiffened as required to support weight/load of concrete and reinforcing steel.

C. Steel Forms: Reusable, segmental, matched and tight fitting, and stiffened to support weight/load of concrete and reinforcing steel.

D. Joist Forms: ANSI A48.1 one-way and A48.2 two-way steel or reinforced fiberglass type as follows.

1.	One-way	A48.1
2.	Two-way	A48.2

E. Round Column Forms: Spirally wound laminated fiber with moisture resistant adhesive and wax impregnated exterior surface, two-piece steel, or, one or two-piece reinforced fiberglass type.

F. Form Ties:

1. Material: Steel
2. Spreader Inserts:
   a. Conical or spherical type.
   b. Securely attached to maintain positive contact with forming material.
   c. Construct so no metal is within 1 inch of concrete surface when forms, inserts, and tie ends are removed.
3. Do not use wire ties.
4. For flat bar ties for panel forms, use plastic or rubber inserts with minimum 1-inch depth and sufficient dimensions to permit proper patching of tie hole.
5. Water Stop Ties: For water-holding structures, basements, pipe galleries, and other accessible spaces below finish grade, use one of the following:
   a. Integral steel water stop 0.103-inch thick and 0.625 inch in diameter tightly and continuously welded to tie.
   b. Neoprene water stop 3/16-inch thick and 15/16 inch in diameter whose center hole is 1/2 diameter of tie, or a moulded plastic water stop of comparable size.
   c. Water Stop: Oriented perpendicular to tie and symmetrical about center of tie.
   d. Construct ties to prevent rotation or disturbance of center portion of tie during removal of ends and to prevent water leaking along tie.
6. Through-Bolts: Tapered minimum 1-inch diameter at smallest end.
7. Elastic Vinyl Plug:
   a. Size plug to allow insertion with tool to elongate plug, place at correct location, and allow plug to return to original length and diameter upon removal forming a watertight seal.

2.2 ACCESSORIES

A. Form Release Agent: Colorless material, compatible with the surface being coated, which shall not bond to, stain, or adversely affect the concrete surfaces, and shall not impair subsequent curing/treatment of or adhesion to the concrete surface.

B. Hole Forms: "Crete-Sleeve" as manufactured by the Building Products Division of Shamrock Industries, "Convoid" as manufactured by Sinco Products Inc. or approved equivalent.

C. Anchor Bolt Sleeves: "Wilson" sleeves as manufactured by Sinco Products Inc. or approved equivalent.

D. Wall and Slab Sleeves: "Wilson" sleeves as manufactured by Sinco Products Inc. or ASTM D1785 Schedule 40 PVC pipe or approved equivalent.

E. Accessories such as end caps, etc. shall be provided by the joist form MANUFACTURER.

F. Fillets for Chamfered Corners: Wood or elastomeric type, 3/4 by 3/4 inch size.

G. Form sealer: Surface sealer that will not bond with, stain, or adversely affect concrete surface, and will not impair subsequent treatment of concrete surfaces when applied to most forms or form liners.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify lines, levels, and measurements before proceeding with formwork.

B. Verify that subgrade surfaces and excavations are ready to receive formwork.

3.2 PREPARATION

A. Form surfaces to be concreted against shall be free of all dirt, mud, mortar, loose or non-adherent rust, and other foreign material.

B. Form and form liner surfaces to be concreted against shall be treated with a form release agent prior to positioning of the forms and placement of the reinforcing steel and concrete.

C. Form surfaces to be concreted against at concrete surfaces exposed to view shall be free of surface irregularities and patches, and, be capable of producing the desired finish.

D. Earth cuts may be used as forms for vertical surfaces of footings which shall not be exposed to view only where the soil is firm and stable and shall be subject to prior review by the OWNER’S REPRESENTATIVE.

E. Earth form surfaces shall be cut neat and accurate in size and shape and shall be compact. Top edges of earth forms shall be cleaned of loose material to prevent sloughing.

F. Concrete section dimensions shall be increased as required to provide reinforcing steel with 3 inches of concrete cover at earth forms.

3.3 ERECTION AND INSTALLATION

A. Form and shoring construction and removal shall be the responsibility of the CONTRACTOR.

B. Forms and shoring shall be adequately erected, braced, and maintained so that all vertical and lateral loads can be carried properly and safely until such loads can be carried by the structure.

C. Forms shall result in a final structure which conforms to the shapes, lines, positions, and dimensions as shown on the Drawings within the allowable tolerances as defined in Section 4.3 of ACI 301 and Section 3.3 of ACI 347.

D. Formed surfaces shall meet the following surface classes as defined in Section 3.3.8 of ACI 347:

1. Surfaces exposed to view – Class A
2. Surfaces to receive sprayed-on protective coatings – Class A
3. Surfaces to receive troweled-on protective coatings – Class B
4. Other surfaces – Class C

E. Forms shall be of sound and sufficiently strong material.

F. Camber slab and beam forms to achieve ACI 301 tolerances.

G. Reset forms shall be held against previously placed concrete at continuous surfaces to accurate alignment and free from offsets and irregularities.

H. Shored forms shall be cambered to compensate for form deflection due to placement and hardening of concrete.

I. Joints in form panels shall be staggered and tight fitting.

J. Studs, wales, and/or braces shall be properly spliced.

K. Install and properly tighten all form ties and/or clamps. Form ties on exposed surfaces shall be located in a uniform pattern.

L. Provide top forms for inclined surfaces where the slope is steeper than 1:1.5.

M. Shoring shall be erected plumb with an allowable tolerance of 1/8 inch in 3 feet but not more than 1 inch in 40 feet.

N. Column clamps shall be used in lieu of form ties at square and rectangular columns.

O. Damaged forming and shoring shall not be used and erected forming and shoring damaged or weakened shall be removed and replaced with adequate forming/shoring.

P. Chamfer and rustication strips shall be installed in the longest possible lengths with splices being butt type and tight fitting.

3.4 APPLICATION OF FORM RELEASE AGENT

A. Form surfaces to be concreted against shall be treated with a form release agent prior to positioning of the forms and placement of the reinforcing steel and concrete.

B. Form release agent shall not be allowed to collect in the forms or come in contact with reinforcing steel or embedded items.

C. Form release agent shall not be used where concrete surfaces are to receive special/protective coatings if required by the MANUFACTURER's written instructions and specifications. Soak contact surfaces of untreated forms with clean water and wet surfaces with water immediately prior to placing concrete.

3.5 EMBEDDED ITEMS AND OPENINGS

A. Provide formed openings where required for work passing through concrete.

B. The position of all pipes and conduits encased in or passing through concrete shall be subject to prior review by the OWNER’S REPRESENTATIVE.

C. Pipes and conduits passing through slabs, grade beams, and walls shall pass through sleeved holes sized 1 inch in diameter larger than the outside diameter of the pipe/conduit. Sleeves shall extend the full thickness of the section.

D. Cast-in-place miscellaneous metals and fasteners, sleeves, pipe penetrations, conduit, waterstops, reglets, etc. shall be installed and set by templating prior to concrete placement.

3.6 FORM REMOVAL

A. Forms and shoring shall be removed in such a manner that the concrete is not damaged and as to ensure the complete safety of the structure.

B. Forms and shoring for elevated slabs and beams shall remain in place until the concrete has attained a compressive strength sufficient to support the intended loading as substantiated by field cured test cylinders.

C. Minimum form removal times shall be in accordance with Section 3.6 of ACI 347.

D. Remove formwork progressively so no unbalanced loads are imposed on structure. Do not damage concrete surfaces during form removal.

3.7 CLEANING

A. Form space in which concrete is to be placed shall be free of all debris and rubbish, spilled concrete, sloughed soil, mud, standing water, ice or snow, etc.

B. Use compressed air to clean out form spaces during cold weather. The use of water to clean out form spaces during cold weather shall not be permitted.

END OF SECTION

SECTION 03210
REINFORCING STEEL

PART 1 GENERAL

1.1 WORK INCLUDED

A. This Section covers the work to design, supply and install the reinforcing steel required for the concrete work and includes, in general:

1. Furnishing and installing all reinforcing steel for cast-in-place concrete.
2. Furnishing and installing all bar supports, spacers, etc. for supporting reinforcing steel.

1.2 SEQUENCING AND SCHEDULING

A. Reinforcing steel shall not be located or placed in the forms until form release and bond breaker coating work is completed.

1.3 DELIVERY, STORAGE, AND HANDLING

A. Reinforcing steel shall be delivered to the site in bundles marked with tags calling out bar size, length, grade, piece number, heat number, and bend diagram.

B. Reinforcing steel and accessories at the site shall be stored off the ground and stored/handled in such a manner as to prevent contamination, soiling, corrosion, and/or damage.

1.4 SUBMITTALS

A. Submittals shall be provided in accordance with Section 01300, Submittals, and the requirements of this Section.

B. Submittals shall be signed by a Professional Engineer licensed in the State of Washington.

C. Shop and placement drawings shall show all piece numbers, quantities, grades, sizes, bar bend requirements, positions, spacings, clearances, splices, supports, etc. for the fabrication and placement of all reinforcing steel and bar supports.

D. Shop and placement drawings shall be submitted to the OWNER’S REPRESENTATIVE for review prior to fabrication and installation.

E. Product information showing compliance with these Specifications shall be submitted to the OWNER'S REPRESENTATIVE for review prior to installation.

PART 2 PRODUCTS

2.1 MATERIALS

A. Reinforcing Steel: ASTM A615 Grade 60 deformed bars except ties and stirrups shall be ASTM A615 Grade 40 deformed bars.

B. Spiral Reinforcement: ASTM A82 cold-drawn steel wire or ASTM A615 Grade 60 hot-rolled plain steel bar.

C. Fabricated Reinforcing Steel Mats: ASTM A184 using ASTM A615 Grade 60 deformed bars.

2.2 ACCESSORIES

A. Tie wire: ASTM A641, A809, A818 or A853 16 gauge or heavier black soft-annealed wire.

B. Bar supports: Proper type for the intended use in conformance with Chapter 3 of CRSI MSP-1.

1. Class 3 - Bright basic supports where the supports do not come in contact with exposed concrete surfaces.
2. Class 1 - Plastic protected supports where the supports come in contact with exposed concrete surfaces
3. Class 3 - Bright basic bar supports with sand plates or 4 inch by 4 inch by 3 inch precast concrete bar supports in concrete placed on grade or against earth cuts.

2.3 FABRICATION

A. Reinforcing steel shall be fabricated completely in the shop except as otherwise shown on the Drawings.

B. Reinforcing steel shall conform accurately to the dimensions as shown on the Drawings within the allowable tolerances as defined in Chapter 7 of CRSI MSP-1.

C. Hooks shall conform to the bend dimensions defined as ACI "Standard Hooks" in Chapter 6 of CRSI MSP-1.

PART 3 EXECUTION

3.1 PREPARATION

A. A the time of concrete placement, reinforcing steel shall be free from dirt, mud, grease, oil, ice or snow, kinks, loose or non-adherent rust, loose mill scale, form release coating/sealer or bond breaker, and any foreign matter or nonmetallic coating that adversely affects the bonding capacity of the reinforcing steel with the concrete.

B. Bars extending through construction joints shall be cleaned of concrete and other contaminants prior to placement of subsequent concrete.

C. Surface preparation for welding shall be in accordance with Section 4.1 of AWS D1.4 except loose or non-adherent rust and loose mill scale shall be removed by wire brushing.

3.2 INSTALLATION

A. Reinforcing steel shall be located and placed to conform accurately with the Drawings within the allowable tolerances as defined in Section 5.4 of ACI 301 and Chapter 8 of CRSI MSP-1.

B. Reinforcing steel shall be located and placed with the cover as defined in Section 5.5 of ACI 301 unless detailed otherwise on the Drawings.

C. The clear distance between parallel horizontal bars shall not be less than one bar diameter nor 1 inch whichever is greater.

D. The clear distance between parallel vertical bars shall not be less than 1-1/2 bar diameters nor 1-1/2 inches whichever is greater.

E. Clear distance limitations shall also apply to adjacent splices of bars.

F. Provide corner bars of the same size and spacing as the horizontal reinforcing steel at all wall corners and intersections unless detailed otherwise on the Drawings. Length each side shall be the lap length plus the wall thickness.

G. Reinforcing steel splices shall be staggered one splice length minimum unless detailed otherwise on the Drawings.

H. Spiral lap splices shall be 48 bar diameters minimum or 12 inches whichever is greater.

I. The maximum allowable bar movement in order to avoid interference with other reinforcing steel, embedded items, or concrete anchors shall be one bar diameter. Bar movement beyond the allowable one bar diameter shall be subject to prior review by the OWNER'S REPRESENTATIVE.

J. Reinforcing steel shall be adequately supported, securely tied, and firmly held in place to prevent displacement and maintain proper spacing and distance from formwork and earth subgrades before and during concrete placement by means of adequate bar supports and side form spacers.

K. Reinforcing steel shall be supported by use of bar supports at 4 foot on center maximum in any direction.

L. Spirals shall be provided with spacers in accordance with Chapter 5 of CRSI MSP-1.

M. Sandwiching or positioning of reinforcing steel during concrete placement shall not be permitted.

N. Reinforcing steel lap splices shall be securely tied to prevent displacement of splices before and during concrete placement.

O. Tie wire shall have 1/2 inch minimum cover at all concrete surfaces.

P. Miscellaneous openings not shown on the Drawings that interrupt reinforcing steel shall have an equivalent area of reinforcing steel placed around the opening and extended on each side of the opening the lap length minimum or 2 feet whichever is greater.

Q. Miscellaneous openings not shown on the Drawings shall be subject to prior review by the OWNER'S REPRESENTATIVE.

R. Field bending of reinforcing steel not shown on the Drawings shall be subject to prior review by the OWNER'S REPRESENTATIVE.

S. Concrete conveying equipment, etc. shall not be supported on reinforcing steel or supporting accessories.

END OF SECTION

SECTION 03250
CONCRETE ACCESSORIES

PART 1 GENERAL

1.1 WORK INCLUDED

A. Furnishing and installing all premolded joint fillers.

B. Furnishing and installing all waterstops.

C. Furnishing and installing all formed construction joints.

D. Furnishing and installing all smooth dowels and inserts.

1.2 DELIVERY, STORAGE, AND HANDLING

A. Vapor barrier materials shall be delivered to the site with the MANUFACTURER's name and the material type labeled.

B. Concrete accessories at the site shall be stored off the ground and stored/handled in such a manner as to prevent contamination, soiling, corrosion, and/or damage.

1.3 SUBMITTALS

A. Submittals shall be provided in accordance with Section 01300, Submittals, and the requirements of the Section.

B. Submittals shall be signed by a Professional Engineer licensed in the State of Washington.

C. Product information showing compliance with these Specifications shall be submitted to the OWNER’S REPRESENTATIVE for review prior to installation.

D. Inspection reports concerning installation of concrete accessories shall be submitted to the OWNER’S REPRESENTATIVE.

PART 2 PRODUCTS

2.1 MATERIALS

A. Premolded Joint Filler:

1. ASTM D994 premolded asphalt-fiber type.

    2. ASTM D1752 Type II premolded cork type.

B. Waterstops: CE CRD C572, nontapered, ribbed, centerbulb, virgin PVC type. The use of reclaimed PVC compounds shall not be permitted.

C. Smooth Dowels: ASTM A36 round bars.

D. Smooth Dowel Sleeves: Sheet steel tubes with one end closed.

E. Formed Construction Joints: 24 gauge galvanized sheet steel tongue and groove type, with radiused key, 7/8 inch knockout holes at 6 inches on center, and splice plates.

F. Coil Rods, Bolts, and Inserts: As manufactured by Richmond Screw Anchor Co. Inc., Acme Wire Products Corp., or Dayton Superior Corp.

G. Ferrule Inserts: As manufactured by Richmond Screw Co. Inc., Acme Wire Products Corp., or Dayton Superior Corp.

H. Shims: Rigid high-impact plastic type as manufactured by Burke Co., Dayton Superior Corp., or Deslauriers Inc.

    1. Compressive strength: 8,000 psi minimum.
    2. Size: 4 inches by 6 inches.
    3. Thickness range: 1/16 inch to 1-1/16 inches.

2.2 FABRICATION

A. Smooth dowels shall conform accurately to the dimensions as shown on the Drawings within the allowable tolerances.

B. Insert groups shall have the inserts tack welded together with No. 9 wire. Welding to the coils/ferrules shall not be permitted.

C. It is the CONTRACTOR’s sole responsibility to coordinate with Vendors for the installation requirements of their equipment.

PART 3 EXECUTION

3.1 PREPARATION

A. Waterstop sections extending through construction joints shall be cleaned of concrete and other contaminants and split sections shall have the two split parts straightened and stitched together prior to placement of subsequent concrete.

B. At the time of installation, all surfaces to receive vapor barriers shall be compact, smooth, and uniform.

C. Dowels extending through construction joints shall be cleaned of concrete and other contaminants and sleeved prior to placement of subsequent concrete.

3.2 INSTALLATION

A. Concrete accessories shall be located and installed so as to conform accurately to the Drawings within the allowable tolerances.

B. Construction joints shall be as detailed on the Drawings. Construction joints not shown on the Drawings shall be subject to prior review by the OWNER’S REPRESENTATIVE.

C. Premolded joint fillers shall extend the full thickness/depth of the section.

D. Install waterstops continuous without displacing reinforcement.

E. Sections shall be spliced with thermostatically controlled electric splicing irons. Lap splices and quenching during cooling shall not be permitted.

F. Dowels shall be adequately supported and firmly held in place to prevent displacement and maintain proper spacing and distance from earth subgrades before and during concrete placement by means of proper dowel supports.

G. One half the length of all smooth dowels shall be encased in a dowel bar sleeve for prevention of bond with the concrete on that side of the joint.

H. Formed Construction Joint Installation Requirements:

1. Joint sections shall be adequately supported and firmly held in place to prevent displacement and maintain proper elevations before and during concrete placement in accordance with the MANUFACTURER's written instructions and specifications.
2. Joint sections shall be in straight alignment for the entire length of joint with "tight fit" joints.
3. Joints shall be provided with splice plates.
4. Where joint sections intersect, the intersecting section shall be trimmed to fit the adjoining section.

I. Cast-in-place inserts, waterstops, etc. shall be installed and set by templating prior to concrete placement.

3.3 FIELD QUALITY CONTROL

A. Concrete accessories shall be inspected by the OWNER'S REPRESENTATIVE after they have been installed and prior to closing of forms and concrete placement.

END OF SECTION

SECTION 03310
CONCRETE

PART 1 GENERAL

1.1 WORK INCLUDED

A. This Section covers the work to design, supply and placing the concrete required for this project and includes, in general:

1. Furnishing, placing, finishing, and curing all cast-in-place concrete and reinforced concrete work.
2. In the event of conflict regarding structural concrete requirements between this Section and any other section, the provisions of this Section shall govern.

1.2 PROJECT/SITE CONDITIONS

A. Placement and curing of concrete shall not be allowed during freezing, excessive heat or cold, rain, sleet, snow, or wind unless proper provisions/arrangements are provided.

B. Concrete shall not be placed on frozen base/subgrade or in forms containing snow or ice.

C. Hot weather concreting shall be in accordance with ACI 305R.

D. Cold weather concreting shall be in accordance with ACI 306.1 and ACI 306R. The use of accelerating admixtures in cold weather shall not relax cold-weather placement requirements except as allowed for protection time periods.

1.3 QUALITY ASSURANCE

A. Testing/Inspection agencies shall be in conformance with ASTM E329.

B. A preplacement conference for concrete shall be held 7 days minimum prior to concrete placement to review the concrete mix proportions, the placement schedule, placing and finishing techniques, floor hardener application, and the climate/ambient conditions.

C. Concrete Preplacement Conference Participants:

1. General Contractor.
2. Concrete subcontractor.
3. Concrete supplier.

4. Admixture supplier.
5. Floor hardener manufacturer.
6. DESIGN-BUILD CONTRACTOR’S structural Engineer.
7. OWNER’S REPRESENTATIVE.
8. OWNER.

1.4 SEQUENCING AND SCHEDULING

A. Placement of concrete in elevated beams and slabs shall not occur until the concrete previously placed in columns and walls is no longer plastic and has been in place a minimum of 2 days.

B. Concrete shall be placed after re-emulsifiable bonding agent is touch-dry and within three days after the bonding agent is applied.

C. Bond breaker shall be applied prior to placement of reinforcing steel and embedded items.

D. Extraction of temporary casing for drilled piers shall begin within one hour of beginning of concrete placement.

1.5 DELIVERY AND HANDLING

A. Transporting of ready-mix concrete shall be in accordance with ASTM C94.

B. Admixtures shall be added to the mix at the batch plant.

C. Disposal of excess concrete on-site shall not be permitted.

1.6 SUBMITTALS

A. Submittals shall be provided in accordance with Section 01300, Submittals, and the requirements of this Section.

B. Submittals shall be signed by a Professional Engineer licensed in the State of Washington.

C. The CONTRACTOR shall submit to the OWNER’S REPRESENTATIVE and the high-range water-reducer admixture manufacturer for review concrete mix designs that demonstrate they produce concrete that meets all the Specification requirements prior to batching for this project. The admixture MANUFACTURER's review and recommendations shall be submitted to the OWNER’S REPRESENTATIVE with the mix design.

D. Independent test reports certifying that the pozzolans meet these Specifications shall be submitted with the mix designs.

E. A certificate of conformance for the aggregates certifying compliance with these Specifications shall be submitted to the OWNER'S REPRESENTATIVE prior to batching for this project.

F. Product information showing compliance with these Specifications including application instructions shall be submitted to the OWNER'S REPRESENTATIVE for review prior to batching for this project.

G. Jointing drawings shall show all construction, control, and isolation/expansion joints for the jointing of all slabs and walls.

H. A concrete placement schedule for slabs and walls, signed by the CONTRACTOR's Engineer, shall be submitted to the OWNER'S REPRESENTATIVE for review prior to concrete placement.

I. Ready-mix delivery tickets shall be submitted to the Inspector for review prior to unloading at the site.

J. Delivery Ticket Minimum Information:

1. Name of ready-mix plant.
2. Serial number of ticket.
3. Date and truck number.
4. Name of Contractor.
5. Job name and location.
6. Mix design number.
7. Amount concrete (cubic yards).
8. Type and amount of admixtures.
9. Amount of water added at the batch plant.
10. Times of loading, arriving at the site, and unloading.
11. Volume of water added by receiver of concrete and his initials.

K. Test reports concerning slump, air content, temperature, and compressive strengths of concrete, and ambient temperature at the time of concrete placement shall be signed by the CONTRACTOR's Engineer and submitted to the OWNER'S REPRESENTATIVE.

L. Inspection reports concerning concrete placement and slab surface flatness shall be submitted to the OWNER'S REPRESENTATIVE.

PART 2 PRODUCTS

2.1 MATERIALS

A. Portland Cement: ASTM C150 Type I.

B. Aggregates: ASTM C33.

1. Material: Natural aggregates, free from deleterious coatings.
2. Aggregates shall not be potentially reactive as defined in Appendix XI of ASTM C33. Import nonreactive aggregates if local aggregates are reactive.
3. Aggregates not in compliance with the soundness and durability requirements of ASTM C33 may be used subject to prior review by the OWNER'S REPRESENTATIVE and provided it can be shown by special testing or a record of past performance that these aggregates produce concrete of adequate strength and durability. Aggregate soundness testing for fine and coarse aggregates shall be in accordance with ASTM C88.
4. Fine Aggregates: Materials finer than the 200 sieve shall not exceed 4 percent.
5. Coarse Aggregate: Materials finer than the 200 sieve shall not exceed 0.5 percent.

C. Pozzolan: ASTM C618 Class C flyash.

D. Water shall be in conformance with ASTM C94.

E. Air-entraining Admixtures: ASTM C260.

F. Water-reducing Admixtures: ASTM C494 Type A normal type.

2.2 EQUIPMENT

A. Ready-mix concrete batch plants shall conform to NRMCA concrete plant standards.

B. Ready-mix concrete trucks shall be mixer-agitator type. The use of non-agitator equipment shall not be permitted.

C. Ready-mix concrete trucks shall be equipped with operable, resettable drum revolution counters.

2.3 ACCESSORIES

A. Curing Compound: ASTM C309 Type 1, Class B, all resin type. The curing compound shall have a documented record/history of compatibility with applied systems specified elsewhere.

B. Waterproof Sheet Curing Materials: ASTM C171.

C. Bond Breaker: ASTM C309. The bond breaker shall have a documented record/history as a bond breaker and of compatibility with applied systems specified elsewhere.

D. Bonding Agent: "Daraweld-C" as manufactured by W.R. Grace & Co., "Intralok" as manufactured by W.R. Meadows Inc., "Akkro-7T" as manufactured by Tamms Industries Co., "Sikabond" as manufactured by Sika Corp., "Acryl 60" as manufactured by Standard Dry Wall Products or approved equivalent.

E. Grout: CE CRD C621 Type D, premix, nongaseous, nonshrink, nonmetallic type.

F. Patching Mortar: Premix, nongaseous, nonshrink, nonmetallic type.

2.4 MIXES

A. Concrete strength shall be as specified on Drawings.

B. Concrete target strengths shall be in accordance with Chapter 4 of ACI 318.

C. The cement and pozzolan content and the water/cement ratio, or water/cement plus pozzolan ratio, if applicable, shall be as set by the reviewed mix designs meeting these Specifications.

D. Maximum water/cement ratio, or water/cement plus pozzolan ratio, if applicable, shall not exceed 0.42.

E. The replacement of cement with pozzolans shall not exceed 15 percent.

F. Maximum Aggregate Size: 1-1/2 inch minus.

G. Allowable Air-entrainment: 7.5 percent plus or minus 1 percent by volume in all exterior concrete.

H. All concrete shall contain a water reducer. The amount of admixture added to the concrete shall be in accordance with the MANUFACTURER's written instructions and specifications.

I. Concrete Temperature, as Delivered to the Site: 50 to 90 degrees F temperature range.

J. The proportion of fine aggregate in tremie concrete shall range from 40 to 50 percent of the total weight of aggregate.

K. The use of frozen materials or materials containing ice or snow shall not be permitted except as allowed by ACI 305R for water.

L. Concrete Mix Design Minimum Information:

1. Name of ready-mix plant.
2. Project.
3. DESIGN/BUILD CONTRACTOR’S Engineer.
4. CONTRACTOR.
5. Mix design number.
6. Specified concrete strength.
7. Water/Cement ratio or water/cement plus pozzolan ratio
8. Maximum aggregate size.
9. Cement content.
10. Pozzolan content.
11. Water content.
12. Type, name, and amount of admixtures.
13. Unit weight.
14. Slump.
15. Ingredient proportions corrected for average moisture content.

PART 3 EXECUTION

3.1 PREPARATION

A. Prior to placement of concrete, the formwork shall have been completed, all reinforcing steel and embedded items positioned and secured in place, the space in which the concrete is to be placed free of all debris and rubbish, spilled concrete, sloughed soil, standing water, etc., and the entire preparation inspected and accepted by the OWNER’S REPRESENTATIVE.

B. Prior to placing of subsequent concrete at construction joints, the contact surface shall be cleaned by sandblasting or other approved means to remove all laitance, expose the aggregate, and roughen the surface to a minimum of 1/4 inch amplitude. Clean contact surfaces to remove loose and/or foreign material.

C. The CONTRACTOR shall take all suitable precautions against damaging waterstops during construction joint preparation.

D. All wall joints, slab joints, and any other joints as shown on the Drawings shall be treated with bonding agent in accordance with the MANUFACTURER's written instructions and specifications prior to subsequent concrete placement.

E. Slab on grade subgrades shall be thoroughly dampened immediately prior to concrete placement, but standing water shall not be permitted on the subgrade/ concrete surface.

F. The CONTRACTOR shall take all suitable precautions against splattering concrete on exposed/finish surfaces.

G. The CONTRACTOR shall provide an operable backup vibrator on site prior to concrete placement.

3.2 PLACEMENT

A. Each batch of concrete shall be mixed in a truck mixer at time of charging for not less that 70 revolutions of the drum at mixing speed after all materials have been charged. Prior to discharging at the site, the batch shall be rotated not less than 10 revolutions of the drum at mixing speed.

B. Construction joints shall be as shown on the Drawings or as specified in these Specifications. Construction joints not shown on the Drawings or specified in these Specifications shall be subject to prior review by the OWNER’S REPRESENTATIVE.

C. Concrete shall be placed within the following time periods for the given concrete temperature ranges after water has been added to the mix.

50 to 70 degrees F 90 minutes
71 to 80 degrees F 60 minutes
81 to 90 degrees F 45 minutes

D. Time periods for given concrete temperature ranges may be extended 30 minutes with use of an approved water-reducing set retarder.

E. Concrete which has not met the temperature-placement requirements or with a temperature greater than 90 degrees F at the time of placement shall not be placed.

F. Concrete with a slump less than specified at the time of placement may be adjusted by the addition of water to increase the slump provided the maximum slump and maximum water/cement ratio are not exceeded.

G. If water is added to the mix at the site, the concrete shall be mixed at mixing speed a minimum of 30 revolutions of the drum after each time water is added to the mix. The amount of water added shall be noted on the delivery ticket.

H. Concrete shall be conveyed/placed at a regular rate, as close as possible to final position, in such a manner as to prevent segregation and/or loss of materials, and in a sequence which minimizes shrinkage.

I. Concrete shall be placed in a continuous operation without interruptions until the sections are completed with no more than 30 minutes elapsing between placing of adjacent layers/sections.

J. Concrete shall be placed and consolidated with the aid of proper vibration equipment and procedures in accordance with ACI 309.

K. Vibration shall be of sufficient duration and intensity to cause thorough compaction and settlement of concrete into place and around all reinforcing steel and embedded items, but not sufficient to cause segregation.

L. Spacing of vibrator insertion shall not exceed twice the radius of action of the vibrator nor more than 18 inches on center.

M. Avoid vibrating or displacing the reinforcing steel with the vibrator. Transporting of concrete laterally with the vibrator shall not be permitted.

N. The addition of water at any time during conveying to and placing into the forms shall not be permitted.

O. Concrete that does not meet these Specifications, or has partially hardened, fallen on the ground, or been contaminated by foreign materials shall not be placed.

P. Concrete shall be placed in 2 foot thick maximum uniform horizontal layers.

Q. Raking or flowing of concrete to move it or retempering of concrete shall not be permitted.

R. Sufficient concrete shall be provided above the bottom of partially withdrawn casing at drilled piers to prevent intrusion of loose soil or overcome hydrostatic pressure but not less than 5 feet.

S. Sufficient concrete shall be provided at the top of partially withdrawn casing at drilled piers to compensate for filling of the void spaces outside the temporary casing as the casing is withdrawn.

T. The minimum diameter of the pumping hose/conduit shall be 4 inches without prior review by the OWNER’S REPRESENTATIVE.

U. The use of aluminum conduits for conveying concrete shall not be permitted.

V. Placement of concrete by tremie method shall be subject to prior review by the OWNER’S REPRESENTATIVE.

W. Placement of tremie concrete shall be in accordance with Chapter 8 of ACI 304.

3.3 CURING

A. All concrete shall be treated/protected by use of an evaporation retardant applied in accordance with the MANUFACTURER's written instructions and specifications. All flat surfaces shall be treated immediately after each screeding, floating, or troweling or any time period greater than 15 minutes between finishing operations until curing.

B. Concrete shall be cured by use of a curing compound or by use of an approved wet curing process for a minimum of 7 days after concrete placement in accordance with ACI 308. Curing compounds shall be applied in accordance with the MANUFACTURER's written instructions and specifications.

C. Concrete surfaces to receive special/protective coatings shall be cured by use of an approved wet curing process only if required by the coating MANUFACTURER's written instructions and specifications. Use of curing compound shall not be permitted.

D. Cementitious waterproofing may be used in lieu of curing compound at below grade walls.

E. All exposed surfaces shall be treated immediately after removal of forms or after the free surface water has disappeared from the surface of the concrete and completion of finishing.

F. Concrete temperature shall be maintained in accordance with Section 1.4 of ACI 306R.

G. Curing compounds shall not be allowed to come in contact with reinforcing steel, embedded items, or hardened concrete to be concreted or grouted against.

3.4 FIELD QUALITY CONTROL

A. Construction joints shall be inspected prior to closing of forms and the placement of concrete.

B. Sampling of concrete for testing shall be in accordance with ASTM C172.

C. Slump tests shall be made in accordance with ASTM C143.

D. Air content tests shall be made in accordance with ASTM C231.

E. Testing of compressive strength specimens shall be in accordance with ASTM C39.

F. One sample of concrete for compressive strength tests shall be taken for every 100 cubic yards or fraction thereof of concrete placed each day.

G. Slump and air content tests as well as temperature tests shall be made every time compressive strength specimens are made.

H. Four standard 6 inch diameter by 12 inch cylinders shall be made at each sampling with one field cured and three laboratory cured. Cylinders for substantiation of concrete strength for construction purposes by the CONTRACTOR shall be in addition to these required cylinders.

I. Compressive strength tests shall be made at 7 days using one field cured cylinder and at 28 days using two laboratory cured cylinders each time. The fourth cylinder shall be tested at 56 days only if the 28 day tests are below the specified strength.

J. Acceptance of test results shall be in accordance with Section 4.8 of ACI 318.

K. Penetration resistance tests of concrete for indication of compressive strength shall be in accordance with ASTM C803.

3.5 PROTECTION

A. Construction loads shall not be allowed on the structure or portions thereof until the concrete has attained 70 percent of its specified compressive strength (7 days minimum) as substantiated by field cured cylinders unless higher strengths are required for the intended loading.

B. Earth backfill behind walls shall not be placed until the concrete has attained 100 percent of its specified 28 day compressive strength as substantiated by field cured test cylinders.

C. Walls with earth backfill behind and tied to slabs shall be braced and removal of bracing shall not be allowed until the slab is complete and has attained 100 percent of its specified 28 day compressive strength as substantiated by field cured test cylinders.

D. No traffic shall be allowed on slabs for a minimum of three days after concrete placement.

E. No vehicle/equipment traffic shall be allowed on slabs for a minimum of 7 days after concrete placement for light vehicles/equipment and 14 days after concrete placement for heavy vehicles/equipment.

F. Finish slabs shall be protected from traffic, mud, dirt, concrete splatter, joint compound, sealants, paint, oil, grease, etc. during construction by use of a durable waterproof Kraft paper.

3.6 PATCHING

A. General:

1. Inject cracks with crack repair epoxy.
2. Prior to starting patching work, obtain quantities of color-matched patching material and MANUFACTURER's detailed instructions for use to provide a structural patch with finish to match adjacent surface.
3. Patching Material: Contain no chlorides or other chemicals that cause steel corrosion.
4. Dress surface of patches that will remain exposed to view to match color and texture of adjacent surfaces. Patching of concrete shall provide a structurally sound surface finish, uniform in appearance or upgrade the finish by other means until acceptable to OWNER'S REPRESENTATIVE.
5. Provide patching to correct structural and appearance defects.

B. Tie Holes:

1. Fill with grout as specified in Section GROUT except where sealant is indicated. Use only enough water to dry pack.
2. Match color of adjacent concrete.
3. Compact grout using steel hammer and steel tool to drive grout to high density. Cure grout with water.

C. Alternate Form Ties – Through-Bolts:

1. Seal through-bolt hole by sandblasting or mechanically cleaning and roughening entire interior surface of hole, epoxy coating roughened surface and driving elastic vinyl plug and then dry packing entire hole on each side of plug with grout, as specified in Section GROUT. Use only enough water to dry pack grout. Dry pack while the epoxy is still tacky or remove epoxy by mechanical means and reapply new epoxy.
2. Fill through-bolt openings with grout, as specified in Section GROUT.
3. Compact grout using steel hammer and steel tool to drive grout to high density. Cure grout with water.

D. Defective Areas:

1. Remove *defective* concrete to a depth of sound concrete.
2. Small shallow holes caused by air entrapment at surface of forms shall not be considered *defective* unless amount is so great as to be considered not the standard of the industry.
3. If chipping is required, make edges perpendicular to surface with a minimum of ½-inch in depth. Do not feather edges. Obtain OWNER'S REPRESENTATIVE's approval of chipping work.

4. Patch *defective* area to match appearance of adjacent concrete surfaces after cracks are filled.

E. Blockouts at Pipes or Other Penetrations:

1. Meet details shown or submit proposed blockouts for review.
2. Use nonshrink, nonmetallic grout.

3.7 CONCRETE SLAB FINISHES

A. General:

1. Do not use “jitterbugs” or other special tools designed for the purpose of forcing coarse aggregate away from the surface and allowing a layer of mortar, which will be weak and cause surface cracks or delamination, to accumulate.
2. Do not dust surfaces with dry materials.
3. Round off edges of slabs with a steel edging tool, except where a cove finish is shown. Steel edging tool radius shall be ¼-inch for slabs subject to wheeled traffic.
4. After curing as specified in Section CONCRETE CURING, and after applying the final floor finish, cover slabs with plywood or particle board or plastic sheeting or other material to keep floor clean and protect if from material and damage due to other construction work.
5. Patch and repair *defective* areas and areas damaged by construction.

B. Type S-1 (Steel Troweled Finish):

1. Finish by screeding and floating with straightedges to bring surfaces to required finish elevation. Use evaporation retardant.
2. While concrete is still green, but sufficiently hardened to bear a person’s weight without deep imprint, wood float to true, even plane with no coarse aggregate visible.
3. Use sufficient pressure on wood floats to bring moisture to surface.
4. After surface moisture has disappeared, hand trowel concrete to produce smooth, impervious surface, free from trowel marks.
5. Burnish surface with an additional troweling. Final troweling shall produce a ringing sound from trowel.
6. Do not use dry cement or additional during troweling, nor will excessive troweling be permitted.
7. Power Finishing:
    a. An approved power machine may be used in lieu of hand finishing in accordance with directions of machine manufacturer.
    b. Do not use power machine when concrete has not attained the necessary set to allow finishing without introducing high and low spots in slab.

        - c. Do first steel troweling for slab S-1 finish by hand.

- C. Type S-2 (Wood Float Finish):

    1. Finish slabs to receive fill and mortar setting beds by screeding with straightedges to bring surface to require finish plane.
    2. Wood float finish to compact and seal surface.
    3. Remove laitance and leave surface clean.
    4. Coordinate with other finish procedures.

- D. Type S-3 (Underside Elevated Slab Finish):

    1. When forming is removed, grind off projections on underside of slab and patch *defective* areas, including small shallow air pockets where schedule of concrete finishes requires:
    2. Leave surfaces ready for painting as specified in Section PAINTING.

- E. Type S-5 (Broomed Finish):

    1. Finish as specified for Type S-1 floor finish, except omit final troweling and finish surface by drawing a fine-hair broom lightly across the surface.
    2. Brooming: In same direction and parallel to expansion joints, or, in the case of inclined slabs, perpendicular to slope, except for round roof slab, broom surface in radial direction.

- F. Type S-6 (Sidewalk Finish):

    1. Slope walks down ¼-inch per foot away from structures, unless otherwise shown.
    2. Strike off surface by means or strike board and float with wood or cork float to a true plane, then flat steel trowel before brooming.
    3. Broom surface at right angles to direction of traffic or as shown.
    4. Lay out sidewalk surfaces in blocks, as shown or as directed by Engineer, with a grooving tool.

- G. Concrete Curbs:

    1. Float top surface of curb smooth, and finish all discontinuous edges with steel edger.
    2. After concrete has taken its initial set, remove front form and give exposed vertical surface and ordinary wall finish.

3.8 WATER LEAKAGE TESTS:

- A. Purpose: Determine integrity, watertightness, and appearance of finished concrete wall surfaces.

B. All Water-Holding Structures:

1. Perform leakage tests after concrete has cured and obtained its design strength, and before backfill, brick facing, or other work that will cover concrete wall surfaces is begun.
2. Install other equipment, e.g., stop gates, sluice gates, and temporary bulkheads, prior to test.
3. As an alternative to having watertight bulkheads, gates, or valves, isolate and accurately measure the leakage through gates, valves, and bulkheads with methods acceptable to OWNER'S REPRESENTATIVE. An assumed leakage through gates and valves based on MANUFACTURER's recommendations is not acceptable.
4. Fill with water to maximum liquid level shown and maintain level for 48 hours for moisture absorption by concrete.
5. Close all valves and gates to the structure and measure the change in water surface for a 24-hour period and record leakage through gates and valves.
6. During test period, examine exposed portions of structure for dampness or leaks and record visible leaks or damp spots.
7. Determine evaporation by floating an evaporation pan in structure during test period.

C. Acceptance Criteria:

1. Allowable 24-Hour Volume Loss: Less than 0.075 percent of volume of liquid contained in water-holding structure, accounting for evaporation when basin is full as shown.
2. No damp spots or seepage visible on exposed surfaces.

D. Repairs When Test Fails; Drain water-holding structure; fill leaking cracks with crack repair epoxy, patch surface areas and damp spots previously recorded, and repeat water leakage tests.

3.9 SCHEDULE OF CONCRETE FINISHES

A. Provide concrete finishes as scheduled:

Area	Type of Finish
EXTERIOR SLABS	
Roof slab/ covered with roofing material	S-1
Water-holding tanks and basins/ top of wall	S-1
Other water-holding tanks and basins	S-1
Stairs and landings	S-5
Sidewalks	S-6
Other exterior slabs	S-1
INTERIOR SLABS	
Buildings	S-1
Slabs to receive quarry tile	S-2

END OF SECTION

SECTION 03600
GROUT

PART 1 GENERAL

1.1 WORK INCLUDED

A. Furnishing, placing, and curing all structural and miscellaneous grout.

B. Furnishing and constructing all formwork required to place and restrain grout.

1.2 PROJECT/SITE CONDITIONS

A. Placement and curing of grout shall not be allowed during freezing, excessive heat or cold, rain, sleet, snow, or wind unless proper provisions/arrangements are provided.

B. Grout shall not be placed on or against frosted surfaces.

C. Hot-weather grouting shall be in conformance with ACI 305R.

D. Cold-weather grouting shall be in conformance with ACI 306R.

1.3 QUALITY ASSURANCE

A. Testing/Inspection agencies shall be in conformance with ASTM E329.

1.4 SEQUENCING AND SCHEDULING

A. Concrete to be grouted against shall be a minimum of 7 days old.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Grout shall be delivered to the site in the MANUFACTURER's original unopened labeled protective packages.

B. Grout materials at the site shall be stored off the ground in an enclosed area and stored/handled in such a manner as to prevent contamination and/or absorption of moisture.

C. Coarse aggregate shall be stored on a smooth hard surface and protected from mixture with foreign materials.

1.6 SUBMITTALS

A. Submittals shall be provided in accordance with Section 01300, Submittals, and the requirements of this Section.

B. Submittals shall be signed by a Professional Engineer licensed in the State of Washington.

C. Product information showing compliance with these Specifications shall be submitted to the OWNER’S REPRESENTATIVE for review prior to grout placement.

D. Test reports concerning compressive strength of grout signed by DESIGN/BUILD CONTRACTOR’S Engineer shall be submitted to the OWNER’S REPRESENTATIVE.

E. Inspection reports concerning grout placement shall be submitted to the OWNER’S REPRESENTATIVE.

PART 2 PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. "Burke" as manufactured by Burke Co.

B. "Sure-Grip" as manufactured by Dayton Superior Corp.

C. "Supreme" as manufactured by the Chemical Division of Gifford-Hill and Co. Inc.

D. "Crystex" as manufactured by L&M Construction Chemicals Inc.

E. "Masterflow 713" as manufactured by Master Builders Co.

F. "Set" as manufactured by Set Products Division of Master Builders Co.

G. "Grout F-100" as manufactured by Sauereisen Cements Co.

H. "Sonogrout" as manufactured by the Sonneborn Building Products Division of Contech Inc.

I. "Upcon High Flow" as manufactured by the Upco Division of Bostik.

J. "Five Star" as manufactured by U.S. Grout Corp.

K. "Sealtight 588" as manufactured by W.R. Meadows Inc.

2.2 MATERIALS

A. Grout: CE CRD C621 Type D, nongaseous, nonshrink, nonmetallic, premix type.

1. Compressive strength: 5,000 psi minimum at 7 days.
2. Shrinkage: 0.00 percent.
3. Expansion: 0.40 percent maximum.
4. Effective bearing area: 95 percent minimum.
5. Consistency: 100 to 125 flow for plastic and 125 to 145 flow for flowable in conformance with ASTM C230.
6. Placement time: 20 minutes minimum.

B. Coarse Aggregate: ASTM C33.

1. Material: Pea gravel.

C. Water shall conform to ASTM C94.

D. Curing Compound: ASTM C309, Type 1, Class B, all-resin type.

2.3 MIXES

A. Grout shall consist of a hydraulic cementitious system, specially graded natural fine aggregates, fluidity improvers, and expansion control additives. The use of iron aggregates, gypsum, carbon, chlorides, gas producing or gas liberating agents, and oxidizing agents shall not be permitted.

B. Maximum aggregate size shall be 3/8 inch minus.

C. No admixtures, antifreeze compounds, or other substances shall be added to the grout without prior review by the OWNER'S REPRESENTATIVE.

PART 3 EXECUTION

3.1 PREPARATION

A. Prior to placement of grout, all necessary formwork shall have been completed, all hole forms removed, all items positioned and secured in place, the space in which grout is to be placed free of all debris and rubbish, mud, standing water, etc., and the entire preparation inspected and accepted.

B. Surfaces to be grouted against shall be free from dirt, mud, dust, oil, grease, wax, curing compound, bond breaker, laitance and/or unsound material, loose or non-adherent rust, loose mill scale, paint/primer, and any foreign matter or coating that adversely affects the bonding capacity to the surfaces.

C. Concrete surfaces to be grouted against shall be roughened to a minimum 1/8 inch amplitude.

D. Surfaces to be grouted against shall be thoroughly dampened immediately prior to grout placement, but standing water shall not be permitted on the surfaces.

E. Form Construction Requirements:

1. Forms shall be of sound and sufficiently strong material.
2. Forms shall be sufficiently tight to prevent leakage of grout.
3. Forms shall be adequately braced and tied together.
4. Forms shall extend 1 inch minimum above bottom of base plates.
5. Exposed corners/edges shall be beveled with 3/4 inch by 3/4 inch chamfer strips.

F. Grout shall extend on all open sides of base plates a minimum distance equal to the thickness of the grout section.

G. Coarse aggregate shall be washed.

H. The CONTRACTOR shall take all suitable precautions against splattering grout on exposed/finish surfaces.

3.2 PLACEMENT

A. Grout shall be mixed and placed in accordance with the MANUFACTURER's written instructions and specifications.

B. Grout shall be mechanically mixed in a mortar mixer in quantities only as required for immediate use for a minimum of three minutes but not more than five minutes after all materials have been placed in the mixer and there is uniform distribution of materials. Hand mixing shall not be permitted.

C. Grout shall not be retempered after initial mixing.

D. Grout at sections thicker than 3 inches may have 25 percent of the grout weight in aggregate added as allowed by the grout manufacturer.

E. Grout shall be placed within 20 minutes after water has been added to the mix.

F. Grout shall be conveyed/placed at a regular rate, as close as possible to final position, in one direction only, in such a manner as to prevent segregation and/or loss of materials, and in a continuous operation until the section is completed.

G. Grout with a flowable consistency shall be placed in such a manner as to prevent formation of air pockets.

H. Grout shall be placed with a flowable or plastic consistency as best suits the situation.

I. Grout that has taken its initial set, has been retempered, has been contaminated by foreign materials, or has fallen on the ground shall not be placed.

J. Grout shall be consolidated. The use of vibratory equipment shall not be permitted.

K. Grout with a plastic consistency shall be consolidated every 3 inches minimum.

3.3 FINISHING

A. Forms shall not be removed until the grout has taken its initial set but not less than two hours after grout placement.

B. Exposed grout surfaces shall have a smooth form or troweled finish.

3.4 CURING

A. Curing of grout shall be by use of a curing compound or by use of an approved wet curing process for a minimum of three days after grout placement. Curing compounds shall be applied in accordance with the MANUFACTURER's written instructions and specifications. Exposed surfaces shall be treated immediately upon finishing or the stripping of forms.

B. Grout surfaces to receive special/protective coatings shall be cured by use of an approved wet curing process if required by the coating manufacturer's written instructions and specifications. Use of a curing compound shall not be permitted.

C. Curing compound shall not be allowed to come in contact with items to be finish painted.

D. Grout temperature shall be maintained above 50 degrees F for a minimum of three days after grout placement.

3.5 FIELD QUALITY CONTROL

A. Grout placement shall be continuously inspected, both during and after placement.

B. Sampling of grout, making and curing of grout prisms for compressive strength tests, and testing of compressive strength specimens shall be in accordance with the applicable provisions of ASTM C109.

C. One sample of grout for compressive strength tests shall be taken for every 25 cubic feet or fraction thereof of grout placed each day.

D. Four standard 2 inch by 2 inch by 2 inch prisms shall be made at each sampling.

E. Compressive strength tests shall be made at three days using one prism and at 7 days using two prisms. The fourth prism shall be tested at 28 days only if the 7 day tests are below the specified strength.

3.6 CLEANING

A. The CONTRACTOR shall clean all grout splatter from exposed/finish surfaces. All cleaned surfaces shall be equal to the original surface and shall not be visible.

3.7 PROTECTION

A. Grout shall be protected from construction operations, mechanical disturbances, water flow, and the weather for a minimum of three days after placement.

END OF SECTION

DIVISION 4
MASONRY

Section 04230 – Reinforced Unit Masonry

SECTION 04230
UNIT MASONRY

PART 1 GENERAL

1.1 SCOPE

A. All materials, labour and equipment required to complete all masonry work together with ancillary work herein described and implied to the full intent of the Drawings and Specifications including, but not limited to, the following: concrete block masonry and masonry reinforcing, anchors from structural steel to masonry, reinforced block lintels, compressible filler, mortar filling voids of hollow metal frame, build-in miscellaneous and structural steel items, door, anchors in frames, supply and setting of rebar at freestanding walls, supply and installation of anchor bolts in masonry for securing precast slab or metal construction, installation of loose steel lintels and other work as shown or specified on the Drawings.

1.2 RELATED WORK IN OTHER SECTIONS

A. It is the DESIGN/BUILD CONTRACTOR'S responsibility to coordinate all works described, shown and referenced in the Contract Documents.

1.3 SUBMITTALS

A. Shop Drawings:

1. Information illustrating horizontal joint reinforcement and preformed control joint materials proposed for use.
2. Grout mix design proposed for use.

B. Samples:

1. Individual samples of each type of masonry unit to be used on project.
2. Approval of samples for color and texture.

C. Quality Control Submittals:

1. Certification from manufacturers that masonry units meet specified requirements.
2. Grout mix design.
3. Certification from supplier that grout meets specified requirements.
4. Method of placing grout.
5. Mortar mix design.

1.4 DELIVERY, STORAGE, AND HANDLING

A. Storage and Protection: Keep lime and other ingredients dry.

1.5 ENVIRONMENTAL REQUIREMENTS

A. Temperature: Do not lay masonry when ambient temperature is below 32°F on a rising temperature or below 40°F on a falling temperature, or when there is a probability of such conditions occurring within 48 hours, unless written approval of procedures for protection from freezing is obtained.

B. Moisture Protection: Protect masonry construction from loss of moisture during curing period of 7 days when ambient air temperature is 90°F or greater and when relative humidity is less than 50 percent.

PART 2 PRODUCTS

2.1 MASONRY UNITS

A. General:

1. Furnish or cut special shapes for corners, jambs, lintels, and other areas shown or required.
2. Special units shall match color and texture of standard units.
3. Where units are placed so end of a unit is exposed, such as at a corner or intersection, the exposed end of that block shall have surface to match color and texture of sides of other units.
4. Furnish sound, dry, clean units free of cracks, prior to placing in structure.
5. Vertical Cells to be Grouted: Capable of alignment sufficient to maintain clear, unobstructed continuous vertical cell measuring minimum 2 inch by 3 inch.
6. Masonry unit size and shape shall allow for all placement patterns to prevent materials such as grout from escaping from cells being filled to adjacent cells where material is not intended to be placed.

B. Structural Concrete Masonry Units (CMU):

1. ASTM C90-90, Type I for humid humidity conditions of use, medium weight.
2. Size: 16 inches long by 8 inches high by thickness shown on Drawings.
3. Color of Units: Natural.
4. Surface Texture on Exposed Surfaces: Smooth.

2.2 MORTAR AND GROUT MATERIALS

A. Cement: ASTM C150-89, Type I or II, Portland cement.

B. Lime: ASTM C207-91, Type S hydrated lime.

C. Aggregates:

1. Mortar: ASTM C144-89, sand.
2. Grout: ASTM C404-87.

D. Water: Fresh, clean, potable.

2.3 HORIZONTAL JOINT REINFORCEMENT

A. Ladder Type Masonry Wall Reinforcement:

1. Install where shown and as specified.
2. Two parallel No. 9 wires, weld connected to No. 9 perpendicular cross wire at 15 inches on center, hot-dipped galvanized after fabrication with a minimum coating of 1.5 ounces per square foot in accordance with ASTM A153.
3. Reinforcement: Clean and free from loose rust, scale, and any coatings that reduce bond.
4. Provide special manufactured corner and wall intersection pieces at these locations.
5. Manufacturers:
    - a. Dur-O-Wall National, Inc., Cedar Rapids, IA.
    - b. AA Wire Products Co., Chicago, IL.

B. Deformed Bars: As specified in Section 03210 Reinforcing Steel.

2.4 MORTAR

A. Proportions: ASTM C270-89, Type S. Freshly prepared and uniformly mixed in ratio of 1 part Portland cement, ¼ part minimum to ½ part maximum lime putty or hydrated lime, damp loose sand not less than 2-1/4 and not more than 3 times the sum of volumes of cement and lime.

B. Mixing:

1. Machine mix in approved mixers.
2. Keep mixer drums clean and free of debris and died mortar.
3. Mix by placing ½ water and ½ aggregate in operating mixer.
4. Add cement.
5. Add remaining aggregate and water and mix for at least 2 minutes.

6. Add lime and continue mixing as long as needed to secure a uniform mass, but no less than 3 minutes after addition of lime.
7. Time addition of admixture in accordance with manufacturer’s instructions. Procedure used for adding it to mix shall provide good dispersion.
8. Follow manufacturer’s instructions for mortar plasticizer admixture.

2.5 GROUT

A. Proportions: Conform to ASTM C476-83 for coarse grout except as follows:

1. For Pouring: Fluid consistency (suitable for pouring without segregation) meeting requirements of ASTM C476-83.
2. For Pumping: Fluid consistency with minimum seven sacks of cement in each cubic yard.
3. Compressive Strength: Minimum 2,000 psi average at 28 days.

B. Mixing:

1. On-site: Follow procedure specified in Article MORTAR.
2. Transit-Mixed Grout: Meet requirements of ASTM C475-83.
3. Add approved grout admixture in accordance with specified grout admixture manufacturer’s recommendations, premix admixture with water and add resulting solution to grout mix and thoroughly mix. Do not exceed quantity of admixture recommended by manufacturer.

PART 3 EXECUTION

3.1 PREPARATION

A. Prepare surface contact area on foundation concrete for initial mortar placement using one of the following methods:

1. Sandblasting foundation and reinforcing dowels after concrete has fully cured to remove laitance and spillage and to expose sound aggregate.
2. Water blasting foundation and reinforcing dowels after concrete has partially cured to remove laitance and spillage and expose sound aggregate.
3. Green cutting fresh concrete with high pressure water and hand tools to remove laitance and spillage from foundation and reinforcing dowels and to expose sound aggregate.

B. Clean surfaces of loose material prior to initial mortar placement.

C. Prevent surface damage to foundation concrete that will be exposed to view outside of contact area.

3.2 LAYING REINFORCED MASONRY UNITS

A. General:

1. Conform to the International Building Code and ACI 530/ASCE 5, as supplemented by these Specifications.
2. Do not start laying masonry units unless foundation wall is plumb within ¼ inch in 10 feet or not straight within 4/16 inch in 10 feet.
3. Finish Tolerances (measured on interior surfaces):
   a. Maximum Permissible Variation from Plumb of Masonry Wall or of Line of Joints in Masonry Wall: 1/16 inch per foot of height, and ¼ inch in the total height of the wall.
   b. Maximum Permissible Variation from Horizontal Line Along Base of Wall or for Lines of Horizontal Joints: 1/16 inch per block, ¼ inch per 50 feet of wall with proportionately greater tolerance for longer walls up to ½ inch in total length of wall.
4. Units with chipped edges shall not be used.

B. Wall Units:

1. General:
   a. If necessary to move a unit after once set in place, remove from wall, clean, and set in fresh mortar.
   b. Toothing of masonry units is not permitted.
2. Running Bond:
   a. Lay up walls in straight, level, uniform courses using a running bond pattern.
   b. Place units for continuous vertical cells and mortar joints to prevent materials such as grout or poured insulation from escaping from cell being filled to adjacent cells where material is not intended to be placed.
3. Corners: Lay standard masonry bond for overlapping units and grout solid.
4. Intersecting Walls: Bond with reinforcement, not with masonry bond.

C. Special Shapes:

1. Provide and place such special units as corner block, door jamb block, lintel block fillers, and similar blocks as may be required.
2. Use required shapes and sizes to work to corners and openings, maintaining proper bond throughout wall.

3.3 BUILT-IN ITEMS

A. Position door frames, windows, vents, louvers, and other items to be built in the wall, and construct wall around them.

B. Install masonry anchors to secure items to wall.

C. Fill spaces around items with mortar or grout.

D. Do not place electrical, instrumentation, or water conduits in a cell containing reinforcement unless approved in writing by OWNER’S REPRESENTATIVE.

3.4 MORTAR JOINTS

A. General:

1. Straight, clean, with uniform thickness of 3/8 inch.
2. Horizontal and vertical mortar joints shall have full mortar coverage on face shells.
3. Vertical Head Joints:
    a. Butter well on each unit for a width equal to face shell of unit, shove tightly so mortar bonds well to both units.
    b. Solidly fill joints from face of block to at least the depth of face shell.
4. As units are laid, remove excess mortar from grout space of cells to be filled.
5. Place mortar before initial setting of cement takes place. Do not retemper mortar that has started to set.

B. Exposed Joints:

1. Tool joints exposed to view after final construction, unless otherwise noted or shown.
2. Cut joints flush and, as mortar takes its initial set, tool to provide a concave joint.
3. Perform tooling when mortar is partially set but still sufficiently plastic to bond.
4. Perform tooling with a tool which compacts mortar, pressing excess mortar out rather than dragging it out.
5. Rake out joints which are not tight at time of tooling, point, and then tool.

C. Concealed Joints: Strike flush with no further treatment required.

3.5 REINFORCING

A. Vertical Reinforcing:

1. Use deformed bars.
2. Hold in position near the ends of bars by wire ties to dowels or by reinforcing positioners.

3. Hold in position at maximum intervals of 160 bar-diameters by reinforcing positioners.

B. Horizontal Reinforcing:

1. Use deformed bars.
2. Lay on webs of bond beam units, and place as wall is built.
3. Lap reinforcing bars 48 bar-diameters minimum where spliced and wire tie together.
4. Minimum Bar Clearance: 1 bar-diameter from masonry and from additional parallel bars in same grout space.

3.6 GROUTING

A. General:

1. Do not mix, convey, or place with equipment constructed of aluminum.
2. Secure vertical and horizontal reinforcement, ties, bolts, anchors, and other required embedments in place, inspect and verify before placing grout.
3. Grout beams over openings in one continuous operation.
4. Maintain vertical alignment in cells to provide a clear, unobstructed, continuous vertical cell measuring not less than 2 inches by 3 inches.
5. Place grout as soon as possible after mortar has set to reduce shrinkage cracking of vertical joints.
6. Vertical Reinforcement:
    a. First wire tie to foundation dowels, then build wall around it.
    b. Provide reinforcing positioners or approved cross-bracing to secure top of steel in place.
    c. Do not drop in vertical steel after block is laid unless reinforcing positioners are provided in the course above previously grouted course.

B. Grouting Requirements:

1. Solid Grouting Requirements: Space vertical grout barriers maximum 30 feet apart, extending full height of wall.
2. Partial Grouting Requirements:
    a. Walls Not Requiring Solid Grouting: Fill cells containing reinforcing steel and others as shown with grout.
    b. Construct cells to be filled to confine grout within cell.
    c. Cover tops of unfilled vertical cells under a bond beam with metal lath to confine grout fill to bond beam section.
3. Form horizontal construction joints between pours by stopping the grout pour 1-1/2 inches below a mortar joint except at a bond beam, stop the pour ½ below the top of the masonry unit.

4. Place grout in lifts not to exceed 6 feet in height.
5. Fully embed horizontal steel by grout in an uninterrupted pour.
6. Do not construct wall more than one course above top of grout pour prior to placing grout.
7. Vibration:
    a. Use internal “pencil” type vibrator to thoroughly consolidate grout and reduce amount of air voids.
    b. After waiting sufficient time to permit the grout to become plastic, but before it has taken ay set, reconsolidate grout. Waiting period will vary depending upon weather conditions and block absorption rates but under “normal” weather conditions with average masonry units the waiting period should be between 30 and 60 minutes.
8. Cleanouts:
    a. Provide of sufficient size to permit cleaning of cell, positioning of reinforcing and inspection at bottom of every vertical cell containing reinforcing.
    b. Location: Concealed from view after final construction unless otherwise approved by OWNER’S REPRESENTATIVE.
    c. After all has been inspected and approved and prior to grouting, cap cleanouts in a manner that will seal them from grout leakage and provide a flush finish.

3.7 CLEANING

A. Immediately after completion of grouting, clean masonry surfaces, using clean water and fiber brushes, of excess mortar, grout spillage, scum, stains, dirt, and other foreign substances.

B. Clean walls not requiring painting or sealing such that there are no visible stains.

3.8 PROTECTION OF INSTALLED WORK

A. Do not allow grout and mortar stains to dry on face of exposed masonry.

B. When moisture protection is required, use light fog spray nozzles to cure mortar.

C. Protect tops of walls at all times. Cover tops of walls with waterproof paper when rain or snow is imminent and when Work is discontinued.

D. Adequately brace walls until walls and roof are completed.

E. Provide sufficient bracing to protect walls against damage from elements, including wind and snow.

F. Protect masonry against freezing for minimum 72 hours after being laid.

G. Protect masonry from damage until final acceptance of Work. Damaged units will not be accepted.

END OF SECTION

DIVISION 5
METALS

Section 05120 –Structural Steel
Section 05500 – Metal Fabrications
Section 05510 – Metal Stairs
Section 05521 – Pipe and Tube Railings
Section 05530 – Metal Grating

SECTION 05120
STRUCTURAL STEEL

PART 1 GENERAL

1.1 WORK INCLUDED

A. Furnishing and erecting all structural steel, accessories, and fasteners.

B. Furnishing and installing all miscellaneous framing and fasteners around openings.

C. Furnishing and installing all bridge crane rails, accessories, and fasteners.

D. Furnishing and installing all under running monorail beams, accessories, and fasteners.

E. Shop priming.

F. Epoxy painting.

1.2 DELIVERY, STORAGE, AND HANDLING

A. Structural steel and fabricated accessories shall be delivered to the site prime painted or special painted, except as otherwise specified, and marked with a piece number.

B. Structural steel, accessories, and fasteners at the site shall be stored off the ground and stored/handled in such a manner as to prevent soiling, corrosion, and/or damage.

1.3 SUBMITTALS

A. Submittals shall be provided in accordance with Section 01300, Submittals, and the requirements of this Section.

B. Submittals shall be signed by a Professional Engineer licensed in the State of Washington.

C. Shop and erection drawings shall show all piece numbers, grades, profiles, sizes, dimensions, cambers, fasteners, welds, holes, hole types, paint masking, positions, spacing, welding processes, connections, etc. for the fabrication and erection of all structural steel.

D. Shop and erection drawings shall be submitted to the OWNER’S REPRESENTATIVE for review prior to fabrication and erection.

E. Mill test reports certifying physical and chemical properties for each lot of A325 bolts, including tension-control type, to be delivered to the site shall be submitted to the OWNER'S REPRESENTATIVE prior to erection.

F. Product information showing compliance with these Specifications shall be submitted to the OWNER'S REPRESENTATIVE for review prior to installation.

G. A copy of all welders certifications shall be submitted to the OWNER'S REPRESENTATIVE for review prior to any welding.

H. Inspection reports concerning fabrication, epoxy painting, and erection of structural steel shall be submitted to the OWNER'S REPRESENTATIVE.

I. Test/Inspection reports concerning welding and high strength bolt tightening shall be submitted to the OWNER'S REPRESENTATIVE.

PART 2 PRODUCTS

2.1 MATERIALS

A. Steel Shapes, Plates, and Bars: ASTM A36 or A572, Grade 50 as shown on the Drawings.

B. Steel Pipe: ASTM A53 Grade B.

C. Steel Shaped Tubing: ASTM A500 Grade B.

D. Standard Hex Head Bolts with Hex Nuts: ASTM A307 Grade A.

E. High Strength Hex Head Bolts with Heavy Hex Nuts: ASTM A325.

F. Hook Bolts with Heavy Hex Nuts: ASTM A307 Grade B.

G. Standard and Heavy Hex Nuts: ASTM A563.

H. Locknuts: IFI-100 Grade A or B prevailing-torque type "Stover" as manufactured by Lawson and Sessions Co. or "Ovalox" as manufactured by Russell, Burdsell & Ward Inc.

Bolt Type	Nut Grade
A307	A
A325	B

I. Plain Washers: ANSI B18.22.1 Type A-W.

J. Plain Hardened Washers: ASTM F436.

K. Load Indicator Washers: ASTM F959 Type 325 "Coronet" as manufactured by the Cooper & Turner Division of J&M Turner Inc.

L. Beveled Washers: ANSI B18.23.1.

M. Helical Spring Washers: AREA type.

N. Welding Filler Metal: AWS A5.1 or A5.5 E70XX for SMAW welding process, AWS A5.18 ER70S-X for GMAW welding process, AWS A5.17 or A5.23 F7X-EXXX for SAW welding process, and AWS A5.20 E7XT-X for FCAW welding process.

O. Standard Prime Paint: SSPC-Paint 13 "Red or Brown One- Coat Shop Paint" or SSPC-Paint 15 "Steel Joist Shop Paint," Type I - Red Oxide Paint.

P. Epoxy Paint: SSPC-Paint 22 Epoxy-Polyamide Paints:

    1. Color: Green

2.2 FABRICATION

A. Structural steel shall be completely shop fabricated except as otherwise shown on the Drawings.

B. Structural steel shall conform accurately to the shape and dimensions as shown on the Drawings within the allowable tolerances as defined in Section 6.4 of AISC "Code of Standard Practice."

C. Sheared and flame cut edges shall be true to line and free from rough corners and projections.

D. Re-entrant cuts/corners shall be filleted to a radius of not less than 1/2 inch.

E. Holes shall be punched, sub-punched and reamed, or drilled in accordance with Section 1.23.4 of AISC "Specifications for Structural Steel." Holes shall not be made by flame cutting.

F. Holes shall be 1/16 inch larger than the nominal bolt diameter, except holes for cast-in-place anchor bolts which shall be 5/16 inch larger than the nominal bolt diameter and as otherwise shown on the Drawings.

G. The use of oversize or slotted holes not shown on the Drawings shall be subject to prior review by the OWNER’S REPRESENTATIVE.

H. Bent plate shall be in accordance with AISC "Minimum Radius for Bending".

I. Column ends bearing upon base and cap plates and beam ends with end plates shall be saw-cut or milled to true surfaces and correct bevels.

J. Column base plate bearing surfaces on plates 2 inches or more in thickness shall be milled to true surfaces except at surfaces to be grouted against.

K. Column caps and base plates and beam end plates shall have full contact when assembled.

L. Welding shall be done in a sequence which minimizes distortion and shrinkage.

M. Headed concrete anchors shall be shop welded in accordance with AWS C5.4 and Chapter 7 of AWS D1.1.

N. Fabrication holes, notches, etc. not required by nor shown on the Drawings shall be subject to prior review by the OWNER’S REPRESENTATIVE.

2.3 FINISHES

A. Structural steel except surfaces and anchors encased in concrete, surfaces to be grouted against, faying surfaces at high strength friction-type bolted A325F connections, surfaces to be epoxy painted, under monorail running surfaces, and surfaces to be welded, shall be prime painted with a minimum dry film thickness of 2 mils.

B. Structural steel, where shown on the Drawings to be epoxy painted, shall be painted with a minimum dry film thickness of 3 mils each for primer and intermediate coats and 2 mils for the finish coat in accordance with SSPC PS 13.01 "Epoxy-Polyamide Painting System."

C. Surface preparation for prime painting shall be in accordance with SSPC SP1 "Solvent Cleaning" and SP2 "Hand Tool Cleaning" or SP3 "Power Tool Cleaning."

D. Surface preparation for epoxy painting shall be in accordance with SSPC SP1 "Solvent Cleaning" and SP6 "Commercial Blast Cleaning."

E. Faying surfaces at high strength friction-type bolted A325F connections shall be protected against over-spray by use of masking. Inadvertent over-spray shall be removed from the faying surfaces at high strength friction-type bolted A325F connections.

F. Surfaces to be welded shall be protected from painting by use of masking. Inadvertent overspray on surfaces to be welded shall be removed by wire brushing.

G. Prime paint application shall be in accordance with SSPC PA1 "Shop, Field, and Maintenance Painting."

2.4 SOURCE QUALITY CONTROL

A. A minimum of 10 percent of high strength bolts in a connection using load indicator washers or tension control bolts, but not less than two bolts, shall be inspected after tightening. Load indicator washers shall be inspected after tightening using a metal feeler gauge.

B. Acceptance of welding inspection results shall be in accordance with Sections 8.15 and 10.17 of AWS D1.1.

C. Structural steel blast cleaned for epoxy painting shall be inspected after cleaning and prior to primer painting.

D. Acceptance of blast cleaning inspection shall be in accordance SSPC VIS-1 "Pictorial Surface Preparation Standards for Painting Steel Surfaces."

E. A minimum of 10 percent of headed concrete anchors shall be tested in accordance with Section 7.7 of AWS D1.1.

PART 3 EXECUTION

3.1 PREPARATION

A. At the time of connecting, all bearing surfaces shall be free from loose or non-adherent rust, loose mill scale, oil, grease, dirt, mud, and any foreign matter, coating, or defect that adversely affects the connection.

B. At the time of connecting, all faying surfaces at high strength friction-type bolted A325F connections shall be free from loose or non-adherent rust, loose mill scale, oil, grease, dirt, mud, and any foreign matter, coating, or defect that adversely affects the connection.

C. Surface preparation for welding shall be in accordance with Section 3.2 of AWS D1.1 except loose or non-adherent rust, loose mill seal and paint shall be removed by wire brushing.

D. At the time of composite concrete slab placement, structural steel beams shall be shored at 10 feet on center maximum with the shores remaining in place until the concrete has attained 60 percent of its specified compressive strength as substantiated by field cured test cylinders.

3.2 ERECTION AND INSTALLATION

A. Structural steel shall be located and erected/placed so as to conform accurately with the Drawings within the allowable tolerances as defined in Section 7.11 of AISC "Code of Standard Practice."

B. Monorails shall be located and erected so as to conform accurately to the Drawings within the allowable tolerances as defined in Section 1.4.2 of CMAA No. 74.

C. Monorail joints shall have a maximum separation of 1/16 inch.

D. Connections shall be as shown on the Drawings. Connections and splices not shown on the Drawings shall be subject to prior review by the OWNER’S REPRESENTATIVE.

E. High strength bolts shall be installed and tightened in accordance with Section 8 of RCSC "Specifications For Structural Joints."

F. High strength bolted connections, except as indicated on the Drawings as "snug tight" or "slip joint," shall be installed and tightened using load indicator washers or tension control bolts.

G. Connection parts in connections using load indicator washers or tension control bolts shall be properly drawn together, bolts initially tightened to a snug-tight condition, and tightening in a connection beginning at the most rigid or stiffest point and progressing toward the free edges.

H. Load indicator washers shall be installed and the bolts tightened so that the washer protrusions flatten in accordance with the MANUFACTURER's written instructions and specifications.

I. Load indicator washer protrusions shall face the bolt head or nut which it is under and bear against a hardened surface bolt head or hardened washer. Bearing against the steel or nut shall not be permitted.

J. Complete flattening of load indicator washer protrusions shall be avoided.

K. Tension control high strength bolts shall be tightened so that the spline drive end shears at the break-neck groove.

L. Connection parts in connections not "slip joints" or using load indicator washers shall be properly drawn together and the bolts tightened to the snug-tight condition, with tightening in the connection beginning at the most rigid or stiffest point and progressing toward the free edges.

M. Bolts in "slip joint" connections shall be provided with lock nuts and initially tightened to the snug-tight condition, then backed off 1/2 turn.

N. Standard bolt heads and nuts at oversized and slotted holes shall be provided with plain washers.

O. High strength bolt heads and nuts at oversized and slotted holes shall be provided with plain hardened washers. Load indicator washers shall not be substituted for these required washers.

P. Bolt heads and nuts at sloped surfaces shall be provided with beveled washers.

Q. Nuts at crane rail connections (joints, rail clips/clamps, hook bolts, etc.) shall be provided with helical spring washers.

R. Welding shall be done in a sequence which minimizes distortion and shrinkage.

S. Shear connector studs shall be welded in accordance with AWSC5A and Chapter 7 of AWS D1.1.

T. Shear connector stud spacing shall be in accordance with Section 1.11.4 of AISC "Specifications for Structural Steel."

U. Holes that must be enlarged to admit bolts shall be reamed. Holes shall not be enlarged by flame cutting.

V. Filler and/or shim plates shall be furnished and installed by the CONTRACTOR to provide alignment of members where required due to mill and/or fabrication tolerances.

3.3 FIELD QUALITY CONTROL

A. Structural steel shall be inspected and approved by DESIGN/BUILD CONTRACTOR’S Engineer and OWNER’S REPRESENTATIVE after erection.

B. A minimum of ten percent of slip joint connections shall be inspected.

C. Acceptance of welding inspection results shall be in accordance with Sections 8.15 and 10.17 of AWS D1.1.

D. A minimum of 10 percent of shear connector studs shall be tested in accordance with Section 7.7 of AWS D1.1.

3.4 REPAIR AND CLEANING

A. Abraded and scarred areas and connections on painted surfaces exposed to view shall be repaired with the same kind of paint and with a minimum dry film thickness equal to that previously applied to the steel.

END OF SECTION

SECTION 05500
METAL FABRICATIONS

PART 1 GENERAL

1.1 WORK INCLUDED

A. Furnishing and installing all miscellaneous metal fabrications and fasteners.

B. Furnishing and installing all steel bar grating, accessories, and fasteners.

C. Furnishing and installing all safety grating, accessories, and fasteners.

D. Shop priming.

E. Hot-dip galvanizing.

F. Epoxy painting.

1.2 SUBMITTALS

A. Shop Drawings: Metal fabrications, including welding and fastener information.

1. Detailed Design Drawings, signed by a professional Engineer licensed in the State of Washington.
2. Anchoring Systems: Specific instructions for all phases of installation including hole size, preparation, placement, procedures, and instructions for safe handling.

B. Samples:

1. Epoxy Anchors: Two self-contained epoxy adhesive cartridges for each batch of epoxy delivered to site, for independent testing.
2. Color Samples of abrasive nosings.
3. Vinyl Ester Anchors: Two self-contained adhesive cartridges for each batch of adhesive delivered to site, for independent testing.

C. Quality Control Submittals:

1. Vinyl Ester and Epoxy Anchors:
    a. MANUFACTURER’s Certificate of Compliance.
    b. MANUFACTURER’s past project experience data.
    c. Test reports for each batch of vinyl ester or epoxy delivered to site.
    d. MANUFACTURER’s Certificate of Qualification for installers.

        e. Current test data indicating that cured adhesive anchors meet or exceed design loads.
    2. Welders: Evidence of certification.

1.3 QUALITY ASSURANCE

A. Qualifications:

    1. Welders: Certified in accordance with AWS D1.1-2010, Chapter 5.
    2. Vinyl Ester and Epoxy Anchor Manufacturers: Experience on at least three similar projects within the last 3 years.
    3. Vinyl Ester and Epoxy Anchor Installers: Trained and certified by the MANUFACTURER.

B. Regulatory Requirements:

    1. Anchoring Systems:
        a. Current evaluation and acceptance reports by ICBO or other similar code organization.
        b. Acceptable for use in potable water structures by EPA and local health agencies or NSF.

C. Welding Procedures: Follow the requirements of AWS D1.1-2010 and AWS D1.2-2008.

1.4 DELIVERY, STORAGE, AND HANDLING

A. Preparation for Shipment:

    1. Insofar as practical, factory assembled items specified herein.
    2. Package and clearly tag parts and assemblies that are of necessity shipped unassembled, in a manner that will protect materials from damage, and facilitate identification and field assembly.

B. Storage of Epoxy Adhesive:

    1. Store epoxy cartridges on pallets or shelving in a covered storage area.
    2. Control temperature above 60°F and dispose of cartridges if shelf life has expired.

C. Storage of Vinyl Ester Products:

    1. Store components on pallets or shelving in a covered storage area with locking door.
    2. Control temperature within 41 to 77°F and dispose of product if shelf life has expired.

PART 2 PRODUCTS

2.1 MATERIALS

A. Unless otherwise indicated, meet the following requirements:

Item	ASTM Specification
Steel Shapes and Plates	A36-08
Steel Pipe	A501-07 or A53-10, Type E or S, Grade B
Structural Steel Tubing	A500-10a, Grade B
Stainless Steel:	
Bars and Shapes	A276-10, AISI Type 316
Steel Plate, Sheet, and Strip	A167-99(2009), AISI Type 316
Bolts and Threaded Rods	A193 -10a, AISI Type 316, B8MN, B8M2, or B8M3
Nuts	A194-10a, AISI Type 316, B8MN, B8M2, or B8M3
Steel Bolts and Nuts:	
Carbon Steel	A307-10 or A36-08
High-Strength	A325-10, Type 3
Galvanized Steel Bolts & Nuts	A307-10 or A36-08, with A153-09 Zinc Coating, and ANSI B1.1-89
Eyebolts	A489-04e1
Threaded Rods	A36-08
Flat Washers (Unhardened)	F844-07a; use A153-09 for Zinc Coating
Flat Washers (Hardened)	F436-10
Aluminum, Structural Shapes & Plates	B209-07 and B308-10, Alloy 6061-T6
Aluminum Bolts and Nuts	F468-10, Alloy 2024-T4
Cast iron	A48-03(2008), Class 35

B. Anchor Bolts: As specified by DESIGN/BUILD CONTRACTOR, appropriate for the intended service, and local seismic conditions.

C. Anchor Bolt Sleeves:

1. High Density Polyethylene Plastic:
   a. Single unit construction with deformed sidewalls such that the concrete and grout lock in place.

    - b. The top of the sleeve shall be self-threading to provide adjustment of the threaded anchor bolt projection.
    - c. Material requirements:
        - 1) Plastic: High density polyethylene.
        - 2) Density: ASTM D1505-10.
        - 3) Vicat Softening Point: ASTM D1525-09.
        - 4) Brittleness Temperature: ASTM D746-07.
    - d. MANUFACTURER: Sinco West, Simi Valley, CA.
  - 2. Fabricated Steel Sleeve: A36-08 steel.

- D. Anti-seizing Lubricant: Lubricant shall contain substantial amounts of molybdenum disulfide, graphite, mica, talc, or copper. Use Loc Tite Co., Permatex.

- E. Neoprene Gasket:

  - 1. ASTM D1056-07 Grade 2C1-E1, soft, closed-cell, neoprene gasket material, suitable for exposure to sewage and sewage gases, unless otherwise shown.
  - 2. Thickness: Minimum ¼-inch.
  - 3. Furnish without skin coat.
  - 4. Manufacturers and Product:
    - a. Rubatex Division of Great American Industries, Bedford, BA; Rubatex No. R-411-N.
    - b. Garlock Manufacturing, San Francisco, CA.

- F. Pipe Sleeves: As specified in Section PLANT PIPING – GENERAL.

2.2 ANCHORING SYSTEMS FOR CURED CONCRETE

- A. Wedge Anchors: AISI Type 316 stainless steel throughout.

  - 1. Manufacturers and Products:
    - a. ITT Phillips Drill Div., Michigan City, IN.
    - b. Hilti, Inc., Tulsa, OK; Hilti Super Kwik-Bolt, stud type.
    - c. Wej-It Corp., Broomfield, CO; Wed-It.
    - d. Molly Division of Emhart Corp., Temple, PA; Parabolt Concrete Anchors.

- B. Expansion Anchors:

  - 1. Self-drilling anchors, snap-off type or flush type.
  - 2. Furnish anchors for use with galvanized bolts.
  - 3. Non-drilling Anchors: Flush type for use with bolt, or stud type with projecting threaded stud.

4. Manufacturers and Product:
   a. ITT Phillips Drill Div., Michigan City, IN.
   b. Hilti, Inc., Tulsa, OK; Hilti HDI Drop-In anchors.

C. Epoxy Anchors:

1. Anchor Rod: Stainless steel threaded rod free of grease, oil, or other deleterious material with a 45-degree chisel point.
2. Epoxy Adhesive:
   a. ASTM C881-10, Type 1, Grade 3, Class A, B, or C.
   b. Two-component, 100 percent solids, non-sag, past, insensitive to moisture, designed to be used in adverse freeze/thaw environments and gray in color.
   c. Cure Temperature, Pot Life, and Workability: Compatible for intended use and environmental conditions.
3. Mixed Epoxy Adhesive: Non-sag paste consistency, with ability to remain in a 1-inch diameter overhead drilled hole without runout, having the following properties:
   a. Slant Shear Strength, ASTM C881-10, No Failure In Bond Line, Dry/Moist Conditions: 5,000 psi.
   b. Compressive Strength, ASTM D695-10: 14,000 psi, minimum.
   c. Tensile Strength, ASTM D695-10: 4,500 psi.
   d. Heat Deflection Temperature, ASTM D648-07: 135°F, minimum.
4. Epoxy Adhesive Packaging: Disposable, self-contained cartridge system capable of dispensing both epoxy components in the proper mixing ratio, and fit into a manually or pneumatically operated caulking gun.
   a. Cartridge Markings: Include manufacturer’s name, batch number, mix ratio by volume, product expiration date, ANSI hazard classification, and appropriate ANSI handling precautions.
5. Manufacturers and Products:
   a. Adhesives Technology Corp.; Anchor-It Fastening Systems, Hs 200 Epoxy Resin.
   b. ITW Ramset/Red Head; Epcon Ceramic 6 Epoxy Anchor System.
   c. Covert Operations; CIA Epoxy Anchors with viscosity to suit application.
   d. Rawlplug Co., Inc.; Rawl/Sika Foil Fast Epoxy Injection Gel System.

D. Vinyl Ester Adhesive Anchor Systems: Two-component, insensitive to moisture, designed to be installed in adverse freeze/thaw environments.

1. Cure Temperature, Pot Life, and Workability: Compatible for intended use and anticipated environmental conditions.

2. Container Markings: Include manufacturer’s name, product name, batch number, product expiration date, ANSI hazard classification, and appropriate ANSI handling precautions.
3. Anchor Rods: Stainless steel threaded rods, sized by adhesive manufacturer for design loads required and adhesive system used.
4. Manufacturer and Product: Hilti, Inc.; HIT Doweling Anchor System (HIT C-100).

2.3 ABRASIVE NOSINGS FOR CONCRETE STAIRS

A. Except as otherwise shown, furnish flush type abrasive nosings on stairs.

B. Nosing Components:

   1. Homogeneous epoxy abrasive, with minimum 50 percent aluminum oxide content, formed and cured upon an extruded aluminum base.
   2. Epoxy abrasive shell extend over and form curved front edge of nosing to minimum depth of ½-inch.
   3. Base of Nosing: Extruded aluminum alloy, 6063-T5, heat-treated.
   4. Uniform disbursement of aluminum oxide grit particles encapsulated in a metal matrix and bonded to substrate by electric arc spray process utilizing high purity aluminum, bonded to base metal.

C. Anchoring System: Double-set anchors consisting of two rows of integrally extruded anchors.

D. Size: 3-inch wide by ¼- to 3/8-inch thick by length 4 inches less than width of stair tread.

E. Manufacturers and Products:

   1. Wooster Products Inc.; Spectra Type WP-3J and WP-3C.
   2. American Abrasive Metals Co.; Amcolun type BF3 and DSA3.
   3. IKG Industries; Mebac Nosings type C-3E.

2.4 FABRICATION

A. General:

   1. Finish exposed surface smooth, sharp, and to well-defined lines.
   2. Furnish necessary rabbets, lugs, and brackets so work can be assembled in neat, substantial manner.
   3. Conceal fastenings where practical; where exposed, flush countersink.
   4. Drill metalwork and countersink holes as required for attaching hardware or other materials.
   5. Round sharp edges to small uniform radius. Grind burrs, jagged edges, and surface defects smooth.

6. Material thinner than 1/8 inch: Either galvanize before fabrication in accordance with ASTM A653-10, Coating Designation G210, or after fabrication in accordance with ASTM A123-09, except the weight of zinc coating shall average minimum 1.2 ounces per square foot of actual surface area with no individual specimen having a weight less than 1 ounce per square foot.

B. Materials: Use steel shapes unless otherwise noted.

C. Fabrication:

1. Fit and assemble in largest practical sections for delivery to site.
2. Fabricate as shown on Drawings and in accordance with ASTM A385-09.
3. Weld connections and grind exposed welds smooth. When required to be watertight, make welds continuous.
4. Use fasteners as shown or scheduled.
5. Grind cut edges smooth and straight.

D. Finish: ASTM A123-09 hot-dip galvanize after fabrication, unless otherwise noted.

1. For items embedded in concrete, coat with System No. 27 as specified in Section PAINTING.
2. Galvanize components of bolted assemblies separately before assembly. Galvanizing of tapped holes is not required.
3. Except for inlet grates not otherwise required to be welded, completely seal edges of tightly contacting surfaces, where galvanizing is required, by welding before galvanizing.

E. Watertight: Where required or shown, furnish rubatex gaskets of a type that is satisfactory for use in contact with sewage. Cover full bearing surfaces.

F. Fitting: Where movement of fabrications is required or shown, cut, fit, and align items for smooth operation. Make corners square and opposite sides parallel.

G. Accessories: Furnish as required for a complete installation. Fasten by welding or with stainless steel bolts or screws.

H. Aluminum:

1. Fabricate in accordance with the Aluminum Association Standards and MANUFACTURER’S recommendations as approved.
2. Grind smooth sheared edges exposed in finish work.

2.5 WELDING

A. General:

1. Meet codes for Arc and Gas Welding in Building construction of the ASW and AISC for techniques for welding employed, appearance, quality of welds made, and the methods of correcting *defective* work.
2. Welding Surfaces: Free from loose scale, rust, grease, paint, and other foreign material, except mill scale which will withstand vigorous wire brushing may remain.
3. A light film of linseed oil may likewise be disregarded.
4. Do no weld when temperature of base metal is lower than 0°F.
5. Finished members shall be true to line and free from twists.
6. Prepare welds and adjacent areas such that there is:
    a. No undercutting or reverse ridges on the weld bead.
    b. No weld spatter on or adjacent to the weld or area to be painted.
    c. No sharp peaks or ridges along the weld bead.
7. Grind embedded pieces of electrode or wire flush with adjacent surface of weld bead.
8. Complete welding before applying finish.

B. Aluminum:

1. Weld with Gas Metal Arc (MIG) or Gas Tungsten Arc (TIG) processes in accordance with MANUFACTURER’s written instructions as approved, and in accordance with recommendations of the American Welding Society contained in the Welding Handbook.
2. Grind smooth all exposed aluminum weld.

PART 3 EXECUTION

3.1 INSTALLATION OF METAL FABRICATIONS

A. General:

1. Install metal fabrications plumb or level, accurately fitted, free form distortion or defects.
2. Install rigid, substantial, and neat in appearance.
3. Erect steel in accordance with applicable portions of AISC Code of Standard Practice, except as modified.
4. Install manufactured products in accordance with MANUFACTURER’s recommendations.
5. Allow for erection loads, and for sufficient temporary bracing to maintain true alignment until completion of erection and installation of permanent attachments.
6. Field weld components indicated.

7. Perform field welding in accordance with AWS D1.1-2010.
8. Obtain OWNER'S REPRESENTATIVE'S approval prior to site cutting or making adjustments not scheduled.
9. After erection, apply prime or galvanize coating to welds, abrasions, and surfaces not in contact with concrete.

B. Erection Tolerances:

1. Maximum Variation from Plumb: ¼-inch per story, noncumulative.
2. Maximum Offset from True Alignment: ¼-inch.

C. Aluminum:

1. Erection: In accordance with the Aluminum Association specifications.
2. Do not remove mill markings from concealed surfaces.
3. Remove inked or painted identification marks on exposed surfaces not otherwise coated after installed material has been inspected and approved.

D. Pipe Sleeves:

1. Provide where pipes pass through concrete or masonry.
2. Holes drilled with a rotary drill may be provided in lieu of sleeves in existing walls.
3. Provide a center flange for water stoppage on sleeves in exterior or water-bearing walls.
4. Provide a rubber caulking sealant or a modular mechanical unit to form a watertight seal in the annular space between pipes and sleeves unless noted otherwise.

3.2 ANCHOR BOLTS

A. Accurately locate and hold anchor bolts in place with templates at the time concrete is placed.

B. Use sleeves for location adjustment and provide two nuts and one washer per bolt of same material as bolt. Minimum bolt size: ½-inch diameter by 12 inches long, unless otherwise shown.

3.3 ANCHORING SYSTEMS FOR CONCRETE

A. Begin installation only after concrete or masonry receiving anchors have attained design strength.

B. Do not install an anchor closer than six times its diameter to either an edge of concrete or masonry, or to another anchor, unless specifically shown otherwise.

C. Install in accordance with MANUFACTURER’s specific quality control submittal instructions. Hole diameters are critical to installation, use only drills recommended by anchor manufacturer. Follow MANUFACTURER’s safe handling instructions.

D. Epoxy Anchors: Do not install when temperature of concrete is below 35°F or above 110°F.

E. Follow specific MANUFACTURER safe handling practices when handling and installing concrete anchors.

3.4 ABRASIVE NOSINGS

A. Provide abrasive nosings on concrete steps not being supplied or coated with another type of nosing or nonskid material.

3.5 ELECTROLYTIC PROTECTION

A. Aluminum:

1. Where in contact with dissimilar metals, or embedded in masonry or concrete, protect surfaces as specified in Section PAINTING, System No. 27.
2. Allow paint to dry before installation of the material.
3. Protect painted surfaces during installation.
4. Should coating become marred, prepare and touch up in accordance with paint manufacturer’s written instructions.

B. Where titanium equipment is in contact with concrete or dissimilar metals, provide full-face neoprene insulation gasket, 3/32-inch minimum thickness and 70 durometer hardness.

3.6 MANUFACTURER’S SERVICES

A. Epoxy and Vinyl Ester Anchors: Conduct site training of installation personnel for safe and proper installation, handling, and storage of epoxy or vinyl ester adhesive system. Notify OWNER’S REPRESENTATIVE of time and place for sessions.

3.7 FASTENER SCHEDULE

A. Provide fasteners as follows:

Service Use and Location	Product	Remarks
Anchor Bolts Cast Into Concrete for Equipment Bases:		
Nonsubmerged	Stainless steel bolts, unless otherwise specified with equipment	
Anchor Bolts Cast Into Concrete for Metal Fabrications and Structural Components:		
Dry or Protected Areas	Zinc-coated steel bolts	
Exterior, Wet, Washdown, and Chemical Handling Areas	Stainless steel bolts	
Anchors for Metal Components to Concrete; e.g., Electrical Panels and Equipment:		
Dry Areas	Expansion Anchors	
Wet and Damp Areas	Wedge anchors or stainless steel expansion anchors	
Submerged or Buried in Earth	Epoxy or adhesive anchors	
Connections for Steel Components and Fabrications:		
Exterior and Interior	High-strength zinc-coated steel bolts with hardened washers under head and nut	Use compressible washer type direct tension indicators
Connections for Steel and Wood Components:		
Exterior and Interior	Zinc-coated steel bolts	
Connections for Aluminum Components:		
Exterior and Interior	Stainless steel bolts	
All Others:		
Exterior and Interior	Stainless steel fasteners	

B. Anti-seizing Lubricant: use on all stainless steel threads.

C. Do not use epoxy anchors near fire or where ambient temperature will exceed 100°F.

END OF SECTION

SECTION 05510
METAL STAIRS

PART 1 GENERAL

1.1 WORK INCLUDED

A. Steel stair frame of structural sections, with open risers.

B. Open grate, Pan to receive concrete fill.

C. Balusters and handrailing.

1.2 WORK FURNISHED BUT INSTALLED UNDER OTHER SECTIONS

A. Furnish anchors to be cast in concrete to Section 03310, Concrete.

1.3 DESIGN REQUIREMENTS

A. Stairs and railings must meet OSHA 1910 requirements, as a minimum.

B. Fabricate stair assembly to support live load of 100 lb/sq ft with deflection of stringer not to exceed 1/240 of span.

C. Load to railing assembly, wall rails, and attachment without permanent set: A simultaneous vertical and horizontal thrust of 50 pounds/in. ft. applied at the top of the railing, or 200 pounds, whichever is greater.

D. Stair Rise and Run: Maximum stair rise 7 inches; minimum run 11 inches.

E. Stair Size: as indicated on the Drawings.

1.4 SUBMITTALS

A. Submittals shall be in accordance with the provisions of Section 01300, Submittals, and the requirements of this Section.

B. Submittals shall be signed by a Professional Engineer licensed in the State of Washington.

C. Indicate profiles, sizes, connection attachments, reinforcing, anchorage, openings, size and type of fasteners, and accessories.

D. Include erection drawings, elevations, and details where applicable.

E. Indicate welded connections using standard AWS welding symbols. Indicate net weld lengths.

PART 2 PRODUCTS

2.1 MATERIALS

A. Steel Section: ASTM A36.

B. Steel Tubing: ASTM A500, Grade B, ASTM A501, ASTM A53, Grade B, Schedule 40.

C. Bolts, Nuts, and Washers: ASTM A325.

D. Gratings: Same as walkway grating type.

E. Welding Materials: AWS D1.1; type required for materials being welded.

F. Touch-up Primer for Galvanized Surfaces: FS TT-P-641.

G. Exposed Mechanical Fastenings: Flush countersunk screws or bolts; unobtrusively located; consistent with design of structure.

H. Stair Treads: same as walkway grating type with nonslip edge.

2.2 FABRICATION - GENERAL

A. Verify dimensions on site prior to shop fabrication.

B. Fabricate items with joints tightly fitted and secured.

C. Fit and shop assemble sections in largest practical sizes, for handling through building openings.

D. Grind exposed welds flush and smooth with adjacent finished surface. Ease exposed edges to small uniform radius.

E. Make exposed joints butt tight, flush, and hairline.

F. Accurately form components required for anchorage of stairs, landings and railings to each other and to building structure.

G. Install continuous plastic handrail cover. Heat weld joints and trim smooth.

2.3 FABRICATION - PAN STAIRS AND LANDINGS

A. Fabricate stairs with open risers and treads of pan construction to receive concrete.

B. Secure tread pans to stringers with clip angles, bolted in place.

C. Form stringers of rolled steel channels.

D. Prime paint components.

2.4 FABRICATION - OPEN GRATING STAIRS

A. Fabricate treads 1 1/2 inch thick in accordance with ANSI A202.1, of mechanically clinched steel bars, bolted to supports.

B. Form stringers of rolled steel channels.

2.5 FINISH

A. Clean surfaces of rust, scale, grease, and foreign matter prior to finishing.

B. Do not prime surfaces in direct contact bond with concrete or where field welding is required.

C. Galvanize items to minimum 2.0 oz/sq ft zinc coating in accordance with ASTM A386.

PART 3 EXECUTION

3.1 ERECTION

A. Erect stairs level and plumb, free from distortion or defects detrimental to appearance or performance.

B. Provide anchors, plates, angles, hangers, and struts required for connecting stairs to structure.

C. Verify alignment with adjacent construction. Coordinate related work.

D. Do not field cut or alter members.

E. Field bolt and weld to match standard of shop bolting and welding. Hide bolts and screws whenever possible. Where not hidden, use flush countersunk fastenings.

F. Mechanically fasten joints butted tight, flush, and hairline. Grind welds smooth and flush.

END OF SECTION

SECTION 05521
PIPE AND TUBE RAILINGS

PART 1 GENERAL

1.1 WORK INCLUDED

A. Steel and Aluminum pipe and tube handrails, balusters, and fittings.

1.2 DESIGN REQUIREMENTS

A. All railings shall meet the requirements of OSHA (29CFR1910.23), as a minimum.

B. Railing assembly, wall rails, and attachments to resist a simultaneous vertical and horizontal thrust of 50 lbs/lin. ft applied at the top of the railing, or 200 pounds on the top railing, whichever is greater.

1.3 SUBMITTALS

A. Submittals shall be provided in accordance with Section 01300, Submittals, and the requirements of this Section.

B. Submittals shall be signed by a Professional Engineer licensed in the State of Washington.

C. Indicate component details, materials, finishes, connection and joining methods, and the relationship to adjoining work.

D. Submit three samples, 6 inches long, of pipe and wall bracket to OWNER'S REPRESENTATIVE for approval.

PART 2 PRODUCTS

2.1 STEEL RAILING SYSTEM

A. Rails and Intermediate Posts: ASTM A120, schedule 40, 1 ½ inch steel pipe.

B. Toeboard: Four inches high by 3/16 inch.

C. Fittings: Elbows, Tee-shapes, wall brackets, escutcheons. ASTM A120, schedule 40, 1 ½ inch steel pipe.

D. Mounting: Adjustable brackets and flanges, with steel inserts for casting in concrete.

E. Splice Connectors: Steel flush welding collars.

F. Galvanizing: 2.0 oz/sq. ft. zinc coating in accordance with ASTM A386.

2.2 FABRICATION

A. Verify dimensions on site prior to shop fabrication.

B. Fit and shop assemble sections in largest practical sizes, for delivery to site and installation.

C. Remove burrs from cut edges.

D. Form elbow bends and wall returns to uniform radius, free from buckles and twists.

E. Welding:

1. Miter and cope intersections of posts and rails, within 2 degrees, fit to within 0.02 inches and weld all around.
2. Thoroughly fuse without undercutting or overlap.
3. Remove splatter, grind exposed welds smooth and flush with adjacent surfaces.

F. Supply components required for secure anchorage of handrails and railings.

G. Make exposed joint butt tight, flush, and hairline.

H. Accurately form components required for anchorage of railings to each other and to building structure.

I. Provide explosion prevention holes at closed ends of pipe.

J. Protection from Entrapped Water: Drill 1/4 inch diameter weep holes, in the plane of the rail, at the lowest possible elevation of each post or rail; in all exterior installations and interior installations and interior installations where high humidity will occur.

K. Install continuous plastic handrail cover. Heat weld joints and trim smooth.

PART 3 EXECUTION

3.1 PREPARATION

A. Supply items to be cast into concrete with setting templates and erection drawings to appropriate sections.

3.2 INSTALLATION

A. Install in accordance with shop drawings and MANUFACTURER's instructions.

B. Coat ends of aluminum posts set in grout or concrete as specified in Section 09900, Painting.

C. Provide expansion joints at intervals not exceeding 40 feet, consisting of a slip joint with internal sleeve extending 2 inches beyond each side of joint; fastened on one side only.

D. Support wall rails at 5 feet on center.

E. Erect work square and level, free from distortion or defects detrimental to appearance or performance.

F. Anchor handrailings to structure.

END OF SECTION

SECTION 05530
METAL GRATING

PART 1 GENERAL

1.1 SUBMITTALS

A. Submittals shall be provided in accordance with Section 01300 and this section.

B. Shop drawings and technical submittals shall be signed by a professional engineer in the state of Washington.

C. Shop Drawings:

1. Grating: Show dimensions, weight, and size, and location of connections to adjacent grating, supports and other Work.
2. Grating Anchorage: Show structural calculations and details of anchorage to supports to prevent displacement from traffic impact.
3. Grating Supports: Show dimensions, weight, size, location, and anchorage to supporting structure.
4. Catalog information and catalog cuts.
5. MANUFACTURER’s specifications, to include coatings.

D. Quality Control Submittals:

1. Special handling and storage requirements.
2. Installation instructions.
3. Factory test reports.
4. MANUFACTURER’s Certification of Compliance for specified products.
5. Written Test Report that swaged crossbars, if used on grating, meet the requirements of the specified test and additional requirements of these Specifications.

1.2 PREPARATION FOR SHIPMENT

A. Insofar as is practical, factory assemble items provided.

B. Package and clearly tag parts and assemblies that are of necessity shipped unassembled and protect the materials from damage, and facilitate identification and final assembly in the field.

PART 2 PRODUCTS

2.1 FOOT TRAFFIC GRATING

A. Design:

1. Uniform Service Load: 100 psf minimum, unless otherwise shown.
2. Maximum Deflection: ¼ inch, unless otherwise shown.
3. Space bearing bars at 1 inch center-to-center.
4. Banding: ¼ inch minimum.

B. Material

1. Galvanized Steel Bar Type Grating: Press-locked, deep rectangular crossbar design, as manufactured by IKG/Borden, Clark, NJ; Type B or Type F.
2. Stair Treads:
   a. Material and Type: Same as grating material and grating type as furnished for connecting walkway or work surface.
   b. Nosings: Nonslip, abrasive on each tread along one long edge.
   c. Carrier Plate or Angle: Furnish at each end for connection to stair stringers.
   d. Dimensions: Width as shown or MANUFACTURER’s standard as close as possible to width as shown.
   e. Manufacturers: Same as for grating.

2.2 LIGHT VEHICULAR TRAFFIC GRATING

A. Design:

1. Maximum Load: 2000 pounds per wheel, minimum wheel base and axle width of 4 feet.
2. Space main bars at 1-3/16" center-to-center (unless otherwise noted).
3. Banding: ¼ inch.

B. Material:

1. Galvanized Steel Bar Type Grating:
   a. After Fabrication: ASTM A123-89a, zinc coating.
   b. Crossbar Size and Shape: As shown.
   c. Manufacturer and Product: IKG/Borden, Clark, NJ; IKG/Borden pressured locked Type B for 3/16-inch bearing bars and heavy duty Type C, Style J (1-3/8-inch center-to-center spacing) for ¼-inch and 3/8-inch bearing bars.

C. Supports:

1. Seat angles and beams where shown:
2. Same material as rectangular bar grating.
3. Coordinate dimensions and fabrication with grating to be supported.
4. Coordinate dimensions with increased depth due to serrations.

2.3 HEAVY VEHICULAR TRAFFIC GRATING

A. Design:

1. Maximum load: AASHTO HS20 or 4,000-pound capacity lift truck loading.
2. Space main bars at 1-7/8-inch center-to-center.

B. Material:

1. Galvanized Steel Bar Type Grating:
   a. After Fabrication: ASTM A123-89a, zinc coating.
   b. Crossbar Size and Shape: as shown.
   c. Manufacturer and Product: IKG/Borden, Clark, N.J., IKG Borden Heavy Duty Type P, Style J.

2.4 ACCESSORIES

A. Anchor Bolts and Nuts:

1. Carbon Steel: ASTM A307-91 or A36-90.
2. Stainless: ASTM A193-90a and ASTM A194-91, Type 316.
3. Galvanized Steel Bolts and Nuts: ASTM A153-82, zinc coating for ASTM A307-91 or A36-90.

B. Flat Washers (Unhardened): ASTM F844-90; use ASTM A153-82 for zinc coating.

C. Fastener Clips and Bolts: In accordance with grating manufacturer’s recommendations, except minimum of four fasteners per grating section and removable from above grating walkway surface.

2.5 FABRICATION

A. General:

1. Exposed Surfaces: Smooth finish and sharp, well-defined lines.
2. Furnish necessary rabbets, lugs, and brackets so work can be assembled in a neat, substantial manner.
3. Conceal fastenings where practical.

4. Drill metalwork and countersink holes as required for attaching hardware or other materials.
5. Weld Connections: Not permitted on grating except at banding bars.

B. Design:

1. Meet minimum dimensional requirements as shown or as specified.
2. Field measure areas to receive grating, verify dimensions of new fabricated supports, and fabricate to dimension required for specified clearances.
3. Section Length: Sufficient to prevent its falling down through clear opening when oriented in the span direction when one end is touching either the concrete or the vertical leg of grating support.
4. Minimum Bearing: ANSI/NAAMM MBG 531-88.
5. Metal Crossbar Spacing: 4-inch maximum, unless otherwise shown or specified.
6. Banding: Same material as grating; ANSI/NAAMM MBG 531-88 and ANSI/NAAMM MBG 532-88.
7. Furnish stainless steel Type 316 threaded anchor studs, as fasteners for grating attachment to metal supports either not embedded or partially embedded in concrete, as manufactured by nelson Studs Welding co., Loraine, OH.

C. Supports:

1. Seat angles and beams where shown:
    a. Same material as rectangular bar grating.
2. Coordinate dimensions and fabrication with grating to be supported.
3. Coordinate dimensions with increased depth due to serrations.

D. Foot Traffic Grating: Any single grating section, individual plank, or plank assembly shall be less than 1 foot 6 inches or greater than 3 feet 0 inch in width or weigh more than 150 pounds, unless otherwise shown on approved Shop Drawings.

E. Vehicular Traffic Grating: Any single grating section, individual plank, or plank assembly shall not be less than 1 foot 6 inches or greater than 3 feet 0 inch in width (except 3/8-inch thick bearing bar grating), or weigh more than 150 pounds, unless otherwise shown on approved Shop Drawings.

PART 3 EXECUTION

3.1 INSTALLATION

A. Install in accordance with approved Shop Drawings, and as shown.

B. Install plumb or level as applicable.

C. Anchor grating securely to supports to prevent displacement from traffic impact.

D. Completed Installation: Rigid and neat in appearance.

E. Commercially Manufactured Products:

1. Install in accordance with MANUFACTURER’s recommendations.
2. Secure grating to support members with fasteners.
3. Welding is not permitted.
4. Fasteners: Field locate and install.
5. Permit each grating section or plank style grating assembly to be easily removed and replaced.

F. Protect painted surfaces during installation.

G. Should coating become marred, prepare and touch up surface in accordance with paint manufacturer’s instructions.

END OF SECTION

DIVISION 6
WOOD AND PLASTIC

NOT USED

DIVISION 7
THERMAL AND MOISTURE PROTECTION

NOT USED

DIVISION 8
DOORS AND WINDOWS

NOT USED

DIVISION 9
FINISHES

NOT USED

DIVISION 10
SPECIALTIES

NOT USED

DIVISION 11
EQUIPMENT

Section 11223 – Cartridge Filter
Section 11226 – Adsorption Columns
Section 11241 – Liquid Chemical Metering Pumps
Section 11242 – Liquid Polymer Dilution System
Section 11261 – Progressing Cavity Pumps
Section 11280 – Centrifugal Sump Pumps
Section 11312 – Horizontal End Suction Centrifugal Pumps
Section 11315 – Air Operated Diaphragm Pumps
Section 11316 – Peristaltic Pumps
Section 11318 – Submersible Well Pumps
Section 11339 – Polyethylene Tanks
Section 11387 – Mixers
Section 11817 – Compressor, Air, Rotary Electric Motor Driven, Stationary, 10 HP and Larger

SECTION 11223
CARTRIDGE FILTER

PART 1 GENERAL

1.1 WORK INCLUDED

A. The Section specifies the particular requirements for the supply and delivery of a duplex cartridge filtration system.

1.2 RELATED WORK

A. This Section shall be used in conjunction with the following other specifications and related Contract Documents to establish the total requirements for the cartridge filter.

1. Section 01300 - Submittals.
2. Section 01430 – O & M Data.
3. Section 01640 – Manufacturer’s Services.
4. Section 015010 – Basic Mechanical Requirements
5. Detailed Drawings

B. In the event of conflict regarding requirements for the cartridge filter between this Section and any other section, the provisions of this Section shall govern.

1.3 SYSTEM DESCRIPTION

A. Process description

1. The specified cartridge filter system is part of a contaminated groundwater treatment system and will pre-treat the clarifier filtrate to meet the influent criteria of the adsorption columns immediately downstream.
2. The system will run on a continuous basis, 24 hours per day.
3. The system will be a duplex system, with two cartridge filter housings arranged in parallel. One will be the active system; the other will be a standby system.
4. The system shall be skid mounted, and pre-piped with all valves and accessories installed at the fabrication facility.

B. The cartridge filtration system must include the following:

1. System must be completely automatic with no operator attention required for normal system operation. Adjusting the valves to bring the standby housing into duty will be a manual operation.

2. Differential pressure transducer across each filter housing, with 4-20 mA output to central treatment system PLC.

1.4 SERVICE CONDITIONS

A. The cartridge filters will be located indoors, in a potentially mildly corrosive environment.

B. The temperature of the wastewater will range from 40 to 90 deg F.

C. All supplied equipment; piping and valves shall be designed for a service lifetime of 10 years at the conditions specified herein.

1.5 DESIGN CRITERIA

A. The system shall be designed to treat groundwater with the following influent conditions:

1. Flow: 75 US gpm. Filter system must be capable of continuously treating this flow.
2. Nature of solids: chemically precipitated metal hydroxide.
3. pH: 6.5 to 7.5
4. Maximum total suspended solids: 20 mg/L
5. Working Pressure: 80 psi
6. Nominal filtration: 5 micrometer

B. The system shall be designed to meet or exceed the following minimum discharge criteria:

1. Total suspended solids: <2 mg/L

1.6 QUALITY ASSURANCE

A. Factory Testing:

1. Factory testing shall be performed by the VENDOR at the VENDOR'S factory prior to shipment.
2. Pressure vessels shall be pressure tested above the operating pressure range with safety factor of 1.5.
3. The cartridge filtration system shall be hydraulically flow tested. The hydraulic flow test shall verify design flow capacity.
4. OWNER shall be notified at least five working days in advance of factory testing, so that they may be present to witness the tests.
5. Filtration system to be pre-assembled at VENDOR’S factory prior to shipment and field assembly.

1.7 SUBMITTALS

A. Submittals shall be provided in accordance with Section 01300, Submittals, and the requirements of this Section.

B. Provide the following in addition to the standard requirements:

1. Shop drawing of housings and skid, showing dimensions and full details
2. Materials of construction
3. Details of connecting piping
4. Cutsheet of valves and accessories
5. Cutsheet of recommended filter cartridges
6. Pressure drop across system at max flow
7. Operation and maintenance manual

PART 2 PRODUCTS

2.1 MATERIALS

A. VENDOR must ensure material and finishes are suitable for the service conditions specified herein.

B. Filter vessels: 304 SS

C. Piping and valves: PVC

D. Frame/skid: epoxy coated carbon steel or 304 SS

E. Filter cartridges to be pleated wound-polyester 5-micron cartridges with PVC core to prevent cartridge collapse.

2.2 FABRICATION

A. Filter Vessel:

1. Vessels shall be manufactured for 150 psig maximum operating pressure.
2. Lifting lugs of the Supplier's design shall be provided for easy handling.
3. Each vessel to be equipped with manual air vent and local pressure gauge.

B. Filter cartridges shall be capable of withstanding 80 psi pressure differential and temperature to 160^{o}F.

C. Mounting Skid: Cartridge filter system shall be supplied mounted on a structural steel skid base such that there is an even distribution of the equipment weight, and when fully loaded, there will be no distortion or unequal stresses upon the vessel or face piping when unit is in use.

D. Face Piping: Face piping between filter unit components must be Schedule 40 and be supported as required from the vessel and skid.

E. Cartridge Removal Port: Supplier's standard design.

2.3 ACCESSORIES

A. Pressure transmitters shall be Dwyer or approved equal.

B. Pressure sensors shall be selected by VENDOR to be appropriate for the service conditions described herein and shall be fully compatible with the pressure transmitter.

C. A pressure relief valve set above than the normal operating high pressure but at least 20 psi below the maximum pressure rating of the tank shall be installed on the top of each vessel.

D. Identification Labels:

1. Each filter vessel shall be supplied with a permanently attached, resin coated equipment identification label. The label shall state the following:
    - a. Vessel name.
    - b. Equipment identification tag number.
    - c. Name of MANUFACTURER.
    - d. MANUFACTURER serial number.
    - e. Year built.
    - f. Purchase order number.
    - g. Design temperature, pressure and flow rate.

2.4 FINISHES

A. VENDOR to provide appropriate finishes on all equipment rated for a lifetime of 10 years in the service described herein.

2.5 SPARE PARTS

A. Provide two additional gaskets for each nozzle.

B. Provide 3 sets of spare cartridge filters.

PART 3 EXECUTION

3.1 GENERAL

A. Code Compliance: All equipment shall be designed and manufactured in accordance with all applicable codes and guidelines for the State of Washington.

END OF SECTION

SECTION 11226
ADSORPTION COLUMNS

PART 1 GENERAL

1.1 WORK INCLUDED

A. This Section specifies the particular requirements for the supply and installation of adsorption columns.

1.2 RELATED WORK

A. This Section shall be used in conjunction with the following other specifications and related Contract Documents to establish the total requirements for adsorption columns.

1. Section 15010 - Basic Mechanical Requirements.
2. Section 15060 - Pipe and Pipe Fittings - General.
3. Section 15100 - Valves - General.
4. Section 15101 - Manual Valves.
5. Instrument Data Sheets
6. Drawings

B. In the event of conflict regarding requirements for adsorption columns between this Section and any other section, the provisions of this Section shall govern.

1.3 SYSTEM DESCRIPTION

A. The adsorption columns are the final stage of a groundwater arsenic removal system.

B. The basic system is shown in drawing PID-04. The system will include two adsorption columns, arranged in series, in a lead/lag arrangement to prevent breakthrough. During normal operation, the process flow will be in the downward direction.

C. Periodically, based on analytical testing of the arsenic in the effluent from the lead column, the media will be replaced. The system valves will be manually adjusted so that the lag column will become the active lead column, and the lead column will become the new lag column.

D. Backwashing will be performed manually when the groundwater treatment system is not running.

E. The system shall be skid mounted. Piping and valve assembly shall be constructed at the manufacturing facility and fully supported by a frame.

1.4 DESIGN CRITERIA

A. The adsorption column vessels will be FRP pressure vessels with a thermoplastic lining. The design, fabrication, testing and quality assurance shall meet or exceed all requirements of ASME Boiler Pressure Vessel Code, Section X (2010 edition).

B. Service conditions:

1. Design flow rate: 60 US gpm
2. Fluid temperature: 40 to 110 F
3. Environmental conditions: indoors, heated
4. pH: 6 to 7.5
5. Fluid: groundwater
6. Specific gravity: 1.0
7. Total hardness: 420 mg/L as $CaCO_3$
8. Working Pressure: 80 psi

C. The vessels shall have a nominal diameter of 4 feet to provide a flux rate less than or equal to 5 US gpm/ft^2 at the design flow rate.

D. Each vessel shall provide sufficient volume for 300 US gallons of activated alumina for an empty bed contact time of at least 5 minutes, plus a minimum freeboard of 30% of the column height to prevent washout during backwashing.

1.5 QUALITY ASSURANCE

A. Vessels shall meet the testing and quality requirements of ASME Boiler Pressure Vessel Code, Section X (2010 edition)

B. Factory Testing:

1. Factory testing shall be performed by the Vendor at the Vendor's factory prior to shipment.
2. The adsorption columns and piping system shall be hydraulically flow tested. The hydraulic flow test shall verify design flow capacity.
3. The adsorption columns shall be hydraulically tested without filter media.
4. OWNER shall be notified at least five working days in advance of factory testing, so that he may be present to witness the tests.

PART 2 PRODUCTS

2.1 ACCEPTABLE SUPPLIERS

A. Aqua Media

B. Hungerford and Terry

C. Siemens Water Technologies

2.2 MATERIALS

A. Vessels shall be FRP with erosion resistant thermoplastic lining.

B. External piping and valves shall be schedule 40 PVC.

C. Media shall be Activated Alumina from Axens Canada Specialty Aluminas. CONTRACTOR shall provide and install 600 US gallons of media.

D. Well Screen: 316 stainless steel by Johnson Screens.

2.3 FABRICATION

A. Filter Vessel:

1. Vessel shall be designed, fabricated in accordance with ASME Boiler Pressure Vessel Code, Section X (2010 edition).
2. Nozzles smaller than 1 inch shall have special reinforcement to prevent damage.
3. Lifting lugs of the Supplier's design shall be provided for easy handling.
4. A vessel sight window shall be provided at the top of the media bed.

B. Mounting Skid: Each vessel shall be supplied mounted on a structural steel skid base such that there is an even distribution of the equipment weight, and when fully loaded, there will be no distortion or unequal stresses upon the vessel or face piping when unit is in use or backwash.

C. Internal Construction:

1. Upper distributor shall be schedule 80 PVC laterals with support.
2. Lower collector shall be gravel-filled bottom with well screen header laterals extending across 80 percent of the vessel diameter. Hub laterals are not acceptable. Laterals shall be adequately supported.

D. Face Piping: Face piping shall be configured as shown in the Equipment Data Sheets, supported as required from the vessel and skid.

E. Media Removal Port: Supplier's standard design with lugged butterfly valve and blind flange.

F. Vessels shall each have one top and one side mounted access port, including flanges and hardware.

2.4 ACCESSORIES

A. A pressure relief valve set above the working pressure but at least 10% below the maximum pressure rating of the vessel shall be installed on the top of the vessel.

B. Differential pressure: Each vessel shall be equipped with a differential pressure sensor, with a 4-20 mA output signal and local indication.

C. System shall include high point vents and low point drains.

D. Identification Labels:

1. Each filter vessel shall be supplied with a permanently attached, resin coated equipment identification label. The label shall state the following:
   a. Vessel name.
   b. Equipment identification tag number.
   c. Capacity in gallons.
   d. Name of manufacturer.
   e. Manufacturer serial number.
   f. Year built.
   g. Purchase order number.
   h. Design temperature, pressure and flow rate.
   i. Type of lining.

2.5 FINISHES

A. The steel skid shall be sandblasted, primed and painted.

1. Sandblast: SP 6 commercial blast.
2. Prime: Rust-inhibitive primer; FSTT-P-636 red iron oxide, alkyd type; shop applied, one coat, 2 mils dry film thickness.
3. Finish: Alkyd enamel; minimum 45 percent solids by volume; two coats, 4 mils dry film thickness.

2.6 SPARE PARTS

A. Provide two additional gaskets for each manway and nozzle.

PART 3 EXECUTION

3.1 SHIPPING

A. System shall be protected and packaged to prevent damage during shipping.

3.2 STORAGE

A. CONTRACTOR shall receive and store adsorption column system as per manufacturer’s recommendations.

END OF SECTION

SECTION 11241
LIQUID CHEMICAL METERING PUMPS

PART 1 GENERAL

1.1 WORK INCLUDED

A. This section covers the work necessary to furnish and install, complete, the chemical metering pumps specified herein and in the attached Pump Data Sheets.

1.2 GENERAL

A. Like items of equipment provided hereunder, although for different services, shall be the end products of one manufacturer.

B. Refer to Section 15160, Pumps - General and Section 15170, Motors for related work.

C. Refer to Section 11950, Process Instrumentation and Controls, for pump controls.

1.3 MANUFACTURER'S REPRESENTATIVE

A. The manufacturer's representative for the equipment specified shall be present at the jobsite for installation assistance, inspection and certification of the installation, equipment testing, startup assistance, and training of OWNER's personnel.

1.4 SUBMITTALS DURING CONSTRUCTION

A. Submittals during construction shall be made in accordance with Section 01300, Submittals.

PART 2 PRODUCTS

2.1 GENERAL

A. The use of a manufacturer's name and model or catalog number is for the purpose of establishing the standard of quality and general configuration desired only. Approved equal products of other manufacturers will be considered in accordance with Section 15160, Pumps - General.

2.2 PUMP AND DRIVER DESCRIPTION

A. The chemical metering pumps specified herein shall be the positive displacement diaphragm type consisting of a simplex pump head and ball check valves on both the inlet and outlet. The driver shall be totally enclosed in a housing. The pump shall be capable of pumping against dead head without damage to the driver. Detailed requirements are provided in the attached Pump Data Sheets.

B. Pumps shall have an automatic/manual switch which when in automatic will allow the pump frequency to be controlled by 4-20 mA signal from the treatment system PLC. It shall be possible to manually override the stroke frequency.

C. Pumps shall be manually adjustable by stroke length and stroke frequency.

2.3 PUMP ACCESSORIES

A. A 16-gauge stainless steel identification plate shall be securely mounted on each pump in a readily visible location. The plate shall bear the 1/4-inch die-stamped equipment identification number that is assigned each pump in the Pump Data Sheet and shown on the Drawings.

B. The pumps for each application shall be supplied as a complete, pre-piped pump skid. The pump skid shall be fully factory assembled. The pump skid assembly shall include the following components:

1. Pressure relief valve, factory set at 50 psig
2. Calibration column, sized appropriately for the flow range of the pump
3. Pulsation dampener
4. Back pressure valve, factory set at 40 psig
5. Isolation valves for each pump, and at final inlet and outlet connections
6. Suction piping, diameter to match suction connection of pump, temperature and pressure rating as per pump data sheet
7. Discharge piping, diameter to match discharge connection of pump, temperature and pressure ratings as per pump data sheet
8. Drip tray with drain valve.

PART 3 EXECUTION

3.1 PUMP INSTALLATION

A. Pumps shall be installed in accordance with the manufacturer's recommendations, and located and mounted as shown on the Drawings.

3.2 FUNCTIONAL TEST

A. The pumps shall be functionally tested at the factory. A detailed report showing successful test results shall be provided to the OWNER before shipping.

B. The complete pump skid piping assembly shall be leak tested at the factory. The piping and accessory connections shall be pressure tested with clean water at 75 psig. Any leaks shall be corrected by replacing the leaking connection. A detailed report showing successful test results shall be provided to the OWNER before shipping.

C. After installation and prior to plant startup, all equipment described herein shall be inspected by the supplier's representative for proper connection and satisfactory performance by means of a functional test. A description of this test shall be provided to the OWNER (OWNER’S REPRESENTATIVE) for approved at the time equipment submittal is made.

3.3 MANUFACTURER'S CERTIFICATE(S)

A. Provide manufacturer's certificate(s) in accordance with Section Manufacturers' Services of the General Requirements.

PUMP DATA SHEET

Quantity	2
Pump Name and Tag Number	Acid Metering Pump , PU-410A, PU-410B
Type	Diaphragm metering pump
Rated Capacity	
Maximum	3 US gal/hr
Minimum	0.1 US gal/hr
Minimum Stroke Frequency	15 strokes/min
Required Discharge Pressure	40 psig
Rated Discharge Pressure	*
Drive Voltage **	120 VAC, 60 Hz, single-phase or 480 VAC, 60 Hz, 3-phase
Suction/Discharge Connections	*
Controls:	
Stroke Length	Manually adjusted 10 to 100 percent
Stroke Frequency	Adjustable via 4-20 mA signal from PLC, with manual override
Output	Fault indicating relay, normally open
Service Conditions:	
Liquid Pumped	93 % (vol/vol) H_2SO_4
Temperature	40 to 90 degrees F
Viscosity	40 centipoises
Specific Gravity	1.85
Materials of Construction:	
Pump Head **	PVDF or PTFE
Diaphragm **	PTFE
Valve Balls **	Ceramic
Valve Seat/Seal Ring **	PTFE
Fitting Connectors **	PVDF
Exposed Fasteners **	PVDF
Manufacturer	Prominent, Grundfos/Aldos, Pulsafeeder or approved equal

PUMP DATA SHEET

Quantity	2
Pump Name and Tag Number	KMnO4 Dosing Pumps, PU-310A and PU-310B
Type	Diaphragm metering pump
Rated Capacity	
Maximum	25 US gal/hr
Minimum	0.7 US gal/hr
Minimum Stroke Frequency	15 strokes/min
Required Discharge Pressure	40 psig
Rated Discharge Pressure	*
Drive Voltage **	120 VAC, 60 Hz, single-phase or 480VAC, 60 Hz, 3-phase
Suction/Discharge Connections	*
Controls:	
Stroke Length	Manual adjusted 10 to 100 percent
Stroke Frequency	Adjustable via 4-20 mA signal from PLC, with manual override
Output	Fault indicating relay, normally open
Service Conditions:	
Liquid Pumped	Potassium permanganate solution, 35 g KMnO4/L
Temperature	40 to 90 degrees F
Viscosity	1.3 centipoises
Specific Gravity	1.0
Materials of Construction:	
Pump Head **	PVDF or PTFE
Diaphragm **	PTFE
Valve Balls **	Ceramic
Valve Seat/Seal Ring **	PTFE
Fitting Connectors **	PVDF
Exposed Fasteners **	PVDF
Manufacturer	Prominent, Grundfos/Aldos, Pulsafeeder or approved equal

***** Vendor to specify
** Vendor to verify

END OF SECTION

SECTION 11242
LIQUID POLYMER DILUTION SYSTEM

PART 1 GENERAL

1.1 WORK INCLUDED

A. This section covers the work necessary to furnish and install, complete, the liquid polymer dilution system specified herein.

1.2 GENERAL

A. Like items of equipment provided hereunder, although for different services, shall be the end products of one manufacturer.

B. Refer to Section 15160, Pumps - General and Section 15170, Motors for related work.

C. Refer to Section 11950, Process Instrumentation and Controls, for pump controls.

1.3 MANUFACTURER'S REPRESENTATIVE

A. The manufacturer's representative for the equipment specified shall be present at the jobsite for installation assistance, inspection and certification of the installation, equipment testing, startup assistance, and training of OWNER's personnel.

1.4 SUBMITTALS DURING CONSTRUCTION

A. Submittals during construction shall be made in accordance with Section 01300, Submittals.

B. Submittals with Bid:

1. Dimensional drawing
2. Cutsheet describing general design and operation, rated flows for polymer and water.
3. Process flow diagram showing complete operational functionality.

C. Submittals After Award:

1. Show drawings showing all dimensions, general arrangement, materials of construction, connection details.
2. Complete, detailed, Operation and Maintenance Manual as per Section 01430, describing installation instructions, functionality, start-up

procedures, shut-down procedures, cleaning and regular maintenance, repair diagrams, replacement parts, spare parts, and troubleshooting.

3. Recommended shipping, receiving, and storage procedures.

PART 2 PRODUCTS

2.1 GENERAL

A. The use of a manufacturer's name and model or catalog number is for the purpose of establishing the standard of quality and general configuration desired only. Approved equal products of other manufacturers will be considered.

2.2 ACCEPTABLE MANUFACTURERS

A. Siemens Water Technologies

B. Or approved equal

2.3 POLYMER DILUTION SYSTEM DESCRIPTION

A. The system shall be design for the purpose of preparing dilute liquid polymer flocculant solution for the purpose of water or wastewater treatment. The system shall be designed to optimally mix neat polymer (either cationic liquid, cationic emulsion, or anionic emulsion) with water to produce the desired solution strength. The polymer shall be properly “inverted” to convert it to the active form as recommended by the polymer manufacturer. The system shall produce a homogenous solution, and shall be designed to prevent the formation of fish eyes.

B. System shall be designed to produce dilute polymer at the full range of concentration from 0.01% to 0.5% by volume. System shall provide provisions for both primary and secondary dilution.

C. The system shall be designed to produce a 60 US gallon batch of polymer at the concentration range specified above, in the period of 20 minutes (maximum).

D. All components of the system shall be frame mounted, pre-piped, pre-wired for easy installation. System shall be designed to allow maintenance access to each component. System shall be designed to minimize required footprint.

   1. Frame shall have provisions to support a 5 gallon pail of neat polymer, situated above the level of the neat polymer pump, to ensure flooded suction.

2.4 NEAT POLYMER PUMP

A. Neat polymer pump shall be variable speed, with speed adjustable from the central treatment system PLC via 4-20 mA signal.

B. Where possible, the neat polymer pump shall be a progressive cavity pump to prevent clogging. If desired flow rate is not achievable with a progressive cavity pump, a solenoid driven diaphragm type metering pump will be considered.

C. Neat polymer outlet line shall include a PRV set 15% below the maximum pressure rating of the piping and system components.

D. Neat polymer intake shall include a y-strainer to prevent pump clogging.

E. Neat polymer intake shall include calibration column, to manually test the flow rate of the polymer pump.

F. System shall include 6 feet of suction tubing, and a drying desiccant vent assembly for the neat polymer pail, to prevent moisture intrusion to the neat polymer.

2.5 MIXER AND MIXING CHAMBER

A. System shall include a mixing chamber with mechanical mixing. The mixing chamber shall have a high energy mixing zone, and a secondary, low energy mixing zone. Neat polymer and water injection points shall be arranged to provide optimal activation of the polymer. Mixer speed, mixer impeller, and configuration of mixing chamber shall be designed to minimize damage to the polymer strands.

2.6 WATER

A. Water input shall include pressure regulator to maintain a constant feed pressure to the system.

B. Water flow shall be manually adjustable with a rotameter and needle valve.

C. System shall include water solenoid valves. Water flow shall be automatically started and stopped by the system as necessary, based on the status of the run/off/remote switch.

2.7 POWER

A. Electrical power supply to the mixer and pump shall be 120 V, 1 phase, 60 Hz

2.8 CONTROLS

A. The system shall be controlled remotely from the central groundwater treatment system PLC. The system shall have an on/off/remote switch to set the mode of operation.

B. Inputs:

   1. 4-20 mA speed input for the neat polymer pump
   2. Remote start contact, normally open

C. Outputs:

   1. Run contact, normally open
   2. Loss of water contact, normally open

D. System shall provide provisions for a timed water flush after each batch of polymer is made. During the flush, the polymer pump shall be turned off, and the water flow shall continue for a set length of time. The duration of the water flush shall be operator adjustable.

2.9 ACCESSORIES

A. A 16-gauge stainless steel identification plate shall be securely mounted to the system in a readily visible location. The plate shall bear the 1/4-inch die-stamped equipment identification number that is shown on the Drawings.

PART 3 EXECUTION

3.1 INSTALLATION

A. The polymer dilution system shall be installed in accordance with the manufacturer's recommendations, and located and mounted as shown on the Drawings.

3.2 FUNCTIONAL TEST

A. The system shall be functionally tested at the factory. A detailed report showing successful test results shall be provided to the OWNER before shipping.

B. The complete piping assembly shall be leak tested at the factory. The piping and accessory connections shall be pressure tested with clean water. Any leaks shall be corrected by replacing the leaking connection. A detailed report showing successful test results shall be provided to the OWNER before shipping.

C. After installation and prior to plant startup, all equipment described herein shall be inspected by the supplier's representative for proper connection and satisfactory performance by means of a functional test. A description of this test shall be provided to the OWNER (OWNER’S REPRESENTATIVE) for approved at the time equipment submittal is made.

3.3 MANUFACTURER'S CERTIFICATE(S)

A. Provide manufacturer's certificate(s) in accordance with Section Manufacturers' Services of the General Requirements.

END OF SECTION

SECTION 11261
PROGRESSING CAVITY PUMPS

PART 1 GENERAL

1.1 WORK INCLUDED

A. The Design/Build CONTRACTOR shall be responsible for selecting a Progressing Cavity Pump Vendor, subject to OWNER's approval, and for the installation of all the progressing cavity pumps complete.

B. This Section covers the work necessary to furnish and install the following progressing cavity pumps complete.

1. Dilute polymer feed pumps

C. The VENDOR shall be responsible for providing documentation for proper handling, storage, installation, power and control connection and start-up for each application specified herein.

D. VENDOR shall provide services to inspect each progressive cavity pump installation at the OWNER'S site prior to start-up, and provide certificate of proper installation of pumps and valves prior to start-up.

E. VENDOR shall provide completed Technical Summary of VENDOR's Equipment, and submit this information along his bid including dimensional drawings and performance data.

1.2 RELATED WORK

A. This Section shall be used in conjunction with the following other specifications and related Contract Documents to establish the total requirements for the referenced progressing cavity pumps.

1. Section 01300 - Submittals
2. Section 01430 – Operation and Maintenance Data
3. Section 01640 – Manufacturer's Services

B. In the event of conflict regarding requirements for the referenced progressing cavity pumps between this Section and any other section, the provisions of this Section shall govern.

1.3 SUBMITTALS

A. Submittals with Bid (Minimum Requirements)

1. A signed letter from the manufacturer or equipment supplier that the equipment proposed to be furnished is in full compliance with the specifications and all addenda issued, except as noted in the letter. At the OWNER’S/OWNER’S REPRESENTATIVE’S discretion, bids will be returned unreviewed if an exception to the Specifications is found that is not noted in the letter.
2. A list of the three most recent installations where similar equipment constructed by the same manufacturer is currently in service. Include contact name, telephone number, mailing address, and the names of the Engineer, OWNER, and installation contractor. If three installations do not exist the list shall include all that do exist, if any.
3. Manufacturers submitting bids for equipment that would require changes in design shall clearly identify change and also include detailed information on structural, electrical, mechanical, and other miscellaneous changes or modifications necessary to adapt their equipment to the arrangement shown.
4. Complete specifications, dimensional drawings, materials of construction, performance data and descriptive literature on the equipment proposed.
5. Complete instructions for installation of the equipment, including off-loading, storage, installation, and initial set-up.

B. Submittals after Award of Contract

1. After award of contract, transmit Submittals in accordance with Section 1300 SUBMITTALS, and deliver equipment to the location indicated in the Invitation To Bid documents.
2. Incomplete Submittals, at the OWNER’S REPRESENTATIVE’S sole discretion, will either (i) be returned complete, for VENDOR's revision/ correction and resubmission, or (ii) portions of the Submittal will be returned and OWNER’S REPRESENTATIVE will request submission/ resubmission of specified items as noted thereon.

1.4 OPERATION AND MAINTENANCE DATA

A. Operation and maintenance data shall be provided in accordance with these specifications and with Section 01430, Operation and Maintenance Data included as part of the Invitation to Bid package.

1.5 MANUFACTURERS' SERVICES

A. Manufacturers services shall be provide in accordance with these specifications and Section 01640, Manufacturer's Services included as part of the Invitation to Bid package.

1.6 WARRANTY

A. The complete pumping assembly shall be guaranteed for pressure, capacity, and power consumption at the specified design operating conditions, and satisfactory application in all respects to the operating conditions specified for the individual pump below.

B. The VENDOR shall guarantee all equipment as to workmanship, materials, and satisfactory functioning for twelve (12) months from the date of its start-up, or eighteen (18) months from the date of shipment of the system. At the VENDOR'S total expense, he shall promptly rectify any failure covered by this guarantee. Start-up is defined as the date on which the equipment is placed into continuous operation for its intended purpose. Vendor further expressly covenants with the OWNER that all goods and services will conform to the OWNER'S order, will be merchantable, fit and sufficient for the particular purpose intended, and free from any defects or liens. The VENDOR agrees to protect and hold OWNER harmless from any loss or claim arising out of the failure of VENDOR to comply with the above. The above mentioned guarantee shall apply to the entire equipment package furnished by the VENDOR.

PART 2 PRODUCTS

2.1 GENERAL

A. Materials shall conform to the requirements of API Standard 674, Positive Displacement Pumps, Appendix A.

B. Equipment supplied shall be new. Used, refurbished, or previously owned equipment is not acceptable.

C. It is the CONTRACTOR'S sole responsibility to ensure that the equipment and any related components are suitable for operation under the following service conditions for a design life of at least 20 years.

D. Service Conditions shall be as outlined in the table below:

Service Condition Parameters	PU-330A Polymer Dosing Pump 1	PU-330B Polymer Dosing Pump 2
Material to be pumped	Dilute polymer flocculant (0.1 to 0.5% concentration)	Dilute polymer flocculant (0.1 to 0.5% concentration)
pH	6 – 9	6 – 9
Abrasion	Low	Low
Particle Size	No significant solids, polymer “fish eyes” will be deformable	No significant solids, polymer “fish eyes” will be deformable
Specific Gravity	1.0 – 1.1	1.0 – 1.1
Viscosity	1000 to 6000 cps	1000 to 6000 cps
Temperature Range	40 to 110°F	40 to 110°F
Pump Type	Progressive Cavity	Progressive Cavity
Inlet Pressure (Static liquid head)	Variable from 1 ft to 3 ft WC flooded suction	Variable from 1 ft to 3 ft WC flooded suction
Discharge Pressure	60 psi	60 psi
Pump Speed	Variable speed, up to maximum of 600 rpm 4-20 mA Control Signal	Variable speed, up to maximum of 600 rpm 4-20 mA Control Signal
Flow Rates	0.5 to 10 US gal/hr (upper end of flow range shall be achievable at 600 rpm or less)	0.5 to 10 US gal/hr (upper end of flow range shall be achievable at 600 rpm or less)
Pump Housing Environment	Indoor and Heated	Indoor and Heated
Seal	double mechanical seal (manufacturer to select based on service conditions)	double mechanical seal (manufacturer to select based on service conditions)

2.2 APPROVED MANUFACTURERS

A. Seepex

B. Moyno

2.3 DESIGN CRITERIA

A. General:

1. Pumps shall operate at speeds recommended by the VENDOR as determined by the type of pump, the viscosity, and characteristics of the pumped liquid and the pump inlet and outlet pressure. Pumps speed should be selected to provide long life of the rotor and stator.

2. Separate speed changers shall be provided by the VENDOR when it is necessary to drive pumps at other than standard electric motor speeds. External chain or belt drives are unacceptable.
3. Pumps shall be sized for the rated capacity and pressure when handling fluid at the maximum viscosity specified.
4. External relief valves will be provided by VENDOR. Internal relief valves are unacceptable.
5. Pumps shall be suitable for continuous operation at a relief valve setting 15 percent above the rated discharge pressure and at the highest pumped liquid viscosity.

6. The pumps shall be equipped with dry running protection device in the form of a temperature sensor in the stator and contact suitable for connection to the OWNER supplied PLC.

B. Pump Casings

1. Wetted pump casings components shall be 304 SS. All other casing components may be ductile or cast iron.

C. Rotor

1. The rotor shall be constructed to provide good wear resistance and long operational life under the service conditions provided.

D. Stator

1. The stator shall be constructed to provide good wear resistance and long operational life under the service conditions provided.

E. Couplings

1. All universal joint assemblies, flexible type couplings and coupling rods shall be furnished and mounted by the VENDOR.
2. Removable, all-metal coupling guards shall be supplied and mounted by the VENDOR.
3. The coupling shall be dynamically balanced when the coupling size-speed relationship is such that balancing is recommended by the coupling manufacturer.
4. Couplings shall be mounted on shafts with cylindrical fit, and keyed in place. Cylindrical fits shall conform to ANSI B4.1.

F. Shafts and Shaft Sleeves:

1. Pump shaft run out, as measured by a dial indicator at the stuffing box face, shall not exceed 0.002 inch total indicator reading.

2. Dynamic shaft deflection under the worst conditions of load shall not exceed 0.002 inch maximum at the face of the stuffing box.

G. Stuffing Boxes for Packing:

1. All progressing cavity pumps shall be equipped with mechanical gland packing with external lantern ring unless otherwise noted.
2. Stuffing boxes shall preferably be integral with the pump casing or cover.

H. Mechanical Seals:

1. The individual service conditions shall indicate if a mechanical seal is to be provided. If a mechanical seal is specified, the pump vendor shall be responsible for obtaining a written recommendation and full guarantee from the seal manufacturer for each mechanical seal service. The recommendation is subject to review by the OWNER'S REPRESENTATIVE prior to placement of a purchase order.

I. Drivers:

1. All electric drive motors shall be induction style motors capable of operating with a Variable Frequency Drive unit.
2. Motors shall be 480 V, 3 phase, 60 Hz.
3. In calculating the horsepower required by the pump driver, gear losses shall be included before driver ratings are selected.
4. The horsepower required to size any driver shall be based on handling fluid at the pump relief valve set pressure (15 percent above the rated discharge pressure) and at the highest pumped liquid viscosity.

2.4 PAINTING

A. The progressing cavity pumps and related equipment shall be delivered to the jobsite finish painted. Primer and finish coat shall be manufacturer's standard for corrosive environments. VENDOR to provide touch-up paint as required.

2.5 ANCHORING

A. Anchor bolts shall be 304 stainless steel. VENDOR to supply all anchor bolts and mounting hardware.

2.6 IDENTIFICATION

A. Each unit of equipment shall be identified with a corrosion resistant nameplate, securely affixed in a conspicuous place. Nameplate information shall include equipment model number, serial number, supplier's name and location, and OWNER'S name.

PART 3 EXECUTION

3.1 CODE COMPLIANCE

A. All equipment shall be manufactured in accordance with codes and guidelines as specifically detailed herein and in accordance with applicable portions of the following (latest edition).

1. Local Laws and Ordinances.
2. State and Federal Laws.
3. National Electrical Code.
4. National Electrical Manufacturers Association (NEMA).
5. Underwriters Laboratories (UL).
6. American National Standards Institute (ANSI).
7. Canadian Standards Association (CSA).
8. American Society of Mechanical Engineers (ASME).
9. Institute of Electrical and Electronic Engineers (IEEE).
10. Instrument Society of America (ISA).
11. Factory Mutual (FM).
12. National Fire Protection Agency (NFPA).

3.2 FACTORY TESTS

A. Progressing cavity pumps shall be factory tested to show functional performance of pumps and control system meeting these Specifications.

3.3 FUNCTIONAL TEST

A. Prior to plant startup, the VENDOR shall inspect all equipment for proper connection, quiet operation, and test the performance by means of a functional test to ensure that the pumps meet the Specifications herein.

3.4 MANUFACTURER’S CERTIFICATE

A. The manufacturer’s representative shall provide a certificate stating that the equipment or system has been installed in accordance with the manufacturer’s recommendation and has been inspected by a manufacturer’s authorized representative, that it has been serviced with the proper initial lubricants, that applicable safety equipment has been properly installed, and that the proper electrical and mechanical connections have been made.

3.5 ACCEPTANCE

A. Acceptance of the works is defined as the date where ALL of the following conditions have been met.

1. System has been fully installed, successfully tested, and the Manufacturer’s Certificate of Proper Installation completed.
2. All Operation and Maintenance data and Manuals have been completed.
3. All spare parts included with the original order have been received by the OWNER.
4. Initial training of the OWNER’S staff is completed.
5. The system is placed in full-time service in its originally intended function, and has performed satisfactorily in the OWNER’S sole opinion, for a period of seven (7) days.
6. Items (1) through (5), inclusively, must be reviewed and accepted by the OWNER’S REPRESENTATIVE in writing.

END OF SECTION

SECTION 11280
CENTRIFUGAL SUMP PUMPS

PART 1 GENERAL

1.1 WORK INCLUDED

A. This Section provides the requirements for single-stage vertical centrifugal pumps for sump services with separate discharge pipe.

B. This Section does not cover multistage or barrel-type vertical pumps.

1.2 RELATED WORK

A. This Section shall be used in conjunction with the following other specifications and related Contract Documents to establish the total requirements for centrifugal sump pumps.

1. Data sheets included at the end of this Section.
2. Contract Drawings

B. In the event of conflict regarding requirements for centrifugal sump pumps between this Section and any other section, the provisions of this Section shall govern.

1.3 DESIGN CRITERIA

A. General:

1. The depth of the sump pit will be specified on the pump data sheet. The pump VENDOR shall size the pump length for the specified depth.

B. Pump Selection:

1. Any pump with a constant speed driver requiring a maximum diameter impeller to meet the rated pumping conditions is not acceptable. The impeller diameter shall be such that at least a 10 percent increase in head at the rated capacity can be obtained by installing a larger diameter impeller of the same pattern.
2. Pumps having the rated capacity point to the right of the peak efficiency point on the head-capacity curve are not acceptable.
3. Pumps noted on the individual pump specification sheets as operating in parallel shall have head-capacity curves rising continuously to shutoff.
4. Pump shall operate at the lowest practicable speed consistent with the required head and capacity; 1,800 rpm is the preferred maximum pump

speed. Design and fabrication shall ensure accurate alignment of shafting and bearings.

C. Pump Casing:

1. Pressure casings shall be of such thickness as will be suitable for the maximum discharge pressure at pumping temperature and hydrostatic testing pressure at ambient temperature.
2. The design stress for any given material shall not be in excess of the values given in Section VIII, "Unfired Pressure Vessels," of the ASME Boiler and Pressure Vessel Code, for the same material. For cast materials, the factor specified in the Code shall be applied.
3. Pressure casings furnished of forged steel, rolled and welded plate, or seamless pipe with welded cover shall comply with the applicable rules of Section VIII of the ASME Code. MANUFACTURER'S data report forms and stamping, as specified in the Code, are not required.
4. The pump shall be furnished with a flanged discharge connection at the support plate.
5. The back of all flanges shall be full-faced.

D. Column Construction:

1. Screwed column construction is acceptable.
2. All flanged joints affecting the alignment of the column shall have faces machined after attachment to the column sections to ensure straightness of the assembled unit.

E. Shafts: Shaft shall be of one-piece construction when feasible. If alternate shaft diameters are available, the largest diameter shall be furnished to reduce shaft whip as much as possible.

F. Impellers:

1. Impellers keyed to the shaft are preferred. If the impeller is screwed onto the shaft or held in place with a threaded fastener, a positive means shall be provided to prevent the impeller from unscrewing if the pump is operated in reverse rotation.
2. When specified in the pump data sheet, "nonclog" type impeller (impeller passages designed to pass any foreign object that can pass through the discharge passage of the pump or open type for stringy material) shall be provided.

G. Vibration: Peak-to-peak vibration limits shall apply to all pumps measured at the top motor bearing. These limits shall cover rotor vibration at rated speed and at a capacity of plus or minus 10 percent from rated capacity. Peak-to-peak limits are:

	Vibration Peak-to-Peak (mils)	
Speed (rpm)	Anti-friction Bearings	Sleeve Bearings
1,800 and below	3.0	3.0
1,801 to 3,600	2.0	2.5

H. Vapor Tight Construction:

1. When specified on the pump data sheet, a stuffing box shall be provided at the point where the shaft passes through the pump support plate. The stuffing box shall be furnished with a lantern ring with inlet and outlet connections.
2. Stuffing box glands shall be easily removable and must permit replacement of packing without removal or disassembly of any other part of the pump.
3. The discharge pipe, bearing lubrication, and flush lines shall be sealed at the pump support plate.
4. When a float level switch is specified on the pump specification sheet, provisions shall be supplied to seal the float switch rod where it passes through the pump support plate or pit cover plate.

I. Drivers:

1. Motors for all pumps shall be of the solid-shaft type.
2. Thrust bearings located in drivers shall be designed to carry the maximum thrust (up and down) that the pump may develop during starting or stopping, or while operating at any capacity.
3. Motor drivers shall have a nameplate rating not less than 115 percent of the maximum brake horsepower required by the pump with the furnished diameter impeller.
4. Where is appears that this will lead to unnecessary oversizing of the driver, an alternate quotation may be submitted for Engineer's consideration.

J. Couplings:

1. If the thrust bearing is in the motor driver, a rigid, adjustable, all steel, flange-type coupling shall be supplied, and the quotation shall state the thrust capacity of the motor bearings and the thrust requirements of the pump.
2. If the thrust bearing is located in the pump head (motor mounting), a Dodge Paraflex coupling or approved equivalent shall be provided.

K. Thrust Bearings:

1. Thrust bearings shall be provided with adequate protection to exclude dirt and moisture under conditions of outdoor operation.

2. Anti-friction bearings shall be in accordance with the "Anti-Friction Bearing Manufacturers Association Standards." All bearings shall be designed for two year minimum life in specified service with continuous operation at maximum radial and axial loads.
3. Thrust bearing housings located in the pump head shall be water jacketed for all pumps operating at temperatures above 200 degrees F.
4. Thrust bearings located in the pump head (motor mounting) shall be designed to carry the maximum thrust (up and down) that the pump may develop during starting or stopping, or while operating at any capacity.

L. Line-Shaft Bearings:

1. The distance between line shaft bearings shall not exceed 48 inches. Bearings may be lubricated by the product pumped, grease lubricated, or lubricated with clean water from an external source.
2. Bearing materials shall be recommended and guaranteed by the pump VENDOR for the specified service. Materials shall be noted in the proposal.
3. If pumps are grease lubricated, bearings shall be grooved to distribute grease over the bearing surface. When bearings are grease lubricated or lubricated with water from an external source, separate pipe or tubing from the baseplate shall be provided to each bearing.
4. Piping for water lubrication from an external source shall have at the cover plate a sight flow indicator or other means of determining that the flush water is flowing to the bearings.
5. Lubrication tubing or pipe shall be corrosion resistant to the pumped fluid and shall be adequately supported to prevent damage from vibration. Grease fittings shall be located on or above the pump support plate.
6. Copper tubing and brass fittings are unacceptable.

M. Pump Support Plate: A pump support plate made to the MANUFACTURER'S standard dimensions with holes drilled for mounting shall be supplied with each pump unless otherwise specified on the pump data sheet.

N. Pit Cover Plate: A pit cover plate made to the Engineer's dimensions with holes drilled for mounting shall be supplied with each pump when specified on the pump data sheet.

O. Suction Strainers: Suction strainers shall be provided with each pump. Strainers shall be of heavy duty construction and shall be corrosion resistant to the liquid pumped. Bronze is acceptable in water services. Suction strainers shall have mesh openings smaller than the smallest passage within the pump.

1.4 WARRANTY

A. The complete pumping assembly shall be guaranteed for pressure, capacity and power consumption at specified design operating conditions, and satisfactory application in all respects to the operating conditions specified on the individual pump specification sheet. Permissible variations from the specified performance is as follows:

	Guarantee Point	Shutoff
Differential head	Minus 2 percent, plus 5 percent	Minus 10 percent, plus 10 percent
Efficiency	Minus ½ point of efficiency	
Brake horsepower	Plus 4 percent	
Required NPSH	Plus 0 percent	

PART 2 PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Gorman-Rupp

B. ITT/Goulds Pumps, Inc.

C. Megga

D. Or approved equal

2.2 GENERAL

A. Materials of construction shall be the pump VENDOR'S standard for the specified operation conditions unless otherwise specified. The metallurgy of all major components shall be identified in the data sheets or in the quotation.

PART 3 EXECUTION

3.1 HYDROSTATIC TESTING

A. Each pressure casing shall be hydrostatically tested with water at ambient temperature. The minimum test pressure shall be 1-1/2 times the maximum allowable casing pressure.

B. Cooling water jackets shall be hydrostatically tested at 115 psig minimum.

C. All hydrostatic tests shall be maintained for a minimum period of 30 minutes. Certification of the test results is required.

3.2 RUNNING TESTS

A. Running, performance, NPSH, and submergence tests shall be performed on water at the rated speed of the pump when specified on the pump specification sheet.

B. Certification of the test curve for the purchased pump is required.

C. Each pump shall be checked for acceptable vibration during the factory running and performance tests.

END OF SECTION

UNIT SPECIFICATION
SUBMERSIBLE CENTRIFUGAL PUMPS

Attachments:	**AMEC** **900 Maple Grove Rd., Unit 10** **Cambridge, ON N3H 4R7**	Spec. No:
		Project No.: SE10160010.4102
		Customer:
		Compiled by: Nick Marek
		Date: 7-Apr-11
		Equip. No.:

P&ID No.	PID-02
PFD No.	PDF-01

Issue:	Date:	Released for:	AMEC Approval:	Client Approval:

DESCRIPTION

Service:	Sump Pump	Pumps req'd:	1	Motor Type:	*
Pump Mtr:	Stainless Steel				
Size & Type:	Submersible				
No. Stages,	Single				

PROCESS DATA

LIQUID		OPERATING CONDITIONS		SITE CONDITIONS	
Name:	Filtrate	Capacity (US GPM):	15		
Pumping Temp. Deg.F:	40 to 80	Norm/Rated	Norm	Temp. Max/Min Deg. F:	110/40
Min/Norm/Max	40/60/80	Disch. Pressure (PSIG)	11	Rel/Max/Min:	
S.G. @ Deg.F:	1.0 @ 70 F	Suction Pressure (PSIG)	0	Altitude (ft.) Hum,%:	100
Vapor Pressure, Psia	0.36 @ 70 F	Max/Rated		Location:	Tacoma, WA
Viscosity cp @ Deg.F.:	1 cp @ 70 F	Diff. Press., psi:	11	Area Classification:	not classified
Corrosion/Erosion Caused by:		Diff. Head ft.	25	Other:	
		NPSH avail . ft	22		
Remarks:		Hyd. Power (HP):	*	Remarks:	
Expected to be 800 mg/L of metal hydroxide solids				Pump located indoors	

PERFORMANCE (To be completed by manufacturer)

Proposal Curve No.:		Min. Continuous Flow:		NPSH Required (ft. water)	
Speed (RPM):		Thermal: Stable:		3% Head Drop:	
Efficiency (%):		Max. Head Rated Imp (ft.):		Suction Specific Speed: RPM	
Rated Power (BHP):		Max. Rated Power (BHP):			

Remarks:

CONSTRUCTION

Nozzles:		SIZE, in.	LOCATION	RATING, PSIG	FACING
	Suction	*	N/A		
	Discharge	1.5"	Head Tank		

Mounting

Guide Rails (y / n)	n
Chain (y / n)	y

Bearings (Type/No.):

Radial: - Thrust:

Lubrication Type:

Impeller diam (in):	*	Packing	
Rated/Max/Min:		Manuf.:	
Rot.(viewed from cplq):(cw/ccw)		Type:	
Impeller Bearings		Size/No. Rings:	
Max.Pressure PSIG @		Mech. Seal: Type - Sgl/dbl/T	*
60 Deg.F/Normal:		Cartridge (y/n)	
@ Pumping deg. F.		Balanced (y/n)	
Hydro Test Pressure psig:		Mfgr.	
Casing Mounting		Model:	
Standard		Material / Mfgr's Code:	

UNIT SPECIFICATION
SUBMERSIBLE CENTRIFUGAL PUMPS

Attachments:		**AMEC** **900 Maple Grove Rd., Unit 10** **Cambridge, ON N3H 4R7**	Spec. No:	
			Project No.:	SE10160010.4102
			Customer:	
			Compiled by:	Nick Marek
			Date:	7-Apr-11
			Equip. No.:	
P&ID No.	PID-02			
PFD No.	PDF-01			

Issue:	Date:	Released for:	AMEC Approval:		Client Approval:

REMARKS

MATERIALS

Case:	*			Baseplate Material, Type:	
Impeller:	*	Shaft:	*	Guide Rails	
		Sleeve:	*	Chain	

MOTOR DRIVER

HP:	*	Temperature Rise (Deg.F):	*	Bearings:
RPM:	*	Full Load AMPS:	*	Lube:
Frame:		Locked Rotor AMPS:	*	Power Cord
Volts/Phase/Hz:		Insulation:		
Type:		Manufacturer:		
Enclosure:				

SUMP INFORMATION

Pit / Sump Depth, ft	4	Guide Bushings, Bowl		*	Float & Rod Mat		
Pump Length, ft	* (~2)	Guide Bush, Line Shft		*	Mfgr		
Min Submergence, ft	*	Guide Bush Lube		*	Model		*
Column Pipe, Flanged/Threaded	*	Level Switch		n	Control Panel	(y / n)	n
Line Shaft, Open/Enclosed		Suction Strainer		y	NEMA		

SEAL COMPONENTS

Inboard(Impeller)Faces(stationary/rotating):		Drive Collar	
Outboard(Motor) Faces(stationary/rotating):		O Rings:	
Springs:		Gland:	
Bellows:		Sleeve:	
		Pumping Ring:	

Remarks:

WEIGHTS		Testing & Inspection		Miscellaneous
Weight of Pump, lbs	*	Testing:		Painting: Std.
Total Weight,lbs	*	Performance		Other
		Hydro		Noise Level @ 3' , dB
		Other		
		Witnessed		
		Inspection Req. (y /n)		

REMARKS

Note: * means VENDOR TO SPECIFY

SECTION 11312
HORIZONTAL END SUCTION CENTRIFUGAL PUMPS

PART 1 GENERAL

1.1 WORK INCLUDED

A. This section covers the work necessary to furnish two adsorption column feed pumps specified herein, f.o.b. OWNER's jobsite, Pierce County, Washington, complete and ready for installation.

1.2 EQUIPMENT NUMBERS

A. Adsorption Column Feed Pumps: PU-420A, PU-420B

1.3 GENERAL

A. Like items of equipment provided hereunder, although for different services, shall be the end products of one manufacturer.

1.4 DEFINITIONS

A. Total Head: Total head in feet of liquid pumped shall be the discharge head minus the suction head (or plus the suction lift), both measured at the pump flanges and corrected to pump centerline, plus the difference in velocity heads at the same points.

B. Net Positive Suction Head Available (NPSHa): Net Positive Suction Head Available shall be the absolute pressure in metres on the surface of the open liquid supply minus the suction lift in meters, minus the vapour pressure of the liquid being pumped in meters, minus the friction losses in the pipe, valves, and fittings.

C. Net Positive Suction Head Required (NPSHr): Net Positive Suction Head required for proper operation of the pump.

D. Overall Efficiency: Overall efficiency shall be the total efficiency for motor and pump from the motor terminals to pumped liquid.

1.5 MANUFACTURER'S SERVICES

A. A Manufacturer's representative for the equipment specified herein shall be present at the jobsite and/or classroom designated by the OWNER for installation assistance, inspection, certification of the installation, functional and performance testing, startup and jobsite training.

B. Manufacturer’s services shall be at such times as requested by the OWNER and shall be included in the VENDOR’s price and shall be defined in the VENDOR’s quotation.

1.6 SUBMITTALS WITH PROPOSAL

A. The VENDOR shall submit, in writing, a listing of all exceptions to the requirements specified herein. Items not specifically included in the list shall be assumed to be as specified regardless of differences in the remainder of the submission.

B. Information to be submitted with the proposal shall include, but not be limited to, the following:

1. Make, model and weight of each pump.
2. Complete specifications, detailed dimensional drawings and descriptive literature of pump and controls. The submittal shall show that pump components are designed and recommended by the manufacturer for wastewater service. Include details on materials of construction for components in contact with wastewater (i.e. casing, impeller, and shaft) and anchor bolt requirements for anchoring base to floor.
3. Performance curves indicating pump performance showing head, capacity, horsepower demand, and pump efficiency over the entire operating range of the pump, from shutoff to maximum capacity. The equipment manufacturer shall indicate separately the head, capacity, horsepower demand, overall efficiency, and NPSHr at the design point. Performance requirements shall be as defined in the Hydraulic Institute Standards.
4. Complete, detailed installation information package for the pumps and related hardware. This package shall contain all necessary instructions and drawings to provide for proper installation.
5. Provide a list of recommended spare parts for the pumping system with unit prices, availability, and delivery time. Include in the list items which would normally be expected to fail in the first 5 years of operating life. List the recommended spare parts inventory and the price, firm for one full year from Acceptance.
6. Location of equipment origin.

C. The VENDOR shall submit complete material specifications, including coating type, descriptive drawings, a complete layout drawing with all appurtenances, and literature for all pump components, including, but not limited to, impeller, housing, seals, support brackets, gasket material, hardware, anchor studs, etc.

D. The VENDOR shall submit a detailed schedule identifying the sequencing and duration for fabrication, purchasing and delivery. Delivery schedule will be a significant factor in the bid evaluation process.

E. The VENDOR shall submit documented evidence of their ability and capacity to complete this work. Documentation shall include, but not be limited to, a list of installations of a similar nature, including the OWNER, size, wastewater type, contact person, and phone number. The list shall include a minimum of the three most recent pump installations.

F. Information regarding the warranty specified herein. The warranty shall state all conditions and exclusions.

1.7 SUBMITTALS AFTER CONTRACT AWARD

A. Within two (2) weeks after receipt of the Contract, and before commencing work, the successful bidder shall submit to the OWNER'S REPRESENTATIVE for review, one (1) complete set of "working drawings" showing the design and method of construction of the pumps and where required, detail drawings and specifications of the equipment.

B. Review of the working drawings and specifications by the OWNER'S REPRESENTATIVE shall not relieve the successful bidder of the responsibility for the correctness thereof, nor from the results arising from any error or omission of detail of design. Review of Drawings and Specifications shall, in every case, be subject to final acceptance of the equipment and materials after they have been put in operation, and the general operation of the equipment and materials has been found satisfactory to the OWNER.

C. The VENDOR shall submit for the OWNER'S REPRESENTATIVE'S review a complete description of their quality control program for fabricating, handling, installing, testing, repairing, and providing a complete and working pump system. The description shall include, but not be limited to, product identification, acceptance testing, fabrication production, testing, installation testing, documentation of changes, alterations, repairs, retests, and acceptance.

D. The VENDOR shall submit a recommended method for handling and storage of pump components and accessories prior to installation.

E. Description of Repair Procedure: Provide detailed information on how to make repairs once the pumps are in operation in accordance with requirements of Section 01430 OPERATION AND MAINTENANCE DATA. The VENDOR shall provide a list of materials, equipment, and training requirements, and cost to equip the OWNER to make repairs not covered by warranty.

F. Advise the OWNER'S REPRESENTATIVE, at least one-week in advance of start of fabrication, shop assembly or shipment, in order that the OWNER'S REPRESENTATIVE may carry out a complete inspection in the fabricator's shop. Cooperate fully to make available reasonable facilities for this shop inspection.

1.8 OPERATION AND MAINTENANCE MANUALS

A. The VENDOR shall furnish within 30 calendar days after Contract award and prior to shipment, five complete copies, and one electronic copy of operating and maintenance instructions for the equipment including initial startup instruction and maintenance schedules. Each copy shall be in a separate, single, bound manual. The operating and maintenance instructions shall include a comprehensive parts list of all parts of the system and the pumps and shall indicate the manufacturer’s identification number for each part.

1.9 WARRANTY

A. The VENDOR shall guarantee all equipment as to workmanship, materials, and satisfactory functioning for twelve months from the date of its startup, or 18 months from the date of shipment of the system. At the VENDOR’s total expense, he shall promptly rectify any failure covered by this guarantee. Startup is defined as the date on which the equipment is placed into continuous operation for its intended purpose. VENDOR further covenants with the OWNER that all goods and services will conform to the OWNER’S order, will be merchantable, fit, and sufficient for the particular purpose intended, and free from any defects or liens. The VENDOR agrees to protect and hold OWNER harmless from any loss or claim arising out of the failure of VENDOR to comply with the above. The above mentioned guarantee shall apply to the entire equipment package furnished by the VENDOR.

PART 2 PRODUCTS

2.1 GENERAL

A. The use of a manufacturer’s name and model or catalog number is for the purpose of establishing the standard of quality and configuration desired only.

2.2 ACCEPTABLE MANUFACTURERS

A. Cornell

B. Goulds

C. Summit

D. Or approved equal

2.3 EQUIPMENT DESCRIPTION

A. The pump specified herein shall be a heavy-duty horizontal end-suction centrifugal pump designed for continuous duty industrial use.

B. Single-stage, single-suction, frame mounted.

C. Pump and motor shall be suitable for use with a variable frequency drive to provide the maximum and minimum flow conditions specified in the pump data sheets.

2.4 SERVICE CONDITIONS

	PU-410A, PU-410B
Liquid Pumped	Groundwater, 10 mg/L suspended solids
pH	pH 6.0 to 7.0
Pumping Temperature, degrees F	40 to 80
Hardness (mg/L as CaCO3)	400
Specific Gravity @ PT	1.0
Maximum Solids Size, inches	1/8

2.5 PERFORMANCE REQUIREMENTS

A. As outlined in attached pump and motor data sheets.

2.6 DRIVE MOTOR

A. Furnish motor compatible with the driven equipment specified herein. The connected load shall not exceed the motor nameplate horsepower rating under any anticipated operating condition. Motor shall conform to NEMA MG 1 and to the detailed requirements as listed in the attached motor data sheets.

2.7 PUMP ACCESSORIES

A. Pump Identification Plate: A 16-gauge stainless steel identification plate shall be securely mounted on each pump in a readily visible location. The plate shall bear the ¼-inch die-stamped equipment identification number that is herein assigned the pump.

B. Lifting Lugs: Equipment weighing over 100 pounds shall be provided with lifting lugs.

C. Vent and Drain Connections: Provide tapped and plugged case vent and drain connections. Provide a ½-inch petcock, rated for the case hydrostatic test pressure, in the casing vent connection to be field installed.

D. Gauge Connections: Provide tapped and plugged suction and discharge gauge connections on the pump nozzles or flanges.

PART 3 PUMP CONSTRUCTION DETAILS

3.1 MATERIALS

A. Manufacturer's standard all-iron, unless otherwise hereinafter specified.

B. AISI, ASTM, etc. numbers, types, and grades specified are typical material composition and quality. Equivalent materials will be considered.

3.2 CASING

A. Cast iron, ASTM A48, flanges faced and drilled 125 psig ANSI Standard. Vertical centerline discharge with back pullout design

3.3 IMPELLER

A. Semi-open, cast iron, ASTM A48 with back pumpout vanes. Secure to shaft by key and self-locking nut, or capscrew and lock washer.

3.4 RENEWABLE SIDEPLATE

A. Cast iron, ASTM A48.

3.5 MECHANICAL SEAL

A. Manufacturer's standard double mechanical seal with carbon seal ring(s) and ceramic seal(s). Provide OWNER with cost information to provide, at OWNER's option, appropriate Chesterton double mechanical seal.

3.6 SEAL LUBRICATION

A. Water from an external source shall lubricate the seal faces.

3.7 SHAFT

A. Steel, AISI 4140, ground and polished.

3.8 SHAFT SLEEVE

A. Stainless steel, ASTM A276, Type 316, hard metal coated, securely locked against reverse rotation. Sleeve shall extend beyond gland.

3.9 BEARINGS

A. Outboard end, steel ball or roller thrust bearing; inboard end, steel ball or roller radial bearing. Rating life 25,000 hours as defined by AFBMA Standards.

3.10 BEARING LUBRICATION

A. Manufacturer’s standard oil lubrication system, with constant level oiler.

3.11 BASEPLATE

A. Manufacturer’s standard cast iron or fabricated steel, with grout holes. Factory mount pump, driver, and other components supplied by the manufacturer.

3.12 V-BELT DRIVE

A. Provide Woods or Dodge V-belt drive, designed for 95 percent efficiency. Provide OSHA approved belt guard with belt inspection port.

3.13 SPARE PARTS AND SPECIAL TOOLS

A. Complete mechanical seal, complete set of bearings, impeller, complete set gaskets and O-ring seals, shaft sleeve, and complete set keys, dowels, ping etc., and one complete set of any special tools required to dismantle pump or maintain pump.

3.14 ANCHOR BOLT SIZE AND MATERIAL

A. Provide OWNER with size and number of anchor bolts required.

PART 4 EXECUTION

4.1 PAINTING

A. The pumps shall be delivered to the jobsite finish painted. Primer and finish coats shall be manufacturer’s standard.

4.2 FIELD TEST

A. Functional Test: Prior to plant startup, all equipment described herein and in the Detail Specifications following shall be inspected for proper alignment, quiet operation, proper connection, and satisfactory performance by means of a functional test.

B. Vibration Test: The complete assembly, consisting of the driving unit and pump, connected and in normal operation, shall not develop amplitudes of vibration exceeding limits recommended by the current edition of Hydraulic Institute Standards.

C. Performance Test:

1. The VENDOR shall perform field tests on all completed pump assemblies, to demonstrate their conformance to the Specifications to the satisfaction of the OWNER'S REPRESENTATIVE. A test log shall be presented to the OWNER'S REPRESENTATIVE upon the completion of each test that records the following:
   a. Flow, as measured by plant instrumentation and/or storage volumes.
   b. Pump suction and discharge pressures as measured by calibrated gauges, converted to feet of the liquid pumped and corrected to pump centerline, calculated velocity heads at the suction and discharge flanges, and total head, all tabulated in feet.
   c. Driving motor voltage and amperage measured for each phase.
   d. Motor manufacturer's guaranteed power factor and efficiency at ¼, ½, ¾, and full load.
2. Units failing to meet the Specifications to the satisfaction of the OWNER'S REPRESENTATIVE must be more accurately tested in accordance with Hydraulic Institute Standards. If the pump fails the second test, the unit will be rejected, and the VENDOR shall furnish a unit that will perform as specified.

4.3 MANUFACTURER'S CERTIFICATE(S)

A. The manufacturer's representative shall provide a certificate stating that the equipment or system has been installed in accordance with the manufacturer's recommendation and has been inspected by the manufacturer's authorized representative, that it has been serviced with the proper initial lubricants, that applicable safety equipment has been properly installed, and that proper electrical and mechanical connections have been made.

4.4 4.4 SUPPLEMENTS

A. The supplements listed below, following "END OF SECTION", are a part of this Specification.

1. Data Sheets:
   a. Pump.
   b. Motor.

PUMP DATA SHEET
HORIZONTAL END SUCTION CENTRIFUGAL PUMPS NO. PU-410A, PU-410B

Project: B&L Woodwaste Site, Pierce County, WA Owner: Service: Groundwater Pump Name: Adsorption Column Feed Pumps Equip. Tag Number(s): PU-410A, PU-410B	Pump Mfr.: ________ Size & Type: _________ Serial No.: ___________ Model No.: __________

No. Pumps Required: 2________ Drive Type: ÿConstant ☑ Adjustable	No. Motor Driven: 2______ Pump Item No.: __________	No. Turbine Driven: 0________ Pump Item No.: _____________
LIQUID	**OPERATING CONDITIONS**	**SERVICE CONDITIONS**
Name: groundwater_ Pumping Temperature (^{o}F): Normal 60 Max 80 Min 40^{o}F Specific Gravity @ 1.0 Vapor Pressure (psia): ____ PH:__ 6 to 7 B. __________________ Remarks: 10 mg/L total suspended solids, 1/8 inch solids max. size	Capacity (U.S. gpm): Normal 40 Max 75 Total Dynamic Head (ft): 156 (at max flow) Suction Pressure (psig): Max ____ Rated _0__ Min. Continuous Flow (US gpm): 15 NPSH Available (ft): 22 Remarks:	Temp (^{o}F): Max 110 Min 40 Rel. Hum (%): Max 60 Min 20 Altitude (ft): 20 ☑ Indoor ☑ Heated ÿ Outdoor ÿ Unheated Area Classification: _not classified _________ Other: ____________________ Remarks:

PERFORMANCE REQUIREMENTS (manufacturer to supply missing data)

Proposal Curve No. _______ Max. Head, Rated Imp. (ft): 250_ NPSH Required (ft water): ______

Speed Range (rpm): Max. Power, Rated Imp. (BHP): ______ 3% Head Drop ____________

Efficiency (%): 25 % min Suction Specific Speed: _______

Rated Power (BHP): ________ Factory Testing:

☑ Required ÿ Not Required

Remarks:

Manufacturer to supply missing data.

Equipment Tag Number(s): PU-410A, PU-410B

PUMP CONSTRUCTION DETAILS (manufacturer to supply missing data)

Nozzles					Miscellaneous Connections		
	Size	Rating	Facing	Location		Size	Location
					Drain		
Suction		125 lb.	FF	Horizontal	Vent		
Discharge		125 lb.	FF	Vertical	Pres. Gauge		

Casing Mount: ÿ Foot
ÿ Centerline ÿ Bracket
ÿ Near Centerline
Hydro Test Pressure (psig): 1-1/2 times shutoff
Field Testing: ☐ Not required
☑ Required, functional and performance

Impeller Diamater (in.):
Rated___ Max.___ Min. ____
Impeller:
ÿ Radial ÿ Cupped
Packing:
Manufacturer _____________
Type ____________________
Size/No. Rings ____________
Mechanical Seal:
API Class Code ____________
Manufacturer:
Model Type:
Manufacturer Code:

Bearings (Type/No.):
Radial ______ Thrust________
Lubrication Type:
ÿ Grease ÿ Oil
Coupling: V-belt Drive
Manufacturer _____________
Type _______ Model _______
Driver Half-Coupling Mounted by:
ÿ Pump Mfr. ÿ Driver Mfr.
ÿ Purchaser
Gland Type/Material: ________
Gland Plate Taps Required:
ÿ Quench ÿ Flush ÿ Drain ÿ Vent

Remarks:

MATERIALS (manufacturer to supply missing data)

Case: Cast Impeller: 316 Stainless Steel Shaft: AISI std. as per manufacturer's recommendation
Case Wear Rings: N/A Impeller Wear Rings: N/A Shaft Sleeve: ASTM A276, Type 410

Remarks: Case thickness shall be minimum of ¾-inch With normal casing tolerances. The suction piece shall be removable and shall have a minimum thickness of 1 inch.

Baseplate:
Type w/Grout Holes
Material Steel

ADDITIONAL REQUIREMENTS

Partially Open Impeller Design

☑ Vent and drain connections tapped and plugged
☑ Suction and discharge gauge connections tapped and plugged

INDUCTION MOTOR DATA SHEET

Project: B&L Woodwaste Site, Pierce County, WA
Owner:
Equipment Name: Adsorption Column Feed Pumps
Equipment Tag Number(s): PU-410A, PU-410B

Type: Squirrel-cage induction meeting requirements of NEMA 4X

Manufacturer: Westinghouse

Hazardous Locations: ÿ Furnish motors for hazardous (classified) locations that conform to UL 674 and have an applied UL listing mark

Motor Horsepower: _______   Guaranteed Minimum Efficiency at Full Load: ________ percent

Voltage: 480________________   Guaranteed Minimum Power Factor at Full Load: _______ percent

Phase: 3___________________   Service Factor (@ rated max. amb. Temp.): ☐ 1.0 ☑ 1.5

Frequency: 60-Hz____________   Enclosure Type: CISD-TEFC______________________________

Synchronous Speed: 1800 rpm   Mounting Type: ☑ Horizontal   ÿ Vertical

ÿ Multispeed, Two-Speed: ÿ Vertical Shaft: ☐ Solid   ☐ Hollow

_______/_______ rpm   ÿ Vertical Thrust Capacity (lb): Up_____ Down _____

☐ Constant Horsepower   ☑ Adjustable Speed Drive

☐ Variable Torque

☐ Constant Torque   Operating Speed Range: 30 to 100 % of Rated Speed

Winding: ☐ One ☐ Two   Thermal Protection: _________________________________

Space Heater: Not required

ÿ Oversize main terminal (conduit) box for all motors

ÿ Terminal for connection of equipment grounding wire in each terminal box

Additional Motor Requirements:

Special Features:

END OF SECTION

SECTION 11315
AIR OPERATED DIAPHRAGM PUMPS

PART 1 GENERAL

1.1 WORK INCLUDED

A. Work necessary to design, furnish, deliver, field test, certify proper installation, and train the OWNER'S personnel in the operation and maintenance of two (2) installed and two (2) spare, air operated diaphragm pumps complete with air flow control valves, to meet the requirements outlined herein, complete and ready for installation by a CONTRACTOR selected by the OWNER.

B. VENDOR shall supply appropriately sized air oilers (2) and moisture removal traps (2), air filters (2) and pump control air solenoid valves (2).

C. The VENDOR shall provide a recommended spare parts list including prices with his bid. Prices quoted shall be firm for one full year from bid date.

D. VENDOR shall provide services to inspect the pump installations prior to start-up, and provide certificate of proper installation, prior to pump start-up.

E. VENDOR shall complete the Technical Summary of Bidders Proposed Equipment Form appended to this section and submit the form with his bid along with dimensional drawings and performance data.

F. The intent of these Specifications is to provide for the works herein enumerated to be fully complete in every detail for the purpose designated. It is hereby understood that the Supplier agrees to furnish any apparatus, appliances or material not herein specifically mentioned or included, but which is found necessary to complete, perfect and test every portion of the apparatus and equipment specified in a substantial manner and in compliance with the requirements written and implied in these Specifications without extra cost to the OWNER.

1.2 RELATED WORK

A. This Section shall be used in conjunction with the following other specifications and related Contract Documents to establish the total requirements for the referenced air operated diaphragm Sludge Pumps.

   1. Data sheets included at the end of this section.

1.3 SUBMITTALS WITH PROPOSAL

A. The English language and U.S. Customary system of measurement shall be used in all correspondence, drawings, data and specifications.

B. The VENDOR shall submit, in writing, a listing of all exceptions to the requirements specified herein. Items not specifically included in the “Exceptions” list shall assume to be as specified regardless of differences in the remainder of the submission.

C. Information to be submitted with the Proposal shall include, but not be limited to, the following:

   1. Make, model, weight, complete specifications, dimensional drawings, performance curves, identification of materials of construction, and descriptive literature of the equipment proposed.
   2. Complete instructions for installation of the equipment, including off-loading, storage, installation, and initial set-up.
   3. Suggested spare parts list to maintain the equipment in service for a period of 1 year and 5 years. Include a list of special tools required for checking, testing, parts replacement, and maintenance with current price information.
   4. List special tools, materials and supplies furnished with equipment for use prior to and during startup and future maintenance.
   5. A signed letter from the MANUFACTURER or equipment supplier that the equipment proposed to be furnished is in full compliance with the specifications and all addenda issued, except as noted in the letter. All submittals may be returned unreviewed if an exception to the Specifications is found that is not noted in the letter.
   6. VENDOR submitting proposals for equipment that would require changes in design shall also include detailed information on structural, electrical, mechanical, and other miscellaneous changes or modifications necessary to adapt their equipment.
   7. Recommended mounting details for base installation shall be provided.
   8. The Technical Summary of Bidders Equipment Form appended to this section shall be completed by the VENDOR and submitted with the bid.

D. The VENDOR shall submit a schedule identifying the sequencing and duration for fabrication, purchasing and installing major system components.

E. The VENDOR shall submit information regarding the warranty specified herein. The warranty shall state all conditions and exclusions.

F. The VENDOR shall submit documented evidence of their ability and capacity to complete this work. Documentation shall include, but not be limited to, a list of the three most recent installations where similar equipment by the MANUFACTURER is currently in service. Include contact name, telephone number, mailing address, and the names of the Engineer, OWNER, and installation CONTRACTOR. If three installations do not exist the list shall include all that do exist, if any.

1.4 SUBMITTALS AFTER CONTRACT AWARD

A. Within two (2) weeks after receipt of the Contract, the successful bidder shall submit to the OWNER'S REPRESENTATIVE for review, five (5) complete sets of "working drawings" showing the design and method of construction of the supplied equipment and accessories and where required, detail drawings and specifications of the equipment. One (1) electronic copy of all documentation in Adobe Acrobat .pdf format shall also be included.

B. Review of the working drawings and specifications by the OWNER'S REPRESENTATIVE shall not relieve the successful bidder of the responsibility for the correctness thereof, nor from the results arising from any error or omission of detail of design. Review of Drawings and Specifications shall, in every case, be subject to final acceptance of the equipment and materials after they have been put in operation, and the general operation of the equipment and materials has been found satisfactory to the OWNER.

C. The VENDOR shall submit factory test results of materials and written certification that the proposed materials meet or exceed the requirements of these Specifications. In addition, the VENDOR shall certify in writing that the materials proposed are similar and of the same formulation as that for which test results are submitted and which by actual usage has been demonstrated to be satisfactory for the intended application.

D. The VENDOR shall submit for the OWNER'S REPRESENTATIVE'S review a complete description of their quality control program for fabricating, handling, testing, repairing, and providing a complete and working internally fed rotary screen. The description shall include, but not be limited to, product identification, acceptance testing, fabrication production, testing, installation testing, documentation of changes, alterations, repairs, retests, and acceptance. The quality control program document shall be submitted for review by the OWNER'S REPRESENTATIVE.

E. The VENDOR shall submit a recommended method for offloading, handling, and storage of equipment and accessories prior to installation.

F. Description of Repair Procedure: In particular, how to make repairs once the equipment is in operation. The VENDOR shall provide a list of materials, equipment, and training requirements, and cost to equip the OWNER to make repairs not covered by warranty.

1.5 WARRANTY

A. The VENDOR shall guarantee all equipment as to workmanship, materials, and satisfactory functioning for 12 months from the date of its startup, but not later than 18 months from the date of shipment of the system (the later of the two dates). At the VENDOR'S total expense, he shall promptly rectify any failure covered by this guarantee. Startup is defined as the date on which the equipment is placed into continuous operation for its intended purpose. VENDOR further expressly covenants with the OWNER that all goods and services will conform to the OWNER'S order, will be merchantable, fit and sufficient for the particular purpose intended, and free from any defects or liens. The VENDOR agrees to protect and hold OWNER harmless from any loss or claim arising out of the failure of VENDOR to comply with the above. The above-mentioned guarantee shall apply to the entire equipment package furnished by the VENDOR.

1.6 MANUFACTURERS' SERVICES

A. The VENDOR shall provide an experienced and fully qualified technician for technical assistance during installation and startup of the equipment and training the OWNER'S personnel. The cost for this technical assistance, including both labor and expenses, shall be included in the lump sum price for the equipment. VENDOR'S services shall be at such times as requested by the OWNER. Site visit(s) shall be coordinated with and approved by the OWNER or OWNER'S REPRESENTATIVE.

B. The field technician shall also assist in training the operating personnel in the operation, maintenance, and peculiarities of the equipment provided.

C. The VENDOR shall indicate the cost, including both labour and expenses, for additional service to be provided at the CONTRACTOR'S or OWNER'S option. This per diem amount shall also be credited to the OWNER should the OWNER elect not to exercise all service options, or if the total service time actually expended is reduced.

1.7 OPERATION AND MAINTENANCE MANUALS

A. The VENDOR shall furnish with delivery, operating and maintenance instructions for the equipment including initial startup instruction and maintenance schedules as per Section 01430 – Operation and Maintenance Data. The operating and maintenance instructions shall include a comprehensive parts list of all parts of the equipment and shall indicate the MANUFACTURER and MANUFACTURER'S identification number for each part.

PART 2 PRODUCTS

2.1 GENERAL

A. Equipment shall be new. Previously owned or refurbished equipment is not acceptable.

B. Materials of construction shall be the VENDOR’S standard for the specified service conditions unless otherwise specified. The metallurgy of all major components shall be identified in the data sheets or in the quotation. Materials of construction selected by the VENDOR shall provide a design life of 10 years for the pumps under the service conditions specified.

2.2 SERVICE CONDITIONS

A. It is the VENDOR’S sole responsibility to ensure that the equipment and any related mounting hardware is suitable for operation under the service conditions specified for a design life of at least 10 years.

2.3 DESIGN CRITERIA

A. General:

1. Pumps shall be air operated diaphragm pumps suitable for the service conditions indicated.
2. Pumps shall be supplied complete with a process air conditioning system with a minimum of an appropriately sized moisture removal trap, air filter, and air oiler. The air conditioning system shall be capable of conditioning air from the compressor supplied with the filter press.
3. Pumps shall be supplied complete with a manually adjustable air control valve. Air flow control valves shall be adjustable to regulate the pumping rate of the diaphragm pumps

2.4 CODE COMPLIANCE

A. All equipment shall be manufactured in accordance with codes and guidelines as specifically detailed herein and in accordance with applicable portions of the following (latest edition).

1. Local Laws and Ordinances.
2. Underwriters Laboratories (UL).
3. American National Standards Institute (ANSI).
4. American Society of Mechanical Engineers (ASME).
5. Instrument Society of America (ISA).
6. Factory Mutual (FM).
7. National Fire Protection Agency (NFPA).

2.5 IDENTIFICATION

A. An equipment identification plate made of 16 gauge stainless steel with 6 mm die stamped markings shall be securely fastened to the equipment in a visible location. Identification plate shall include model number, serial number, VENDOR’S name and location, and OWNER’S name.

2.6 PAINTING

A. Surfaces of the pumps, and accessories specified herein shall be factory prepared and primed with the MANUFACTURER’S standard primer and finish coating, provided it meets or exceeds the surface preparation and coating requirements for the service conditions indicated herein.

PART 3 EXECUTION

3.1 FACTORY TESTING

A. Pumps shall be factory tested.

B. Certification of the test curve for the purchased pump is required.

3.2 MANUFACTURER’S SERVICES

A. Allow at least one (1) day of labour and travel expenses in this Bid for factory-trained personnel to inspect the installation of the equipment, test the equipment, certify proper installation of the equipment and instruct plant personnel in its operation and maintenance. VENDOR is to co-ordinate the site visit with the OWNER’S REPRESENTATIVE.

B. During the inspection of equipment installation, the VENDOR shall perform field tests on all completed pump assemblies, to demonstrate their conformance to the Specifications to the satisfaction of the OWNER’S REPRESENTATIVE. A test log shall be presented to the OWNER’S REPRESENTATIVE upon the completion of each test that records the following:

1. Flow, as measured by plant instrumentation and/or storage volumes.
2. Pump suction and discharge pressures as measured by calibrated gauges, converted to feet of the liquid pumped and corrected to pump centerline, calculated velocity heads at the suction and discharge flanges, and total head, all tabulated in meters.

C. VENDOR shall provide a certificate stating that: the equipment or system has been installed in accordance with the MANUFACTURER’S recommendation and has been inspected by a VENDOR’S authorized representative; that the equipment has been serviced with the proper initial lubricants; that applicable safety equipment has been properly installed; and that the proper connections have been made.

D. Units failing to meet the Specifications to the satisfaction of the OWNER'S REPRESENTATIVE must be more accurately tested in accordance with Hydraulic Institute Standards. If the pump fails the second test, the unit will be rejected, and the VENDOR shall furnish a unit that will perform as specified.

3.3 ACCEPTANCE

A. Acceptance of the works is defined as the date where ALL of the following conditions have been met.

1. System has been fully installed, successfully tested, and the MANUFACTURER'S Certificate of Proper Installation completed.
2. All Operation and Maintenance data and Manuals have been completed.
3. All spare parts included with the original order have been received by the OWNER.
4. Initial training of the OWNER'S staff is completed.
5. The system is placed in full-time service in its originally intended function, and has performed satisfactorily in the OWNER'S sole opinion, for a period of thirty (30) days.
6. Items (1) through (5), inclusively, must be reviewed and accepted by OWNER in writing.

3.4 SUPPLEMENTS

A. The supplements listed below, following "END OF SECTION", are a part of this Specification.

1. Pump Data Sheets

END OF SECTION

Attachments:		Spec No:	
reference specifications section		Project No:	**SE10160010**
11315 Air Operated Diaphragm Pumps		Customer:	
		Compiled by:	**L. de Vlaming**
		Date:	**12-Apr-11**
		Equip. No.:	**P-230**
P&ID No:	**2**		
PFD No:	**1**		

Issue:	Date:	Released for:	Checked by	Approved by
0	**14-Apr-11**	**Review**		

DESCRIPTION

Service	Filter Press Feed	Number Reqd	**2**

PROCESS DATA

Liquid	Material	**contaminated water**	Temperature, deg F	**50+**	Vapor Pressure, mmHg	**n/a**
			SG	1.1 est	Corrosive, etc?	**no**
Solids	Material	**metal hydroxide floc**	Weight %	2-Jan	Particle Size, in/mm	**unk.**
			SG		Abrasive, etc?	**possible**
Vapor	Material		Volume %		Bubble Size, in/mm	**n/a**
Other						

Design Capacity, GPM	7.5 (nom); 15 (peak)	Suction Pressure, PSIA	flooded suction
Rated Discharge Pressure, PSIG	100	Suction Lift, ft	
Total Head, ft		NPSH Available, ft	
Available Air/N2 Pressure	**as required**	Air/N2 Consumption, SCFM	*
Performance Curve No.	*	Duty	

CONSTRUCTION

Surge Suppressor - Inlet, Y/N	**N**	Inlet Connection Size	*
Surge Suppressor - Outlet, Y/N	**N**	Outlet Connection Size	*
Drain Connection Size	*	Air Connection Size	*
Mounting	**concrete floor**	Lubricator, Y/N	**NOTE 1**
Noise Level @ 3 FT., dBA	**per vendor**	Single/Double Diaphragm?	**single**

MATERIALS

Inlet Manifold	as recomm for pumped material	Outlet Manifold	as recomm for pumped material
Diaphragm/s	as recomm for pumped material	Bolts	as recomm for pumped material
Diaphragm Liner	*	Nuts	as recomm for pumped material
Ball Valves	as recomm for pumped material	Clamps	as recomm for pumped material
BallValve Seats	as recomm for pumped material	Pump Base	as recomm for pumped material
Air Regulating Valve	to be included	Casing	as recomm for pumped material

Remarks

NOTES * **VENDOR TO SPECIFY**

NOTE 1 VENDOR TO PROVIDE FILTER, PRESSURE
REDUCER, GAUGE, LUBRICATOR, AND EXHAUST
MUFFLER

Attachments:		Spec No:	
reference specifications section		Project No:	**SE10160010**
11315 Air Operated Diaphragm Pumps		Customer:	
		Compiled by:	**L. de Vlaming**
		Date:	**12-Apr-11**
		Equip. No.:	**P-220**
P&ID No:	**2**		
PFD No:	**1**		

Issue:	Date:	Released for:	Checked by	Approved by
0	**14-Apr-11**	**Review**		

DESCRIPTION

Service	Clarifier Underflow Sludge	Number Reqd	**2**

PROCESS DATA

Liquid	Material	**contaminated water**	Temperature, deg F	**50+**	Vapor Pressure, mmHg	**n/a**
			SG	1.1 est	Corrosive, etc?	**no**
Solids	Material	**metal hydroxide floc**	Weight %	2-Jan	Particle Size, in/mm	**unk.**
			SG		Abrasive, etc?	**possible**
Vapor	Material		Volume %		Bubble Size, in/mm	**n/a**
Other						

Design Capacity, GPM	4 (nom); 7.5 (peak)	Suction Pressure, PSIA	flooded suction
Rated Discharge Pressure, PSIG	25	Suction Lift, ft	
Total Head, ft		NPSH Available, ft	
Available Air/N2 Pressure	**as required**	Air/N2 Consumption, SCFM	*
Performance Curve No.	*	Duty	

CONSTRUCTION

Surge Suppressor - Inlet, Y/N	**N**	Inlet Connection Size	*
Surge Suppressor - Outlet, Y/N	**N**	Outlet Connection Size	*
Drain Connection Size	*	Air Connection Size	*
Mounting	**concrete floor**	Lubricator, Y/N	**NOTE 1**
Noise Level @ 3 FT., dBA	per vendor	Single/Double Diaphragm?	**single**

MATERIALS

Inlet Manifold	as recomm for pumped material	Outlet Manifold	as recomm for pumped material
Diaphragm/s	as recomm for pumped material	Bolts	as recomm for pumped material
Diaphragm Liner	*	Nuts	as recomm for pumped material
Ball Valves	as recomm for pumped material	Clamps	as recomm for pumped material
BallValve Seats	as recomm for pumped material	Pump Base	as recomm for pumped material
Air Regulating Valve	to be included	Casing	as recomm for pumped material

Remarks

NOTES

*** VENDOR TO SPECIFY**

NOTE 1 VENDOR TO PROVIDE FILTER, PRESSURE REDUCER, GAUGE, LUBRICATOR, AND EXHAUST MUFFLER

SECTION 11316
PERISTALTIC PUMPS

PART 1 GENERAL

1.1 WORK INCLUDED

A. This section covers the work necessary to furnish and install two peristaltic pumps specified herein, complete.

1.2 EQUIPMENT NUMBERS

A. A. Lime Recirculation Pumps: PU-320A, PU-320B (second pump will be a shelf spare).

1.3 GENERAL

A. Like items of equipment provided hereunder, although for different services, shall be the end products of one manufacturer.

1.4 DEFINITIONS

A. Total Head: Total head in feet of liquid pumped shall be the discharge head minus the suction head (or plus the suction lift), both measured at the pump flanges and corrected to pump centerline, plus the difference in velocity heads at the same points.

B. Net Positive Suction Head Available (NPSHa): Net Positive Suction Head Available shall be the absolute pressure in metres on the surface of the open liquid supply minus the suction lift in meters, minus the vapour pressure of the liquid being pumped in meters, minus the friction losses in the pipe, valves, and fittings.

C. Net Positive Suction Head Required (NPSHr): Net Positive Suction Head required for proper operation of the pump.

D. Overall Efficiency: Overall efficiency shall be the total efficiency for motor and pump from the motor terminals to pumped liquid.

1.5 MANUFACTURER’S SERVICES

A. A Manufacturer’s representative for the equipment specified herein shall be present at the jobsite and/or classroom designated by the OWNER for installation assistance, inspection, certification of the installation, functional and performance testing, startup and jobsite training.

B. Manufacturer’s services shall be at such times as requested by the OWNER and shall be included in the VENDOR’s price and shall be defined in the VENDOR’s quotation.

1.6 SUBMITTALS WITH PROPOSAL

A. The VENDOR shall submit, in writing, a listing of all exceptions to the requirements specified herein. Items not specifically included in the list shall be assumed to be as specified regardless of differences in the remainder of the submission.

B. Information to be submitted with the proposal shall include, but not be limited to, the following:

1. Make, model and weight of each pump.
2. Complete specifications, detailed dimensional drawings and descriptive literature of pump and controls. The submittal shall show that pump components are designed and recommended by the manufacturer for the fluid service. Include details on materials of construction of the hose, and anchor bolt requirements for anchoring base to floor.
3. Performance curves indicating pump performance showing head, capacity, horsepower demand, speed, and pump efficiency over the entire operating range of the pump, from shutoff to maximum capacity. The equipment manufacturer shall indicate separately the head, capacity, horsepower demand, speed, overall efficiency, and NPSHr at the design point. Performance requirements shall be as defined in the Hydraulic Institute Standards.
4. Complete, detailed installation information package for the pumps and related hardware. This package shall contain all necessary instructions and drawings to provide for proper installation.
5. Provide a list of recommended spare parts for the pumping system with unit prices, availability, and delivery time. Include in the list items which would normally be expected to fail in the first 5 years of operating life. List the recommended spare parts inventory and the price, firm for one full year from Acceptance.
6. Certified bearing life.
7. Schematic of control and power wiring
8. Location of equipment origin.

C. The VENDOR shall submit complete material specifications, including coating type, descriptive drawings, a complete layout drawing with all appurtenances, and literature for all pump components, including, but not limited to, hose, housing, seals, support brackets, gasket material, hardware, anchor studs, etc.

D. The VENDOR shall submit a detailed schedule identifying the sequencing and duration for fabrication, purchasing and delivery. Delivery schedule will be a significant factor in the bid evaluation process.

E. The VENDOR shall submit documented evidence of their ability and capacity to complete this work. Documentation shall include, but not be limited to, a list of installations of a similar nature, including the OWNER, size, fluid type, contact person, and phone number. The list shall include a minimum of the three most recent pump installations.

F. Information regarding the warranty specified herein. The warranty shall state all conditions and exclusions.

1.7 SUBMITTALS AFTER CONTRACT AWARD

A. Within two (2) weeks after receipt of the Contract, and before commencing work, the successful bidder shall submit to the OWNER'S REPRESENTATIVE for review, one (1) complete set of "working drawings" showing the design and method of construction of the pumps and where required, detail drawings and specifications of the equipment. The drawings shall be in Adobe portable document format (PDF) and shall be set up to print on 11 x 17 inch paper as a maximum. Submit hard copies if larger drawings are required.

B. Review of the working drawings and specifications by the OWNER'S REPRESENTATIVE shall not relieve the successful bidder of the responsibility for the correctness thereof, nor from the results arising from any error or omission of detail of design. Review of Drawings and Specifications shall, in every case, be subject to final acceptance of the equipment and materials after they have been put in operation, and the general operation of the equipment and materials has been found satisfactory to the OWNER.

C. The VENDOR shall submit for the OWNER'S REPRESENTATIVE'S review a complete description of their quality control program for fabricating, handling, installing, testing, repairing, and providing a complete and working pump system. The description shall include, but not be limited to, product identification, acceptance testing, fabrication production, testing, installation testing, documentation of changes, alterations, repairs, retests, and acceptance.

D. The VENDOR shall submit a recommended method for handling and storage of pump components and accessories prior to installation.

E. Description of Repair Procedure: Provide detailed information on how to make repairs once the pumps are in operation in accordance with requirements of Section 01430 OPERATION AND MAINTENANCE DATA. The VENDOR shall provide a list of materials, equipment, and training requirements, and cost to equip the OWNER to make repairs not covered by warranty.

F. Advise the OWNER'S REPRESENTATIVE, at least one-week in advance of start of fabrication, shop assembly or shipment, in order that the OWNER'S REPRESENTATIVE may carry out a complete inspection in the fabricator's shop. Cooperate fully to make available reasonable facilities for this shop inspection.

1.8 OPERATION AND MAINTENANCE MANUALS

A. The VENDOR shall furnish with delivery, operating and maintenance instructions for the equipment including initial startup instruction and maintenance schedules as per Section 01430 – Operation and Maintenance Data. The operating and maintenance instructions shall include a comprehensive parts list of all parts of the equipment and shall indicate the MANUFACTURER and MANUFACTURER'S identification number for each part.

1.9 WARRANTY

A. The VENDOR shall guarantee all equipment as to workmanship, materials, and satisfactory functioning for twelve months from the date of its startup, or 18 months from the date of shipment of the system. At the VENDOR's total expense, he shall promptly rectify any failure covered by this guarantee. Startup is defined as the date on which the equipment is placed into continuous operation for its intended purpose. VENDOR further covenants with the OWNER that all goods and services will conform to the OWNER's order, will be merchantable, fit, and sufficient for the particular purpose intended, and free from any defects or liens. The VENDOR agrees to protect and hold OWNER harmless from any loss or claim arising out of the failure of VENDOR to comply with the above. The above mentioned guarantee shall apply to the entire equipment package furnished by the VENDOR.

PART 2 PRODUCTS

2.1 GENERAL

A. The use of a manufacturer's name and model or catalog number is for the purpose of establishing the standard of quality and configuration desired only.

2.2 EQUIPMENT DESCRIPTION

A. The pumps specified herein shall be horizontal, positive displacement, peristaltic hose pumps. The pumps shall heavy-duty and designed for continuous duty industrial use.

B. Pumps shall be capable of running dry without damage to the pump or hose.

C. Pumps shall have valveless/glandless design with no dynamic seals in contact with the fluid.

D. Single-stage, frame mounted.

2.3 SERVICE CONDITIONS

	PU-320A, PU-320B
Liquid Pumped	Hydrated lime slurry, 3.5 lb $Ca(OH)_2$ per US gallon
pH	13
Liquid Temperature, degrees F	40 to 90
Specific Gravity @ PT	1.25
Location	Indoor, heated

2.4 PERFORMANCE REQUIREMENTS

A. As outlined in attached pump and motor data sheets.

2.5 DRIVE MOTOR

A. Furnish motor compatible with the driven equipment specified herein. The connected load shall not exceed the motor nameplate horsepower rating under any anticipated operating condition. Motor shall conform to NEMA MG 1 and to the detailed requirements as listed in the attached motor data sheets.

2.6 PUMP ACCESSORIES

A. Pump Identification Plate: A 16-gauge stainless steel identification plate shall be securely mounted on each pump in a readily visible location. The plate shall bear the ¼-inch die-stamped equipment identification number that is herein assigned the pump.

B. Lifting Lugs: Equipment weighing over 100 pounds shall be provided with lifting lugs.

C. Vent and Drain Connections: Provide tapped and plugged case vent and drain connections. Provide a ½-inch petcock, rated for the case hydrostatic test pressure, in the casing vent connection to be field installed.

D. Gauge Connections: Provide tapped and plugged suction and discharge gauge connections on the pump nozzles or flanges.

PART 3 PUMP CONSTRUCTION DETAILS

3.1 MATERIALS

A. Manufacturer's standard all-iron, unless otherwise hereinafter specified.

B. AISI, ASTM, etc. numbers, types, and grades specified are typical material composition and quality. Equivalent materials will be considered.

3.2 HOSE AND LUBRICANT

A. Hoses shall be layered elastomer, with nylon reinforcement, and a wetted layer compatible with the process fluid.

B. Hose must be replaceable without cover or pump removal.

C. Pump housing shall contain manufacturer recommended hose lubricant blended to provide a medium for cooling and lubrication.

3.3 PUMP HOUSING, ROTOR AND INTERNAL BEARING FRAME

A. Housing shall be cast iron, with an internal bearing hub to support the rotor on its own bearings. Provide a threaded drain plug at the lowest point of the pumping chamber to allow complete drainage of the lubricating fluid.

B. Rotors shall be cast iron and adjustable to perfectly match the pump process conditions and eliminate slip.

C. Pump rotor shall be independently supported on its own set of heavy duty ball bearings such that the bearings are located directly under the rotor's load.

D. Gearing shall be direct coupled to the back of the pump housing. Gear unit and drive components shall be serviceable without removal of the pump rotor.

3.4 DRIVE SYSTEM

A. Provide gearing with direct coupled mounting to the pump housing.

B. Design gear reduction to match output speed requirement of the pump using two or three stage gearing and matching torque rating of pumping equipment. Gearing shall be classified for continuous heavy shock duty, 24 hr duty, with a minimum service factor of 1.4.

3.5 BEARINGS

A. Bearings shall be sealed and greased for life. Rating life 25,000 hours as defined by AFBMA Standards.

3.6 FLANGED CONNECTORS

A. Supply pump with flanged inlet and outlet to ANSI 150# standards with wetted inserts compatible with the process fluid.

3.7 PUMP COVER

A. Pump cover shall be cast iron.

B. Cover shall be bolted along the perimeter, with a gasket seal.

3.8 BASEPLATE

A. Baseplate shall be torsion free. Manufacturer’s standard cast iron or fabricated steel, with grout holes. Factory mount pump, driver, and other components supplied by the manufacturer.

3.9 SPARE PARTS AND SPECIAL TOOLS

A. Provide two replacement hoses, and two hose lubricant refills.

B. Provide one complete set of any special tools required to dismantle pump or maintain pump.

3.10 CONTROLS

A. High lubricant leak detector: Provide float type switch located near top of pump to detect leakage of pumped fluid into the pump housing.

B. Revolution Sensor: Provide inductive type sensor to detect rotor revolutions.

PART 4 EXECUTION

4.1 PAINTING

A. The pumps shall be delivered to the jobsite finish painted. Primer and finish coats shall be manufacturer’s standard.

4.2 INSTALLATION

A. Pump shall be installed as per manufacturer’s instructions and recommendations.

4.3 FIELD TEST

A. Functional Test: Prior to plant startup, all equipment described herein and in the Detail Specifications following shall be inspected for proper alignment, quiet operation, proper connection, and satisfactory performance by means of a functional test.

B. Vibration Test: The complete assembly, consisting of the driving unit and pump, connected and in normal operation, shall not develop amplitudes of vibration exceeding limits recommended by the current edition of Hydraulic Institute Standards.

C. Performance Test:

1. The VENDOR shall perform field tests on all completed pump assemblies, to demonstrate their conformance to the Specifications to the satisfaction of the OWNER’S REPRESENTATIVE. A test log shall be presented to the OWNER’S REPRESENTATIVE upon the completion of each test that records the following:
   a. Flow, as measured by plant instrumentation and/or storage volumes.
   b. Pump suction and discharge pressures as measured by calibrated gauges, converted to feet of the liquid pumped and corrected to pump centerline, calculated velocity heads at the suction and discharge flanges, and total head, all tabulated in feet.
   c. Driving motor voltage and amperage measured for each phase.
2. Units failing to meet the Specifications to the satisfaction of the OWNER’S REPRESENTATIVE must be more accurately tested in accordance with Hydraulic Institute Standards. If the pump fails the second test, the unit will be rejected, and the VENDOR shall furnish a unit that will perform as specified.

4.4 MANUFACTURER’S CERTIFICATE(S)

A. The manufacturer’s representative shall provide a certificate stating that the equipment or system has been installed in accordance with the manufacturer’s recommendation and has been inspected by the manufacturer’s authorized representative, that it has been serviced with the proper initial lubricants, that applicable safety equipment has been properly installed, and that proper electrical and mechanical connections have been made.

4.5 SUPPLEMENTS

A. The supplements listed below, following “END OF SECTION”, are a part of this Specification.

1. Data Sheets:
   a. Pump.
   b. Motor.

PUMP DATA SHEET 1 of 1
PERISTALTIC PUMPS NO. PU-320A, PU-320B

Project: B&L Woodwaste Site, Pierce County, WA
Owner:
Service: Hydrated lime slurry
Pump Name: Lime Recirculation Pumps
Equip. Tag Number(s): PU-320A, PU-320B

Pump Mfr.: ________
Size & Type: _________
Serial No.: ___________
Model No.: __________

No. Pumps Required: 2________
Drive Type: ☑ Constant
ÿ Adjustable

No. Motor Driven: 2______
Pump Item No.: __________

No. Turbine Driven:
0________
Pump Item No.: _____________

LIQUID

Name: hydrated lime slurry_
Pumping Temperature (^oF):
Normal 60 Max 80 Min 40^{o}F
Specific Gravity @ 1.25
Vapor Pressure (psia): ____
PH:__ 13
Viscosity: 45 to 700 cP

Remarks: 3.5 lb $Ca(OH)_2$ per US gallon
- potential for non-Newtonian behavior

OPERATING CONDITIONS

Capacity (U.S. gpm):
Normal 20 Max 20
Total Dynamic Head (psi): 140
Suction Pressure (ft):
Max _15_ Rated ___
Min. Continuous Flow (US gpm): 20
NPSH Available (ft):
Remarks: constant flow

SERVICE CONDITIONS

Temp (^oF): Max 110 Min 40
Rel. Hum (%): Max 100 Min 20
Altitude (ft): 20
☑ Indoor ☑ Heated
ÿ Outdoor ÿ Unheated
Area Classification: _not classified _________
Other: ____________________

Remarks:

PERFORMANCE REQUIREMENTS (manufacturer to supply missing data)

Proposal Curve No. _______ Max. Head, Rated Imp. (ft): _____ NPSH Required (ft water): ______
Speed Range (rpm): Max. Power, Rated Imp. (BHP): ______ 3% Head Drop ____________
Efficiency (%): Suction Specific Speed: _______
Rated Power (BHP): ________
Factory Testing:
☑ Required ÿ Not Required

Remarks:
Manufacturer to supply missing data.
PU-320A shall be installed, PU-320B shall be shelf spare

Equipment Tag Number(s): PU-320A, PU-320B							
PUMP CONSTRUCTION DETAILS (manufacturer to supply missing data)							
Nozzles					Miscellaneous Connections		
	Size	Rating	Facing	Location		Size	Location
					Drain		
Suction		150 lb.	FF	Horizontal	Vent		
Discharge		150 lb.	FF	Vertical	Pres. Gauge		
Remarks:							
ADDITIONAL REQUIREMENTS							

INDUCTION MOTOR DATA SHEET

Project: B&L Woodwaste Site, Pierce County, WA
Owner:
Equipment Name: Lime Recirculation Pumps
Equipment Tag Number(s): PU-320A, PU-320B

Type: Squirrel-cage induction meeting requirements of NEMA 4X

Manufacturer: Westinghouse

Hazardous Locations: ÿ Furnish motors for hazardous (classified) locations that conform to UL 674 and have an applied UL listing mark

Motor Horsepower: _______   Guaranteed Minimum Efficiency at Full Load: ________ percent

Voltage: 480_______________   Guaranteed Minimum Power Factor at Full Load: _______ percent

Phase: 3__________________   Service Factor (@ rated max. amb. Temp.): ☐ 1.0 ☑ 1.15

Frequency: 60-Hz___________   Enclosure Type: CISD-TEFC_____________________________

Synchronous Speed: 1800 rpm   Mounting Type: ☐ Horizontal   ☐ Vertical

ÿ Multispeed, Two-Speed: ☐ Vertical Shaft: ☐ Solid   ☐ Hollow

_______/_______ rpm   ☐ Vertical Thrust Capacity (lb): Up_____ Down _____

☐ Constant Horsepower   ☐ Adjustable Speed Drive

☐ Variable Torque

☐ Constant Torque   Operating Speed Range:

Winding: ☐ One ☐ Two   Thermal Protection: _________________________________

Space Heater: Not required

ÿ Oversize main terminal (conduit) box for all motors

ÿ Terminal for connection of equipment grounding wire in each terminal box

Additional Motor Requirements:

Special Features:

END OF SECTION

SECTION 11318
SUBMERSIBLE WELL PUMPS

PART 1 GENERAL

1.1 WORK INCLUDED

A. This section covers the work necessary to furnish and install, complete, the submersible well pumps specified herein and in the attached Pump Data Sheets.

1.2 GENERAL

A. Like items of equipment provided hereunder, although for different services, shall be the end products of one MANUFACTURER.

1.3 MANUFACTURER'S REPRESENTATIVE

A. The MANUFACTURER'S representative for the equipment specified shall be present at the jobsite for installation assistance, inspection and certification of the installation, equipment testing, startup assistance, and training of OWNER'S personnel.

1.4 SUBMITTALS DURING CONSTRUCTION

A. Submittals during construction shall be made in accordance with Section 01300, Submittals.

B. Submittals with Bid:

1. Product cut sheets
2. Pump curves, showing flow, speed, horsepower, and efficiency
3. Dimensional drawings

C. Submittals After Award:

1. Shop drawings showing pump and motor details, materials of construction
2. Electrical/control wiring schematic
3. MANUFACTURER’S recommended storage and installation instructions
4. Operation and Maintenance manuals as per Section 01430 – Operation and Maintenance Data.

PART 2 PRODUCTS

2.1 GENERAL

A. The use of a MANUFACTURER'S name and model or catalog number is for the purpose of establishing the standard of quality and general configuration desired only. Approved equal products of other MANUFACTURERS will be considered.

2.2 PUMP DESCRIPTION

A. Pumps shall be Grundfos 5SQ05-90 and 5SQE05-90. The Detailed requirements are provided in the attached Pump Data Sheets.

B. Pumps shall include the following features:

1. High efficiency pump and motor
2. Dry run protection
3. High temperature shut off
4. Top bearing to prevent damage from upthrust
5. Overload protection – reduction of speed or shut down motor automatically on high current.

2.3 ACCESSORIES

A. Provide Grundfos pump controller, as specified on pump data sheet, for each well pump supplied.

B. Provide one (qty 1) R100 controller programmer.

PART 3 EXECUTION

3.1 PUMP INSTALLATION

A. Pumps shall be installed in accordance with the MANUFACTURER'S recommendations, and located and mounted as shown on the Drawings.

3.2 FUNCTIONAL TEST

A. The pumps shall be functionally tested at the factory. A detailed report showing successful test results shall be provided to the OWNER before shipping.

B. After installation, all equipment described herein shall be inspected by the supplier's representative for proper connection and satisfactory performance by means of a functional test. A description of this test shall be provided to the OWNER for approval at the time equipment submittal is made.

3.3 MANUFACTURER'S CERTIFICATE(S)

A. Provide MANUFACTURER'S certificate(s) in accordance with Section MANUFACTURER’S Services of the General Requirements.

PUMP DATA SHEET

Quantity	10
Tag Numbers	PU-52012 through PU-52021
Type	Constant speed submersible well pump
Manufacturer	Grundfos
Model	5SQ05-90
Rated Capacity	
Maximum	6 US gpm
Minimum	0.2 US gpm
Required Discharge Pressure	28 psig
Drive Voltage **	120 VAC, 60 Hz, single-phase or 480 VAC, 60 Hz, 3-phase
Discharge Connection	*
Required Controls:	
Start/Stop	Digital input from PLC
Fault Alarm	Relay output to PLC
Run Status	Relay output to PLC
Controller	CU-300 for each pump supplied
Service Conditions:	
Liquid Pumped	Groundwater
Temperature	40 to 80 degrees F
Viscosity	1.3 kg/(m.s)
Specific Gravity	1.0
Materials of Construction:	
Bottom/Top/Discharge chamber	*
Valve Casing	*
Valve Seat	*
Valve O-Ring	*
Impeller	*
Bearing	*

***** VENDOR to specify
** VENDOR to verify

PUMP DATA SHEET

Quantity	11
Tag Numbers	PU-51001 through PU-51011
Type	Variable speed submersible well pump
Manufacturer	Grundfos
Model	5SQE05-90
Rated Capacity	
Maximum	6 US gpm
Minimum	0.2 US gpm
Required Discharge Pressure	28 psig
Drive Voltage **	120 VAC, 60 Hz, single-phase or 480 VAC, 60 Hz, 3-phase
Discharge Connection	*
Controls:	
Start/Stop	Digital input from PLC
Speed Control	4-20 mA analog speed input from PLC
Fault Alarm	Relay output to PLC
Run Status	Relay output to PLC
Controller	CU-300 for each pump supplied
Service Conditions:	
Liquid Pumped	Groundwater
Temperature	40 to 80 degrees F
Viscosity	1.3 kg/(m.s)
Specific Gravity	1.0
Materials of Construction:	
Bottom/Top/Discharge chamber	*
Valve Casing	*
Valve Seat	*
Valve O-Ring	*
Impeller	*
Bearing	

***** VENDOR to specify
** VENDOR to verify

END OF SECTION

SECTION 11339
POLYETHYLENE TANKS

PART 1 GENERAL

1.1 WORK INCLUDED

A. This section covers work necessary to fabricate, load, deliver and install polyethylene (PE) tanks, including all tank accessories, as described on the drawings and data sheets.

1. Polymer day tank
2. Groundwater collection tank

1.2 RELATED WORK

A. Section 15010 - Basic Mechanical Requirements.

1.3 REFERENCES

A. The latest edition of the following listed specifications, practices and test methods are included in these specifications.

1. International Building Code
2. ASTM D1505
3. ASTM D1693
4. ASTM D638
5. ASTM D1525
6. ASTM D746
7. ASTM D790
8. Conflicts - In cases where these specifications conflict with the referenced specifications, procedures and test methods above, these specifications will prevail. In cases of conflict between two or more references, the VENDOR will describe in writing the conflict in detail and the OWNER’S REPRESENTATIVE will resolve the conflict in writing.

1.4 GENERAL

A. Tank dimensions and accessory types, number and sizes are shown on the attached Tank Data Sheets. The final accessory sizes (+/- one nominal size) and locations are subject to change until approval of VENDOR shop drawings.

B. Where substitution of standard tank or accessory dimensions can reduce OWNER'S cost, VENDOR can submit an alternate design including the amount of savings.

1.5 DESIGN CRITERIA

A. All tanks shall be designed to meet or exceed requirements for liquid containment at the conditions specified in Section 15010, Basic Mechanical Requirements.

B. All tanks shall be designed to meet the following additional design criteria over and above that required for liquid containment:

1. Appropriate seismic load for the project location.

C. The tanks shall not be painted.

D. Tanks shall be supplied with integrated support for top mounted mixers. Tank and mixer support design shall account for load, torque, bending moments, and vibration from the mixers under continuous service. CONTRACTOR shall provide actual design values for the mixer mount requirements to tank MANUFACTURER after final mixer selection by CONTRACTOR.

1.6 SUBMITTALS

A. With Bid:

1. Detailed description of the polymeric materials including any additives.
2. Overall dimensions of tank, total volume in U.S. gallons, number and size of nozzles.
3. Description and number of gaskets to be supplied.
4. List and description of potential conflicts and proposed alternates to Specifications (if any).
5. Design pressure and temperature.

B. After Purchase Order Acceptance:

1. Submittals shall be in accordance with Section 01300 and Section 15010. In addition, VENDOR shop drawings shall be submitted for approval which include but are not limited to:
    a. Overall and detailed dimensions and locations of tank, fittings, nozzles and all accessories supplied by tank fabricator.
    b. General material of construction for each accessory.
    c. Design pressure and temperature.
    d. Seismic load.
    e. Empty tank weight in pounds.

C. Calculations signed by a registered engineer in the jurisdiction of the project shall be provided per the design requirements, and stating that the proposed tank design is structurally suitable to the service, and that the proposed lifting and tie-down lug designs are suitable to the service, including unloading and installation. These calculations will be submitted with VENDOR shop drawings described in 1.06B. above for review and approval.

1.7 QUALITY ASSURANCE

A. One Supplier: The tanks specified herein shall be the end products of one MANUFACTURER in order to achieve standardization of fabrication, quality and MANUFACTURER'S service.

B. Testing, Inspection:

1. Tanks shall be tested and inspected at the point of manufacture by the Supplier with written documentation of the test results supplied to the OWNER'S REPRESENTATIVE. Tests shall include, but are not limited to the following:
    - a. Visual internal and external examination of all tank surfaces and fittings, including nozzle interiors, and accessories. Acceptable tanks will have no visual defects. The tanks shall be free from air bubbles, pin holes, craters, crazing and other cracking that will impair the serviceability of the tank.
    - b. Cut edges shall be trimmed to have smooth edges.
    - c. Hydrostatic test of 24-hours duration to detect leakage. Any leakage or weeping is unacceptable.
    - d. Compliance check of tank and accessory dimension per approved VENDOR drawings.
2. OWNER'S REPRESENTATIVE may inspect tanks after fabrication but prior to loading tanks. VENDOR shall notify customer, at least 72 hours prior to loading, when tanks will be available for inspection.
3. After loading and before shipping tanks, OWNER'S REPRESENTATIVE may also visually inspect both interior and exterior surfaces of tanks, cradles, padding and tie-down straps.
4. Tanks shall not be shipped without approval.

1.8 DELIVERY AND HANDLING

A. Per provisions of Section 15010.

B. Shipment:

1. Preparation:
    - a. Prior to inspection and loading, all dirt and extraneous materials shall be removed from the tank interior. All exterior surface

markings, coatings, or contaminants shall be removed prior to shipment.

2. Packing and loading:
    a. Tanks shipped in the horizontal position and shall be mounted on padded cradles at least 6-inches wide. Cradle padding will contact each tank along at least 20 percent of the exterior circumference. At least four (4) inches of high density foam rubber, two (2) inches of styrofoam, or approved equal padding will be used to protect tanks. All tank end blocking, used to prevent shifting of tanks during transit, must also be padded and bear only upon the knuckle radius of flat or dished heads. Tanks shipped in the vertical position shall be secured to a padded pallet or skid.
    b. Tanks shall be secured to the cradles or skids to prevent rotation or other movement with cloth webbed strapping at least three, and preferably six, inches wide. Padded metal strapping of equal width is also acceptable. In turn, the cradles or skids shall be securely fastened to the truck bed.
    c. Tank fabricators are responsible for assuring that clearances along the transit route are not exceeded.
    d. Tie-down straps shall not be tightened to where the tank is oblated. Open top tanks will be cross-braced with padded lumber to prevent tank oblation.
    e. Flange faces shall be protected from damage by covering them with securely fastened pieces of plywood. Closed top tanks shall remain positively vented at all times.
    f. Pipe, tubing, fittings, gaskets, bolts, or any other small miscellaneous parts and accessories shall be padded and packaged in a crate or box and shipped with the tank.
    g. Additional protection, such as battens, end wrapping, or other interior fastening may be necessary to assure that the tanks are not damaged during shipment.
    h. Exterior fittings such as nozzles and tie-down lugs will be padded and prevented from contacting other tanks and accessories in the same shipment.

C. The tanks shall also be inspected by the OWNER'S REPRESENTATIVE upon delivery prior to unloading, for damage. Any damage occurring during shipment shall be the responsibility of the fabricator. Tanks not passing this inspection may not be unloaded. Tank fabricator may, but is not required, to be present for this inspection.

1.9 WARRANTY

A. Provide MANUFACTURER'S warranty under provisions of Section 15010.

PART 2 PRODUCTS

2.1 MATERIALS

A. Tanks shall be constructed of linear polyethylene or cross-linked polyethylene as appropriate to provide suitable properties for the intended service.

B. Fillers: Tanks shall contain no fillers

C. Ultra Violet Light Stabilizers: Plastic shall contain a minimum of 0.25 to a maximum of 0.5 long term UV stabilizer.

D. Pigment: If required pigment shall be fully compatible with the polyethylene and will not exceed 0.5% dry blended and 2% compounded in total weight.

2.2 FABRICATION

A. Tanks shall be one piece, rotationally molded, with flat bottoms and straight sides as specified in the Tank Data Sheets and Drawings.

B. Nozzles shall be provided as shown on the Tank Data Sheets. Flange diameters and drillings shall meet ANSI B16.5 150-pound standard.

C. Flange bolts and nuts shall be cadmium plated heavy hex, grade B, as per referred standard and dimensions shall be per ASME B18.2.1 for bolts and ASME B18.2.2 for nuts.

D. Internal Baffles: Per attached Tank Data Sheets and fabricated of the same materials as used to fabricate the tank.

E. Underflow Weir: Per attached Tank Data Sheets and fabricated of the same materials as used to fabricate the tank.

2.3 MECHANICAL PROPERTIES

A. Material properties shall meet the minimum requirements in the table below:

Property	ASTM	Value
Density	D1505	59 lb/ft^3
Environmental Stress Cracking, spec thickness 125 mils F-50	D1693	1000 hours
Tensile Strength, ultimate, 2 inch/min	D638	2600 psi
Elongation at Break, 2 inch/min	D638	450%
Vicat Softening Temperature	D1525	240 deg F
Brittleness Temperature	D746	-180 deg F
Flexural Modulus	D790	100,000 to 11,000 psi

2.4 DIMENSIONS AND TOLERANCES

A. Outside diameter: Tolerances on diameter shall be +/- 3% including out of roundness.

B. Shell wall and head thickness: Tolerance for thickness shall be +/-20% of design thickness. Total area below design thickness shall not exceed 10% of the total tank outside surface area. Each individual area below design thickness shall not exceed 1 ft^2.

C. Nozzle flange faces shall be perpendicular to the axis of the pipe within ½° and shall be flat within ± 1/32 inch for 18 inch nozzle size and smaller, and ± 1/16 inch for larger nozzle sizes.

2.5 ACCESSORIES

A. Identification Labels:

1. VENDOR will attach a permanent weatherproof equipment identification label to each tank. The label shall state the following information:
    a. Tank name.
    b. Equipment identification number.
    c. Service.
    d. Capacity in U.S. gallons.
    e. Name of MANUFACTURER.
    f. MANUFACTURER serial number.
    g. Year built.
    h. Purchase order number.
    i. Material.
    j. Design temperature, pressure, and fluid specific gravity.
2. The label will be clear coated to prevent chemical corrosion.

B. Gaskets: All nozzles will be supplied with full face, one piece gaskets. Gaskets will be fabricated from 1/8-inch thickness Hypalon, Viton, or approved equal. PTFE envelope gaskets are not acceptable.

PART 3 EXECUTION

3.1 UNLOADING AND STORAGE

A. After inspection and acceptance by the OWNER'S REPRESENTATIVE, the tanks will be unloaded and stored by the General CONTRACTOR. Tanks will be stored on a smooth, padded (as described for shipping) surface until installation. Care will be taken during storage to prevent damage.

3.2 INSTALLATION

A. Installation shall follow MANUFACTURER’S recommendations.

B. Where required for safe operation, or required by International Building Code, tanks will be attached to pad with a suitable tie-down system, considering seismic requirements for the location of the project.

C. A factory representative shall inspect the installation of the tanks prior to operating start-up and shall recommend the necessary adjustments for satisfactory operation. The representative shall also instruct the OWNER'S personnel in maintenance and repair of the tanks.

D. Where anchor bolts are required, the bolts shall be stainless steel and at least 5/8-inch in diameter unless shown otherwise on the Drawings. The area under tie down lugs shall also be grouted as described above.

3.3 FINAL INSPECTION

A. Prior to plant startup and after field installation all tanks shall be inspected by the General CONTRACTOR for proper alignment, connection, function, and to verify compliance with the Drawings and Specifications.

TANK DATA SHEETS
1 of 2

Tag number:	TK-330
Tank name:	Polymer Day Tank
Nominal dimensions	
Diameter:	28 inch
Height:	42 inch
Volume:	100 US gal
Shape:	Vertical, cylindrical
Bottom:	Flat
Top:	Open top
Service location:	Indoors, heated
UV Stabilizer:	Yes

Nozzles:

Drain	1 inch PVC union	sidewall, near bottom
Outlet	1 inch PVC union	sidewall, near bottom
Overflow	3 inch 150 lb ANSI flange, with gussets	Sidewall, 6 inch down from top

Final nozzle locations to be determined by General CONTRACTOR, and confirmed during shop drawing approval, before start of fabrication.

TANK DATA SHEETS
2 of 2

Tag number: TK-100

Tank name: Groundwater Collection Tank

Nominal dimensions
- Diameter: 48 inch
- Height: 54 inch
- Volume: 400 US gal

Shape: Vertical, cylindrical

Bottom: Flat

Top: Open top

Service location: Indoors, heated

UV Stabilizer: Yes

Nozzles:

Drain	1 inch PVC union	Sidewall, minimum elevation
Outlet	1.5 inch PVC union	Sidewall, minimum elevation
Overflow	3 inch 150 lb ANSI flange, with gussets	Sidewall, invert 6 inch down from top

Final nozzle locations to be determined by General CONTRACTOR, and confirmed during shop drawing approval, before start of fabrication.

END OF SECTION

SECTION 11387
MIXERS

PART 1 GENERAL

1.1 WORK INCLUDED

A. This section covers the work necessary for furnishing, installing, and starting up complete, the tank mixers indicated on the drawings and in the mixer data sheets at the end of this specification.

B. Mixers for the flocculation tank and flash mix tank integrated with the inclined plate clarifier will be part of the scope of supply of the inclined plate clarifier vendor.

1.2 RELATED WORK

A. Section 11337, Fiberglass Reinforced Plastic Tanks.

1.3 MANUFACTURER'S REPRESENTATIVE

A. The manufacturer's representative for the equipment specified shall be present at the jobsite for installation assistance, inspection and certification of the installation, equipment testing, startup assistance, and training of OWNER's personnel.

1.4 SUBMITTALS WITH BID

A. Completed data sheets.

B. Equipment cutsheet.

C. Impeller type, size, speed.

D. Proposed mounting arrangement.

E. Motor HP, and electrical requirements.

F. Weight of mixers.

1.5 SUBMITTALS WITH ORDER PLACEMENT

A. Mixer loads due to bending moments, torque, and weight (static and dynamic).

B. Critical speed calculations.

C. Detailed shop drawings, showing dimensions, materials of construction, and mounting details.

1.6 SUBMITTALS DURING CONSTRUCTION

A. Submittals during construction shall be made in accordance with Section 01300, Submittals.

B. Submittals shall include fully detailed operation and maintenance manuals.

1.7 REFERENCES

A. AGMA - Standard Practice 420.04.

B. NEMA MG 1-78 - Motors and Generators.

1.8 PERFORMANCE REQUIREMENTS

A. Mixers shall provide degree of mixing specified in the mixer data sheet.

PART 2 PRODUCTS

2.1 ACCEPTABLE SUPPLIERS

A. Chemineer Inc.

B. Hayward Gordon.

C. Lightnin.

D. Philadelphia Mixing Solutions.

2.2 MATERIALS

A. General:

1. The use of a manufacturer's name and model or catalog number is for the purpose of establishing the standard of quality and general configuration desired only. Products of other manufacturers will be considered in accordance with the Basic Mechanical Requirements.
2. The mixers shall be top entering fixed mount type, complete with angle riser mounting plates and hardware for mounting. Mixer shall be gear reduced drive type.

2.3 IMPELLER SHAFT

A. The impeller shaft shall be of stainless steel construction. Where welding is used for fabrication, the shaft shall be annealed after fabrication or made from a low carbon stainless steel. The shaft shall be designed for a safety factor of 4 based on the yield strength of the particular metal. It shall be of overhung design. Use of bottom steady bearings is not permitted. Shaft shall be free of surface imperfections and inclusions which might seriously affect the fatigue strength of the shaft and its corrosion resistance. Lower shaft straightness, rigid coupling squareness, and output shaft accuracy must be such as to give a maximum runout at the lower end of the shaft of 1/8 inch for every 10 feet of overhang.

B. The shaft shall be capable of withstanding the motor continuous torque, assuming a jammed impeller.

C. Shaft keyways shall be so designed as to allow the turbines to be moved up or down from the design setting a minimum of 6 inches. Shaft supporting the impellers shall be removable from the speed reducer without disturbing the internal gearing of the speed reducer.

D. Lower mixer shaft shall be connected to output shaft with rigid, stainless steel flanged coupling. Weld shall be full penetration, blended and stress relieved. Hub shall be interference-fit with key and taper pin connection. Mating coupling faces shall be machined to provide accurate alignment and the coupling halves registered to assure concentricity.

E. The shaft design shall limit operating speed to a maximum of 65 percent of first lateral harmonic vibration frequency (critical speed) without the use of stabilizing devices or guide. The critical speed and torsional and bending stress calculations shall include the mass and moment of inertia of the impeller and couplings. Mixer shall be factory balanced as specified in Section 15240, Mechanical Sound and Vibration.

2.4 IMPELLERS

A. Impeller selection shall be as recommended by the mixer manufacturer, to meet the mixing requirements in the mixer data sheets.

B. The impellers shall be of stainless steel construction, designed and operated at a speed which does not require dynamic balancing.

2.5 DRIVE MOTORS

A. The motors shall be vertical AC squirrel-cage induction type, designed, manufactured, and tested in accordance with the latest revised edition of

NEMA MG 1. The motors shall be totally enclosed fan cooled, rated at 480-volt, 3-phase, 60-Hz, with 1.15 service factor, rated for chemical duty, and epoxy-sealed. The connected load shall not exceed the motor nameplate horsepower rating under any anticipated operating conditions. Motors shall meet the requirements of Section 15170, Motors.

B. Motor horsepower shall be determined by the mixer manufacturer as sufficient to provide mixing as specified under the performance section.

C. Where variable speed is indicated in the mixer data sheets, motors shall be rated for inverter-duty, and shall have a 1.15 service factor in variable speed service.

2.6 GEARBOX

A. The agitator gearbox shall be selected to suit either the shaft size or 24 hour continuous operation with shock loading and 1.5 service factor, whichever results in a more conservative gearbox rating.

2.7 MIXER SUPPORT

A. Unless otherwise noted, mixers shall be supported by beams integrated into the top of the tanks, as supplied by the tank manufacturer. CONTRACTOR shall ensure mixer support is suitable for actual loads, torque, and bending moments associated with final mixer selection.

B. Exception to 2.7.A: polymer tank mixer shall be supported from the side of the polymer day tank. CONTRACTOR shall ensure tank wall will provide sufficient support for actual loads, torque, and bending moments associated with final mixer selection.

2.8 SPARE PARTS AND SPECIAL TOOLS

A. One complete set of seals, O-rings, retaining rings, and packing, as necessary, for each type of mixer drive unit, shall be furnished with each mixer.

B. All spare parts shall be interchangeable with and of the same materials and workmanship as the corresponding original parts of the appropriate mixers furnished under these Specifications.

C. The manufacturer shall furnish one set of any special wrenches and tools which may be required for assembly, disassembly, or adjustment of mixer drives, shafts, and impellers.

PART 3 EXECUTION

3.1 PAINTING, ASSEMBLY, AND DELIVERY

A. The equipment shall be supplied with the manufacturer's standard prime and finish paint plus any additional paint specified herein.

B. Each drive unit, including motor, shall be completely factory assembled, aligned, and securely crated for shipment. Accessory equipment which cannot be shipped assembled to the unit, such as shafts, baseplates, impellers, spare parts, and anchorage materials, shall be separately crated, clearly marked as to the contents, and shipped on the same shipment as the drives.

C. All exposed surfaces subject to rust, such as mounting flange faces, etc., shall be covered with a rust- preventative compound such as Kendall No. 5.

3.2 TESTING

A. Shop Test:

1. Each motor shall be shop-tested prior to shipment from the mixer manufacturer's factory.

B. Field Performance Test:

1. Prior to acceptance, each mixer shall be inspected for proper installation and operation. In addition, a performance test shall be performed by the OWNER or the OWNER'S REPRESENTATIVE which shall verify compliance with the performance requirements.

C. Final Acceptance:

1. Final acceptance of the mixers shall be subject to satisfactory completion of the performance tests. Should the mixer fail the performance test, the mixer supplier shall modify the mixer to meet the requirements at no additional cost to the OWNER.

MIXER DATA SHEET 1 of 7

Quantity	1
Mixer Name and Tag Number	Oxidation tank
Motor Horsepower	To be determined by manufacturer
Mixing Required	Complete mix, blend in potassium permanganate solution
Service Conditions	
Liquid	Groundwater, with small amounts of sand, silt, clay
Liquid Temperature	50 to 80 deg F (10 to 25 deg C)
Viscosity	1.3 cP
Specific Gravity	1.0
pH	5 to 8
Total Suspended Solids	50 mg/L
Control	
Operating Cycle	Continuous
Variable or Constant Speed	Constant speed
Tank	
Configuration	Vertical cylindrical, flat bottom, FRP, open top
Nominal Dimensions (Diameter x Height)	6 ft x 7.5 ft
Working Volume	1200 US gal
Maximum Liquid Level	6 ft
Minimum Liquid Level	5 ft
Design Liquid Flow Rate	40 US gpm
Baffles	qty 4 x 6 inch wide baffles, no offset from wall
Materials of Construction	
Impeller and Shaft	Stainless Steel
Mixer Housing	Aluminum
Coupling	Stainless Steel

MIXER DATA SHEET 2 of 7

Quantity	1
Mixer Name and Tag Number	Co-precipitation Tank
Motor Horsepower	To be determined by manufacturer
Mixing Required	Complete mix, blend in dilute lime slurry, maintain iron hydroxide solids solids in suspension
Service Conditions	
Liquid	groundwater with lime slurry added
Liquid Temperature	50 to 80 deg F (10 to 25 deg C)
Viscosity	1.3 cP
Specific Gravity	1.0
pH	9
Total Suspended Solids	900 mg/L
Control	
Operating Cycle	Continuous
Variable or Constant Speed	Variable speed
Tank	
Configuration	Vertical cylindrical, flat bottom, FRP, open top
Nominal Dimensions (Diameter x Height)	6 ft x 7.5 ft
Working Volume	1200 US gal
Maximum Liquid Level	6 ft
Minimum Liquid Level	5 ft
Design Liquid Flow Rate	40 US gpm
Baffles	qty 4 x 6 inch wide baffles, 3 inch offset from wall
Materials of Construction	
Impeller and Shaft	Stainless Steel
Mixer Housing	Aluminum
Coupling	Stainless Steel

MIXER DATA SHEET 3 of 7

Quantity	1
Mixer Name and Tag Number	pH Adjust Tank
Motor Horsepower	To be determined by manufacturer
Mixing Required	Complete mix, blend in H_2SO_4
Service Conditions	
Liquid	groundwater
Liquid Temperature	50 to 80 deg F (10 to 25 deg C)
Viscosity	1.3 cP
Specific Gravity	1.0
pH	5 to 7
Total Suspended Solids	20 mg/L
Control	
Operating Cycle	Continuous
Variable or Constant Speed	Constant speed
Tank	
Configuration	Vertical cylindrical, flat bottom, FRP, open top
Nominal Dimensions (Diameter x Height)	6 ft x 7.5 ft
Working Volume	1200 US gal
Maximum Liquid Level	6 ft
Minimum Liquid Level	3 ft
Design Liquid Flow Rate	40 US gpm
Baffles	qty 4 x 6 inch wide baffles, no offset from wall
Materials of Construction	
Impeller and Shaft	Stainless Steel
Mixer Housing	Aluminum
Coupling	Stainless Steel

MIXER DATA SHEET 4 of 7

Quantity	1
Mixer Name and Tag Number	Potassium Permanganate Tank
Motor Horsepower	To be determined by manufacturer
Mixing Required	Complete mix, dissolve $KMnO_4$ powder in water
Service Conditions	
Liquid	potassium permanganate solution in water (35 g $KMnO_4$/L water)
Liquid Temperature	50 to 80 deg F (10 to 25 deg C)
Viscosity	1.3 cP
Specific Gravity	1.0
pH	Not Available
Total Suspended Solids	0 mg/L
Control	
Operating Cycle	Continuous
Variable or Constant Speed	Constant speed
Tank	
Configuration	Vertical cylindrical, flat bottom, FRP, open top
Nominal Dimensions (Diameter x Height)	6 ft x 11 ft
Working Volume	1800 US gal
Maximum Liquid Level	8.5 ft
Minimum Liquid Level	2 ft
Design Liquid Flow Rate	None, solution make up and storage
Baffles	qty 4 x 6 inch wide baffles, no offset from wall
Materials of Construction	
Impeller and Shaft	Stainless Steel
Mixer Housing	Aluminum
Coupling	Stainless Steel

MIXER DATA SHEET 5 of 7

Quantity	1
Mixer Name and Tag Number	Lime Slurry Storage Tank
Motor Horsepower	To be determined by manufacturer
Mixing Required	Complete mix, maintain hydrated lime solids in suspension
Service Conditions	
Liquid	Hydrated lime slurry (3.5 lb dry $Ca(OH)_2$/US gal water)
Liquid Temperature	50 to 80 deg F (10 to 25 deg C)
Viscosity	45 to 700 cP, potential for non-Newtonian behavior
Specific Gravity	1.25
pH	12.4
Total Suspended Solids	500 g/L
Control	
Operating Cycle	Continuous
Variable or Constant Speed	Constant speed
Tank	
Configuration	Vertical cylindrical, flat bottom, FRP, open top
Nominal Dimensions (Diameter x Height)	9 ft x 12 ft
Working Volume	4580 US gal
Maximum Liquid Level	9.7 ft
Minimum Liquid Level	2 ft
Design Liquid Flow Rate	None, solution make up and storage
Baffles	qty 4 x 9 inch wide baffles, 4.5 inch offset from wall
Materials of Construction	
Impeller and Shaft	Stainless Steel
Mixer Housing	Aluminum
Coupling	Stainless Steel

MIXER DATA SHEET 6 of 7

Quantity	1
Mixer Name and Tag Number	Sludge Storage Tank
Motor Horsepower	To be determined by manufacturer
Mixing Required	Complete mix, maintain metal hydroxide solids in suspension
Service Conditions	
Liquid	Clarifier underflow (lime and metal hydroxide sludge)
Liquid Temperature	50 to 80 deg F (10 to 25 deg C)
Viscosity	Not Available
Specific Gravity	1.1
pH	9
Total Suspended Solids	10,000 to 20,000 mg/L
Control	
Operating Cycle	Continuous
Variable or Constant Speed	Constant speed
Tank	
Configuration	Vertical cylindrical, cone bottom, FRP, open top
Nominal Dimensions (Diameter x Height)	8 ft x 11 ft
Working Volume	3500 US gal
Maximum Liquid Level	9 ft
Minimum Liquid Level	2 ft
Design Liquid Flow Rate	None, solution make up and storage
Baffles	qty 4 x 9 inch wide baffles, 4.5 inch offset from wall
Materials of Construction	
Impeller and Shaft	Stainless Steel
Mixer Housing	Aluminum
Coupling	Stainless Steel

MIXER DATA SHEET 7 of 7

Quantity	1
Mixer Name and Tag Number	Polymer Day Tank
Motor Horsepower	To be determined by manufacturer
Mixing Required	Low speed, low shear, polymer blending
Service Conditions	
Liquid	Dilute anionic polymer flocculant (0.5% to 1% vol/vol)
Liquid Temperature	50 to 80 deg F (10 to 25 deg C)
Viscosity	Not Available
Specific Gravity	1.0
pH	6 to 8
Total Suspended Solids	0 mg/L
Control	
Operating Cycle	Intermittent, only used when batch of polymer is made
Variable or Constant Speed	Variable speed
Tank	
Configuration	Vertical cylindrical, flat bottom, polyethylene, open top
Nominal Dimensions (Diameter x Height)	28 inch x 42 inch
Working Volume	80 US gal
Maximum Liquid Level	30 inch
Minimum Liquid Level	6 inch
Design Liquid Flow Rate	35 US gal/day
Baffles	None
Materials of Construction	
Impeller and Shaft	Stainless Steel
Mixer Housing	Aluminum
Coupling	Stainless Steel

END OF SECTION

SECTION 11817
COMPRESSOR, AIR, ROTARY, ELECTRIC MOTOR DRIVEN, STATIONARY, 10 HP AND LARGER

PART 1 WORK INCLUDED

1.1 SCOPE

A. This specification covers stationary service, lubricated or non-lubricated (oil-free), electric motor driven, rotary air compressors with frame ratings of 10 horsepower (hp) and larger.

1.2 CLASSIFICATION

A. The compressor unit will be of the style, drive, air end, rated capacity in cubic feet per minute (cfm) and rated discharge pressure in pound-force per square inch gauge (psig) as specified (see 2.2.B).

1.3 APPLICABLE DOCUMENTS

A. Order of precedence: In the event of a conflict between the text of this specification and the references cited herein, the text of this specification shall take precedence. Nothing in this specification, however, shall supersede applicable laws and regulations unless a specific exemption has been obtained.

B. 40 CFR 204 - Noise Emission Standard for Construction Equipment

C. American Society of Mechanical Engineers (ASME) Section VIII, Division 1-Rules for Construction of Pressure Vessels. Power Test Code PTC 9 - Displacement Compressors, Vacuum Pumps and Blowers.

D. Compressed Air and Gas Institute (CAGI) PN2CPTC2 - Acceptance Test Code for Electrically Driven Packaged Displacement Air Compressors

E. National Electrical Manufacturer's Association (NEMA)

1. NEMA ICS 2 - Industrial Control Devices, Controllers and Assemblies.
2. NEMA ICS 6 - Industrial Controls and Systems.
3. NEMA MG 1 - Motors and Generators.
4. NEMA MG 10 - Energy Management Guide for Selection and Use of Polyphase Motors.

F. National Fire Protection Association (NFPA)

1. NFPA 70 - National Electrical Code.

G. Society of Automotive Engineers, Inc. (SAE)

1. SAE J534 - Lubrication Fittings.
2. SAE J551 - Performance Levels and Methods of Measurement of Electromagnetic Radiation of Vehicles and Devices.

PART 2 REQUIREMENTS

2.1 DESCRIPTION

A. The compressor unit or the equipment, as referred to in this specification, consists primarily of sub-assemblies such as the air end (compressor), drive end (electric motor), required type of mounting, instruments and control panel, safety devices, wiring, interconnected piping, and when applicable, include the intercooler, aftercooler, oil cooler, air/oil separator, air receiver, and metal enclosure.

2.2 STANDARD COMMERCIAL PRODUCT

A. The compressor unit shall, as a minimum, be in accordance with the requirements of this specification and shall be the manufacturer's standard commercial product. Additional or better features which are not specifically prohibited by this specification but which are a part of the manufacturer's standard commercial product, shall be included in the compressor unit being furnished. A standard commercial product is a product which has been sold or is being currently offered for sale on the commercial market through advertisements or manufacturer's catalogs or brochures, and represents the latest production model.

B. The compressor shall meet the following specific process requirements

1. 110 psi discharge pressure
2. 75 SCFM minimum installed capacity.
3. 460 VAC 3-phase
4. Electrical Enclosures NEMA 4X minimum; area is non-hazardous.
5. Air receiver sized per vendor recommendation with switching strategy to ensure steady supply pursuant to conditions 1 and 2.
6. Include air dryer as a line item adder price.

C. Acceptable vendors include:

1. Kaeser
2. Ingersoll Rand
3. Sullivan
4. BOGE
5. Or approved equal.

2.3 MATERIALS.

A. Materials used shall be free from defects which would adversely affect the performance or maintainability of individual components or of the overall assembly. Materials not specified herein shall be of the same quality used for the intended purpose in commercial practice. Unless otherwise specified herein, all equipment, material, and articles incorporated in the work covered by this specification are to be new and fabricated using materials produced from recovered materials to the maximum extent possible without jeopardizing the intended use. The term "recovered materials" means materials which have been collected or recovered from solid waste and reprocessed to become a source of raw materials, as opposed to virgin raw materials. None of the above shall be interpreted to mean that the use of used or rebuilt products is allowed under this specification unless otherwise specified.

2.4 INTERCHANGEABILITY.

A. All units of the same classification furnished with similar options under a specific contract shall be identical to the extent necessary to insure interchangeability of component parts, assemblies, accessories, and spare parts.

2.5 PERFORMANCE.

A. The compressor unit shall be capable of delivering not less than the specified rated capacity (cfm) under dry air atmospheric conditions of 14.7 pound-force per square inch absolute (psia) pressure and 60 degrees Fahrenheit (°F) temperature when operating at the specified discharge pressure (psig). The power required by the compressor shall be within +/-3 percent of the manufacturer's indicated rating. Rated capacity, pressure, and horsepower shall be measured in accordance with ASME PTC 9 or CAGI PN2CPTC2.

2.6 DESIGN AND CONSTRUCTION

A. The compressor unit shall be designed for constant speed and continuous operation. The compressor shall be unitized, completely assembled to the required type of mounting, to form a single unit ready for service upon hook-up to field power supply and distribution piping. Instruments and controls, for both the compressor and driver, shall be panel mounted and conveniently located so as not to be affected by vibration, and to provide ease of operation and maintenance. All electrical components and installation shall meet the requirements of NFPA 70.

2.7 ENVIRONMENTAL CONDITION

A. The compressor shall be designed for outdoor or indoor installation as specified (see 2.2.B). Unless otherwise specified (see 2.2.B), the environmental condition (minimum and maximum temperature range) shall be as follows:

1. Outdoor installation: Zero to 110°F
2. Indoor installation: 40 to 90°F

2.8 SAFETY

A. Rotating parts or parts subject to high temperatures that could be hazardous to operating personnel shall be fully enclosed or provided with protective guards or shields.

2.9 NOISE LEVEL

A. For outdoor installation, the noise level shall conform to the requirements and test procedure of EPA 40 CFR 204. For indoor installation, the noise level, shall not exceed 85 dab at 3.28 feet, when measured in accordance with nationally recognized industry standards for sound measurement.

2.10 EASE OF MAINTENANCE

A. The compressor and components shall be so arranged to provide adequate clearance area and safe access to all components for safe operation and maintenance.

2.11 ROTARY COMPRESSOR.

A. Frame lubrication. The rotary compressor's frame lubrication shall be furnished with a complete pressurized oil system. The air/oil receiver shall conform to ASME Section VIII, Division 1. When specified (see 2.2.B), the gear case or reservoir shall be equipped with an electric, thermostatically controlled immersion heater with a maximum watt density not to exceed 15 watts per square inch.

B. Metal enclosure. When specified (see 2.2.B), the rotary compressor shall be provided with metal enclosure which houses the motor, compressor, and instrument panel. When specified (see 2.2.B), the enclosure shall be furnished with electrical space heating equipment for maintaining satisfactory minimum temperature during periods of non-operation. The housing shall include quick opening side panels or hinged access openings to the motor, compressor, and instrument panel. Sheet metal for the housing and panels shall be not less than 0.0598-inch (US revised standard gauge No. 16) thick. Panels shall be sized to provide maximum accessibility to the compressor components. Upward-opening hinged access panels shall be equipped with quick-disconnect fasteners. Enclosures for outdoor installation shall have provisions for preventing rain and snow ingestion.

2.12 MOUNTING

A. Each type of mounting shall be furnished with bolt holes for anchoring the unit to a concrete foundation, wood, or steel decking. The number and size of bolt holes shall be designed under the most severe condition of vibration or thrust likely to develop during operation, or to resist a horizontal force with a value of not less than 1/3 of the total weight of the whole unit and applied at the center of gravity of the unit, whichever is larger.

B. Base mounted. The base plate shall be a single fabricated steel unit, with provisions to allow for grouting the load carrying structural members for installation on a concrete foundation. When specified (see 2.2.B), the base plate main frame shall be provided with openings designed for forklift lifting of the whole compressor unit.

2.13 AIR RECEIVER

A. The receiver shall be of sufficient volume required for delivery of non-pulsating flow of compressed air at the rated capacity and discharge pressure. The receiver shall be designed and constructed in accordance with ASME Section VIII. The receiver shall be provided with an automatic condensate drain valve.

2.14 INTERCOOLERS AND AFTERCOOLERS

A. Air-cooled intercoolers, after coolers, and oil coolers shall be of finned construction. Water-cooled intercoolers, after coolers, and oil coolers shall be the shell and tube type. When water-cooled after coolers are required, the intercoolers and oil coolers (when applicable) shall also be water-cooled. When air-cooled after coolers are required, the intercoolers and oil coolers (when applicable) shall also be air-cooled. Water-cooled intercoolers and after coolers shall be provided with sight-flow indicator to visually observe the flow of water to the cooler. All intercoolers and after coolers shall be provided with a moisture separator and automatic drain trap.

2.15 DRIVE

A. Direct drive units shall be either of the close-coupled, integral-coupled, or flexible-coupled type as specified (see 2.2.B). Multiple V-belts for belt driven compressors shall be oil resistant and shall be designed with a service factor not less than 1.75 times the motor horsepower rating. Belt-driven units shall have means for adjusting belt tension. Belt drives shall be limited to compressor applications with frame rating of 100 hp or less.

2.16 AIR FILTER

A. The compressor air intake shall be fitted with an air filter-silencer which is readily removable for cleaning.

2.17 SAFETY VALVES

A. When no receiver is supplied, a safety valve shall be installed in the discharge piping. A safety valve shall also be furnished between compressor stages. When the receiver is supplied, the safety valve shall be installed on the receiver. The safety valve(s) shall be the spring-loaded type, marked to show its capacity and pressure rating, and stamped with the ASME code symbol to identify conformance to ASME Section VIII.

2.18 DISCHARGE SHUT-OFF VALVE

A. When specified (see 2.2.B), the compressor discharge shall be equipped with the shutoff valve installed downstream of the safety valve.

2.19 REGULATION

A. Regulation of the compressor shall be accomplished by one of the following methods of control as specified (see 2.2.B). The regulation shall have adjustments for changing discharge and differential pressures. The compressor shall automatically unload after every shutdown, and the cooling water, when applicable, shall automatically shut off.

2.20 START/STOP CONTROL

A. The motor shall stop automatically when the discharge pressure reaches the maximum pressure setting and start automatically when the discharge pressure falls to the minimum setting. This type of control shall be limited to compressors with frame rating of 25 hp and below.

2.21 SAFETY DEVICES

A. The safety devices, as applicable to the compressor classification (see 1.2), shall include but not be limited to, those listed below. Alarm indicator shall be by flashing red lights. When specified (see 2.2.B), a sounding horn alarm (with reset button) shall be furnished. Alarms, including gauges or microprocessors and indicating lights, shall be wired or piped to the control panel.

1. High-lubrication oil temp
2. Cylinder lubrication failure
3. High main bearing temperature
4. High discharge air temperature
5. High discharge air pressure

6. High intercooler air temperature
7. Low lube oil reservoir level
8. Low lube oil pressure
9. Motor overload

2.22 GAUGES

A. Dial type pressure indicating gauges shall be provided to indicate the discharge or receiver air pressure, air pressure between stages (as applicable), and oil pressure for pressurized or force feed lubrication system. Gauges shall have an approximate range of twice the rated pressure or normal operating pressures.

2.23 MOTORS

A. The compressor motor shall conform to NEMA MG-1. The motor shall be designed for operation with electrical power supply having characteristics as specified (see 2.2.B). The motor shall have an hp nameplate rating equal to or greater than 110 percent of the hp required for continuous operation of the compressor at full load. Drip proof motors shall be polyphase induction type. When specified (see 2.2.B), motors 125 hp and larger shall be the synchronous type. Motors that drive auxiliary components shall conform to NEMA MG-1 and shall have electrical power supply characteristics as specified (see 2.2.B).

B. Motor efficiency. Motor efficiency shall be in accordance with the criteria of NEMA MG-10 and efficiency tables of NEMA MG-1. When specified (see 2.2.B), a high efficiency motor shall be furnished.

C. Motor starter. A magnetic starter conforming to NEMA ICS-2 shall be furnished. When specified (see 2.2.B), motors rated above 50 hp shall have reduced voltage, partial winding, or other means to limit starting current inrush to 200 percent of the normal full load value for reciprocating and non-lubricated rotary compressors, 260 percent for lubricated rotary compressors with standard efficiency motors, and 300 percent for lubricated rotary compressors with high efficiency motors. The starter shall include thermal overload protection and type 1 enclosure conforming to NEMA ICS-6.

2.24 STARTING CONTROL CIRCUIT

A. Unless otherwise specified (see 2.2.B), the control circuits for motors shall be nominal 110 volts alternating current. When specified (see 2.2.B), a spare thermal overload relay shall be furnished and securely fastened inside the starter enclosure.

2.25 ELECTROMAGNETIC INTERFERENCE CHARACTERISTICS

A. When specified (see 2.2.B), the compressor shall conform to the electromagnetic interference suppression requirements and test limits of SAE J551.

2.26 CLEANING, TREATMENT, AND PAINTING

A. Surfaces normally painted in good commercial practice shall be cleaned, treated, and painted. Surfaces to be painted shall be cleaned and dried to insure that they are free from contaminants such as soil, grease, welding slag and spatter, loose mill scale, water, dirt, corrosion product, or any other contaminating substances. As soon as practicable after cleaning, and before any corrosion product or other contamination can result, the surfaces shall be prepared or treated to insure the adhesion of the coating system. The painting shall consist of at least one coat of primer and one finish coat. The primer shall be applied to a clean, dry surface as soon as practicable after cleaning and treating. Painting shall be with manufacturer's current materials according to manufacturer's current processes and the total dry film thickness shall be not less than 2.5 mils over the entire surface. The paint shall be free from runs, sags, orange peel, or other defects.

2.27 LUBRICATION

A. Unless otherwise specified (see 2.2.B), means for lubrication shall be in accordance with the manufacturer's standard practice. The lubricating points shall be easily visible and accessible. Hydraulic lubrication fittings shall be in accordance with SAE J534. Where use of high-pressure lubricating equipment, 1,000 pound-force per square inch (psi) or higher, will damage grease seals or other parts, a suitable warning shall be affixed to the equipment in a conspicuous location.

2.28 LIFTING AND TIEDOWN ATTACHMENTS

A. When specified (2.2.B), the compressor shall be equipped with lifting and tiedown attachments. Lifting and tiedown attachments shall conform to type II or type III of MIL-STD-209. A nonferrous transportation plate shall be provided and mechanically attached to the compressor. Transportation plates shall be inscribed with a diagram showing the lifting attachments and lifting slings, the capacity of each attachment, and the required length and size of each sling cable. A silhouette of the item furnished showing the center of gravity shall be provided on the transportation plate. Tiedown attachments may be identified by stenciling or other suitable marking. Tiedown marking shall clearly indicate that the attachments are intended for the tiedown of the compressor on the carrier when shipped.

2.29 INSTRUCTION PLATES

A. The compressor unit shall be equipped with instruction plates or decals suitably located, describing any special or important procedures to be followed in operating and servicing the equipment. Plates or decals shall be of a material which will last and remain legible for the life of the equipment. Plates shall be securely affixed to the equipment with nonferrous screws or bolts of not less than 1/8-inch diameter.

2.30 IDENTIFICATION MARKING

A. Identification shall be permanently and legibly marked directly on the compressor and sub-assemblies or on a corrosion-resisting metal plate securely attached to the compressor and sub-assemblies at the source of manufacture. Identification shall include the manufacturer's model and serial number, name, and trademark to be readily identifiable to the manufacturer.

2.31 ROTATION ARROW

A. Rotation arrow shall be cast-in or attached near the drive end of the compressor. If attached, the rotation arrow and attachment pins shall be of corrosion resisting materials.

2.32 SPARE PARTS AND MAINTENANCE TOOLS

A. When specified (see 2.2.B), spare parts and maintenance tools shall be furnished. Special tools shall be kept to a minimum.

2.33 WORKMANSHIP

A. Steel fabrication. The steel used in fabrication shall be free from kinks, sharp bends, and other conditions which would be deleterious to the finished product. Manufacturing processes shall not reduce the strength of the steel to a value less than intended by the design. Manufacturing processes shall be done neatly and accurately. All bends shall be made by controlled means to insure uniformity of size and shape.

B. Bolted connections. Boltholes shall be accurately punched or drilled and shall have the burrs removed. Washers or lockwashers shall be provided in accordance with good commercial practice, and all bolts, nuts, and screws shall be tight.

C. Riveted connections. Rivet holes shall be accurately punched or drilled and shall have the burrs removed. Rivets shall be driven with pressure tools and shall completely fill the holes. Rivet heads, when not countersunk or flattened, shall be of approved shape and of uniform size for the same diameter of rivet. Rivet heads shall be full, neatly made, concentric with the rivet holes, and in full contact with the surface of the member.

D. Welding. Welding procedures shall be in accordance with a nationally recognized welding code. The surface of parts to be welded shall be free from rust, scale, paint, grease, or other foreign matter. Welds shall be of sufficient size and shape to develop the full strength of the parts connected by the welds. Welds shall transmit stress without permanent deformation or failure when the parts connected by the weld are subjected to proof and service loadings.

E. Castings. All castings shall be sound and free from patching, misplaced coring, warping, or any other defect which reduces the casting's ability to perform its intended function.

PART 3 QUALITY ASSURANCE PROVISIONS

3.1 RESPONSIBILITY FOR INSPECTION

A. Unless otherwise specified in the contract or purchase order, the contractor is responsible for the performance of all inspection requirements as specified herein. Except as otherwise specified in the contract or purchase order, the contractor may use his own or any other facilities suitable for the performance of the inspection requirements specified herein. The OWNER or OWNER’s REPRESENTATIVE reserves the right to perform any of the inspections set forth in the specification where such inspections are deemed necessary to assure supplies and services conform to prescribed requirements.

3.2 RESPONSIBILITY FOR COMPLIANCE

A. All items must meet all requirements of sections 3 and 5. The inspection set forth in this specification shall become a part of the contractor's overall inspection system or quality program. The absence of any inspection requirements in the specification shall not relieve the contractor of the responsibility of assuring that all products or supplies submitted to the Owner for acceptance comply with all requirements of the contract. Sampling in quality conformance does not authorize submission of known defective material, either indicated or actual, nor does it commit the Owner to acceptance of defective material.

3.3 EXAMINATION

A. Each compressor unit shall be examined for compliance with the requirements specified in section 3 of this specification. Any redesign or modification of the contractor's standard product to comply with specified requirements, or any necessary redesign or modification following failure to meet specified requirements shall receive particular attention for adequacy and suitability. This element of inspection shall encompass all visual examinations and dimensional measurements. Noncompliance with any specified requirements or presence of one or more defects preventing or lessening maximum efficiency shall constitute cause for rejection.

3.4 TESTS

A. Failure to pass any of the following tests shall constitute cause for rejection.

1. Receiver test. The receiver shall be hydrostatically tested in accordance with the requirements of ASME Section VIII, Division 1. Leaks or distortion shall constitute failure of this test.
2. Safety valve test. The safety valve shall be tested to determine if its relieving capacity and popping pressure are in accordance with requirements of ASME Section VIII, Division 1.
3. Performance test. The compressor shall be tested to determine conformance to 3.6. The test results shall be corrected from the atmospheric conditions on the test site to the atmospheric conditions in 3.6. Inability of the compressor to meet the performance requirements of the specification or to operate satisfactorily shall constitute failure of this test.
4. Operational test. Each compressor shall be tested for not less than 15 minutes to verify satisfactory operation of the compressor and all controls. During the test, all necessary adjustments in controls shall be made as required to insure that performance requirements relating to the compressor output and regulation shall be met.

3.5 PREPARATION FOR DELIVERY INSPECTION

A. The preservation, packaging, packing, and marking of the item shall be inspected to verify conformance to the requirements of section 5.

3.6 PREPARATION FOR DELIVERY

A. Preservation, packaging, packing, and marking. Preservation, packaging, packing, and marking shall be sufficient for safe shipment from point of manufacture to point of installation, without damage or loss of loose parts.

END OF SECTION

DIVISION 12
FURNISHINGS

NOT USED

DIVISION 13
SPECIAL CONSTRUCTION

Section 13120 – Pre-Engineered Buildings
Section 13720 – Instrumentation Equipment

SECTION 13120
PRE-ENGINEERED BUILDINGS

PART 1 GENERAL

1.1 WORK INCLUDED

A. For all pre-engineered structures, design, furnish, and install the following items for a full and complete building:

1. All structural steel framing, bracing, purlins, girts, base angles and connections.
2. Reinforcing for openings in the building envelope.
3. Bridge crane runway framing and branching.
4. Metal roof and wall panels, translucent panels and accessories.
5. Building insulation and accessories.
6. All man-doors, windows, hardware and accessories.
7. All ventilators, louvers, and accessories.
8. Product design.

1.2 DESIGN CRITERIA

A. Loading combinations shall be in full compliance with all applicable codes and standards in the State of Washington.

1.3 WARRANTY

A. The CONTRACTOR shall warrant that the materials furnished will be free from defects in material and workmanship on the shipment date; furthermore, that he will correct by repair or replacement, any such defect within one year from the shipment date. In addition, the CONTRACTOR shall warrant the following:

1. The paint film on roof panels will not, under normal weather and atmospheric conditions, crack, check, blister, peel, flake, chip, or lose adhesion for a period of 15 years from the shipment date; and
2. The paint film on wall panels will not, under normal weather and atmospheric conditions (1) chalk in excess of ASTM D4214, No. 8 rating, within 15 years from the shipment date; (2) fade more than 5 NBS units within ten years from the shipment date; and (3) crack, check, blister, peel, flake, chip, or lose adhesion within ten years from the shipment date.

B. Should failure be reported within such period as enumerated in A above, the CONTRACTOR shall repaint in accordance with original requirements any such panels at no cost to the OWNER.

1.4 DELIVERY, STORAGE, AND HANDLING

A. Materials shall be delivered to the site prime painted, crated with protective wrap or otherwise protected, and marked with a piece number at locations not exposed to view.

1.5 SUBMITTALS

A. Submittals shall be provided in accordance with Section 01300 Submittals, and the requirements of this Section.

B. Provide the following in addition to the standard requirements:

1. Submit five sets of coordinated shop drawings showing all components, including doors and other accessories, and structural calculations. The shop drawing shall show all material, components, finishes, fastenings, methods of joining, and sealants. The shop drawings shall include as a minimum the following:
    - a. Drawings showing foundation and footing dimensions.
    - b. Foundation anchor bolt plan with anchor bolt, shear angle, and baseplate details.
    - c. The building roof plan showing sizes and locations of all structural members and bracing.
    - d. Detailed drawings of the rigid frames together with building elevations showing sizes and locations of all wall structural members and bracing. MANUFACTURER'S standard details that pertain to the building may be used in addition to these Drawings listed above provided that the portions that apply are clearly marked and those parts that do not apply are clearly marked. Blanket submittal of all standard details, regardless of application to the specific project, will be returned for non-compliance with this Specification.
    - e. Calculations specifically for this project and shall include a complete structural stress and deflection analysis of all structural components and connections; should the building design proposed use bolted moment-resistant connections in the main frames, the prying action of the bolts shall be considered in the design.
    - f. All door and other openings or accessories details.
    - g. Specifications for painting system including paint manufacturer's name, product trade-name, and preparation for shop and field coats.
    - h. The building and foundation design calculations and drawings shall be stamped by a Professional Engineer registered in the State of Washington.

        i. Color samples: Color samples of all prefabricated metal building components requiring color selection shall be submitted to the OWNER’S REPRESENTATIVE for review.

    2. Do not start fabrication without OWNER’S REPRESENTATIVE’S review of the Shop Drawings.

PART 2 PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. MANUFACTURERS shall be as stated in the DESIGN BUILD CONTRACTOR’S bid.

2.2 MATERIALS

A. Structural Framing: All structural steel members shall conform to AISC Specification for the Design, Fabrication, and Erection of Structural Steel for Buildings. Minimum steel shall be ASTM A36. If MANUFACTURER'S standard primer is used, it shall be compatible with the finish coat as specified herein.

2.3 WALL AND ROOF PANELS

A. The interior and exterior wall and roof panels shall be ribbed steel panel construction, with roll-formed corrugations for structural stiffness and appearance. Wall panels shall be one-piece from base to building eave or door guide channel. Roof panels shall be of maximum length to minimize endlaps. Sidelaps shall be at least one full corrugation and endlaps shall be at least 6 inches. All panel joints shall be self-sealing. Panel-to-panel and panel-to-structural frame connections shall be made with self-tapping screws that maintain a weathertight seal. Roof ridge panels may be of the same configuration as the roof panels and shall be one-piece factory-curved to fit the roof slope. Ridge panels shall extend beyond the first purlin from the centerline of the building. Suitable closure sections shall be employed to seal the building corners, gables, and other panel intersections.

B. Insulation: Provide roof and wall insulation systems which meet the minimum R-value requirements of the Washington State Energy Code (Chapter 51-11 WAC).

C. Wall panels insulation shall be classified by Underwriters Laboratory, Inc. (UL) as having a maximum flame spread of 25.

D. Insulated wall panels may be either the foam-in-place sandwich panels or the wall liner type panel achieving the required R-value at no additional cost to the OWNER.

E. Panels shall have a factory-applied baked enamel finish with a white interior and an exterior standard color as selected by the OWNER.

F. Doors and Frames: Provide full flush hollow metal doors as shown on the Drawings. Doors shall be constructed to receive and be provided with cylindrical locksets, automatic closing devices, panic exit hardware, full weatherstripping, and thresholds, as applicable. Louvers in exterior doors shall be of a vandal-resistant design and shall be provided with 18 to 14 mesh screen.

G. Windows: Provide aluminum windows as shown on the Drawings. Windows shall be constructed from 6063-T5 extruded aluminum and shall meet the requirements of Architectural Aluminum Manufacturer's Association Specification. Exposed surfaces shall be finished in accordance with the Aluminum Association Designation System for Aluminum Finishes AA-M21C21A42. Provide screens for all project-out ventilators.

H. Ventilators: Provide ventilators, size and quantity as required, with interior baffles and exterior wind blades. Ventilators shall be furnished with bird screens and dampers operated by a pull chain. Fabricate ventilators from galvanized steel and paint as specified herein. Finish coat of paint shall match the color of the roof or wall panels, as appropriate.

I. Louvers: Furnish framed openings and louvers as shown or indicated on the Drawings or as required in the CONTRACTOR’s design. Louvers shall be fabricated from 20 gauge galvanized steel and shall be factory finished to match the wall panels. Louvers shall have a minimum free airflow of 45 percent and shall provide 60 percent or more weather projection. Furnish louvers with MANUFACTURER'S standard 14 to 18 mesh insect screen.

J. Framing for Wall Openings: Framing for wall openings where personnel doors, overhead doors, and louvers occur shall be stiffened flange channels and shall be provided by the CONTRACTOR. Provide, in addition, all accessory clips as required for fastening frames of said items to framing.

K. Trim: All trim shall be factory-formed and factory-painted. Trim shall include ridge cap, rake trim, simple eave trim, panel side trim, and corner trim, door trim, and other trim necessary to complete the building in an acceptable manner.

L. Gutters and Downspouts: Gutter fascia and downspouts shall be fabricated from 26 gauge galvanized steel and shall equal or exceed ASTM A653, Type

1, Class D. Butter fascia shall be building MANUFACTURER'S standard, prefinished in a color as selected by the OWNER and shall be supplied with factory-applied painted hangers. Preformed corner closures shall be supplied to match configuration of gable fascia. Downspouts shall be factory finished to match wall panels and shall be a nominal 4 inch corrugated rectangular box with a minimum of 11 square inches cross section area.

M. Miscellaneous: Items such as panel fasteners, weather sealing compounds, roof jacks, roof curbs, bolts, nuts, gaskets, and other similar necessary components shall be in new and unused condition and shall be in accordance with the building MANUFACTURER'S recommendations.

2.4 FABRICATION

A. The building shall be factory-fabricated to the MANUFACTURER'S written standards and shall be in accordance with AISC Specification for the Design, Fabrication, and Erection of Structural Steel Buildings and Code of Standard Practice for Steel Buildings and Bridges.

B. All material shall be completely fabricated and prepared for shipment knocked down including any necessary crating or bundling. All parts of building are to be accurately made and true to dimension so that in erecting the same all parts will easily fit together.

2.5 FINISHES

A. Painting: All doors, door frames, and structural components shall be given a shop coat of zinc chromate primer and two field coats of gloss alkyd enamel, 35 percent solids by volume, minimum, 3/16” minimum dry film thickness. Prepare surfaces in conformance with the paint manufacturer's specifications and recommendations. Color shall be as selected by the OWNER’S REPRESENTATIVE.

PART 3 EXECUTION

3.1 EXAMINATION

A. Inspection: Prior to performing any work of this Section, verify that all work of other trades, as applicable, is complete to the point where the installation may properly commence.

3.2 ERECTION

A. Erection of the building shall be in accordance with the MANUFACTURER'S standards. No field cutting of structural parts will be permitted. Field cutting and patching of panels or accessories will not be permitted unless required, in the sole and absolute judgment of the OWNER’S REPRESENTATIVE, to make installation of the panels or accessories feasible, and then only with his explicit approval. Such field modification shall be performed in a manner which will not impair the appearance, weathertightness, or structural quality of the material. Erection shall be accomplished in sufficient time to meet the schedule specified.

3.3 FIELD QUALITY CONTROL

A. The prefabricated metal building MANUFACTURER'S field representative shall make a minimum of three (3) onsite inspections during the erection and installation of the buildings as required to assure the erection is in accordance with the MANUFACTURER'S standards.

B. Complete MANUFACTURER’S Certificate of Proper Installation, Section 01640 Manufacturers’ Services.

3.4 CLEANING

A. Surface finishes which are damaged prior to or during erection, shall be replaced or restored to the original condition at no extra cost to the OWNER. Minor scratches, dents, and holes shall be repaired and painted with similar enamel of thickness and color to match original coating.

END OF SECTION

SECTION 13720
INSTRUMENTATION EQUIPMENT

PART 1 GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Functional specifications for all electronic instrumentation to be installed as part of the project. This includes primary elements for process variable measurements, analog display and control elements, and discrete display and control elements.
2. Accepted vendors list for each category of instrumentation.
3. General installation guidelines and practice requirements.

1.3 PERFORMANCE REQUIREMENTS

A. General Performance: Unless otherwise indicated, all devices specified herein shall withstand indoor installation with a minimum ambient temperature of 50 °F without failure due to defective manufacture, fabrication, installation, or other defects in construction. Any additional shelters, enclosures, covers etc. required for instrument protection shall be included as part of the Contract and installed as per vendor recommendations and industry best practices. Equipment installed outdoors shall be suitable for year round exposure in Washington State, with NEMA 4 enclosures as the minimum standard.

B. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes as appropriate for the general region of the installation.

C. Signal Characteristics: Wherever possible and feasible, components shall be of electronic solid-state design and meet the following requirements:

1. transmission signals shall be 4-20 Ma.
2. signal isolators shall be provided where required.

1.4 SUBMITTALS

A. Product Data: For each type of product indicated, include:

  1. Construction details, material descriptions, dimensions of individual components and profiles, enclosure details, and finishes.
  2. Rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories
  3. Installation details including required clearances, installed load, support requirements, mounting space, penetration fitting type, dielectric connections, gaskets and seals etc.
  4. Schematic/general arrangement drawings and wiring diagrams
  5. A list of recommended spare parts for one year of operation following acceptance, broken down by individual instrument
  6. A schedule showing all recommended vendor servicing for replacement of consumable parts, recalibrations, software upgrades etc.

B. Individual Data Sheets: shall be provided for all components described in this section. The purpose of the data sheets is to supplement the generalized catalog information provided, by citing all specific features of each component at each size or type (e.g. scale range, line size, materials of construction, special options etc). Each component data sheet shall bear the component name and instrument number designation shown in the Drawings and Specifications.

C. Manuals: Three full sets of maintenance and operations manuals shall be provided for all instrumentation outlined herein.

1.5 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. Calibration Certificates: As appropriate, the CONTRACTOR shall provide documentation indicating proper calibration or other fitness-for-service criteria from the vendor(s) of each item on the instrumentation list.

1.6 DELIVERY, STORAGE, AND HANDLING

A. All instruments and associated appurtenances will be packaged to withstand the rigors of shipping from their point of origin.

  1. protect threads, flange faces, weld nipples etc.
  2. protect displays, lights and other surface mounted elements from damage.

3. protect cables from mechanical damage to insulation, casings, retention sleeves etc.

B. Labelling:

1. All packaging to be marked “FRAGILE – CONTAINS DELICATE ELECTRONICS” or other appropriate message, including stack height limitations, crush / drop warnings etc
2. Each device will be clearly labeled, either with a tag or in dedicated subpackaging, with:
    a. Vendor.
    b. model #.
    c. project tag #.

C. The integrity of all instrumentation equipment will be verified visually by the CONTRACTOR prior to acceptance from the delivering agent or site supervision. Verification of delivered equipment shall be provided to the Contract Manager, Engineer, or designated agent.

D. Prior to installation, all received instrumentation will be stored in a clean, dry, dust- and rodent-free environment with appropriate security. Any required portable storage will be obtained by the CONTRACTOR at their own expense.

1.7 PROJECT CONDITIONS

A. Do not install instruments that appear to be damaged.

B. Weather Limitations: Proceed with installation only when existing and forecasted weather conditions permit, according to manufacturer's written instructions and warranty requirements.

C. Field Measurements: Verify actual dimensions of installation point by field measurements before proceeding.

1.8 EXTRA MATERIALS

A. All consumables, maintenance spares and other materials recommended by equipment vendor(s) for one years’ operation are to be turned over to the OWNER following acceptance of the completed installation.

PART 2 PRODUCTS

2.1 INSTRUMENTATION – GENERAL REQUIREMENTS

A. A detailed instrument list containing functional description, tag#, operating characteristics and any other special requirements is attached to the end of this section document. Refer to Process Flow Diagrams (PFD-01) and Piping and

Instrumentation Diagrams (PID-01 through 05) for information on the functional context of each element specified.

B. Unless otherwise indicated, system temperatures shall be considered environmental ambient. Note, however, that all field elements will need to be protected from direct sunlight and other environmental effects as required, and appropriate shields or covers will be fabricated and installed as part of the contract. All enclosures in outdoor service shall comply to NEMA 4X standards.

C. Pressure and temperature ratings should meet or exceed that for the line or location in which each element is being installed.

D. Line sizes are to match upstream piping for in-line instruments unless otherwise indicated or expressly recommended by the vendor.

E. In the event that an instrument connection does not match the field connection type installed under the mechanical contract, or the field connection type appears not to agree with vendor recommended or other best practices, please consult with the OWNER or OWNER'S REPRESENTATIVE for resolution.

F. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include the following OR APPROVED EQUAL:

1. Siemens / Milltronics.
2. Foxboro / Invensys.
3. Emerson / Fisher Rosemount.
4. ABB Automation Products and Instrumentation.
5. Ohmart Vega.

2.2 FUNCTIONAL SPECIFICATIONS

A. Process Building Flow Measurement: All flow measuring devices provided shall be:

1. Magnetic style.
2. Supplied with wetted materials appropriate to the service fluid, as outlined in the attached table.
3. Capable of the full range of flow measurement indicated.
4. Accurate to 1% or less of rated flow.
5. Supplied with, either integrally or as a separate unit, the appropriate transmitter to send a proportional 4-20 mA signal to a remote PLC or distributed control system.
6. Supplied with flanged ends appropriate to the piping system.

7. Capable of the required accuracy in each installed location, after accounting for the local characteristics of the piping system (elbow, isolation points etc.).
    a. Particular attention must be paid to proper minimum straight pipe requirements per vendor recommendations.
8. Powered by 24 VDC

B. Well Field Flow Measurement: All flow measuring devices provided shall be:

1. Mechanical only, gear or nutating disc style.
2. Supplied with wetted materials appropriate to the service fluid, as outlined in the attached table.
3. Capable of the full range of flow measurement indicated.
4. Accurate to 1% or less of rated flow.
5. Supplied with, either integrally or as a separate unit, a mechanical only register displaying instantaneous and totalized flow.
6. Supplied with pipe ends appropriate to the piping system.
7. Capable of the required accuracy in each installed location, after accounting for the local characteristics of the piping system (elbow, isolation points etc.).
    a. Particular attention must be paid to proper minimum straight pipe requirements per vendor recommendations.
8. Equipment for this specific item may be supplied by:
    a. Badger.
    b. Burkert.
    c. GPI.
    d. or approved equal.

C. Level Measurement: All full range level sensing devices provided shall be:

1. Ultrasonic style.
2. Assembled with materials appropriate to the service environment, as outlined in the attached table.
3. Capable of covering the full range indicated for the process fluid indicated in the attached table.
4. Accurate to within 1% or less of indicated range.
5. Supplied with, either integrally or as a separate unit, the appropriate transmitter to send a proportional 4-20 mA signal to a remote PLC or distributed control system.
6. Supplied with a flanged mounting face or appropriate mounting bracket (i.e. for open topped tanks) as indicated in the mechanical drawings for each element.

D. High Level Detection: All level switches provided shall be:

1. Floating Ball or Pivoting Ball style.

2. Assembled with materials appropriate to the service environment, as outlined in the attached table.
3. Capable of delivering an essentially instantaneous output signal to a remote PLC or distributed control system upon detection of an immersed condition.
4. Designed to be non-fouling from repeated immersion in service fluid.
5. Supplied with the appropriate mounting style as indicated in the mechanical drawings for each element.

E. Pressure Sensors and Differential Pressure Sensors shall be:

1. Supplied with wetted materials appropriate to the service fluid, as outlined in the attached table.
2. Capable of the full range of pressure measurement indicated.
3. Accurate to within 1% or less of indicated range.
4. Supplied with, either integrally or as a separate unit, the appropriate transmitter to send a proportional 4-20 mA signal to a remote PLC or distributed control system.
5. Supplied with the appropriate mounting style as indicated in the mechanical drawings for each element.

F. pH sensors shall be:

1. Supplied with a combination pH/reference electrode with temperature compensation.
2. Suitable in a flow through application with occasional exposure to air.
3. Of sufficient probe length to remain immersed in the local piping geometry.
4. Equipped with a sensor housing with ¾” NPT male connection, electrodes, reference junction, and 10 feet of interconnecting cable.
5. Supplied with an analyzer / transmitter with the following characteristics.
   a. local LCD display.
   b. integral preamplifier with solid state electronics for continuous pH measurement of an aqueous solution over the range of 2 to 12.
   c. All readings shall be compensated for temperature variations between 32 °F and 212 °F with an accuracy of +/- 0.01 pH units.
   d. 4-20 mA output signal to remote PLC or distributed control system.
   e. Housing suitable for local mounting via wall, panel, or pipe stand.
6. Probe shall be of combined service with ORP probe where possible.

G. ORP (Oxidation / Reduction potential) sensors shall be

1. Supplied with a combination pH/reference electrode with temperature compensation.
2. Suitable in a flow through application with occasional exposure to air.

3. Of sufficient probe length to remain immersed in the local piping geometry.
4. Equipped with a sensor housing with ¾” NPT male connection, electrodes, reference junction, and 10 feet of interconnecting cable.
5. Supplied with an analyzer / transmitter with the following characteristics.
    a. local LCD display.
    b. integral preamplifier with solid state electronics for continuous pH measurement of an aqueous solution over the range of 2 to 12.
    c. All readings shall be compensated for temperature variations between 32 °F and 212 °F with an accuracy of +/- 0.01 pH units.
    d. 4-20 mA output signal to remote PLC or distributed control system.
    e. Housing suitable for local mounting via wall, panel, or pipe stand.
6. Probe shall be of combined service with pH probe where possible.

H. Pressure Gauges

1. Gauges shall withstand a pressure of 1.3 times the scale upper range value.
2. Diaphragm seals shall be used for winterizing, corrosive services, and for materials that will plug the impulse line.
3. All gauges shall include either a gauge valve with a bleed plug, or a two-valve manifold for the purpose of isolating the gauge and bleeding the pressure off the gauge.
4. All gauges shall be 4½” in the dial face diameter. All pressure gauges shall be of the liquid filled type.
5. Materials and Construction
    a. Gauges shall be industrial grade.
    b. Pressure gauge cases are constructed of aluminium alloy, phenol plastic, or die pressed steel. Phenol is preferred.
    c. Bourdon tubes are constructed of type 316 stainless steel.
    d. Movement shall be quadrant and pinion design using stainless steel parts and Teflon coating for the moving parts.
    e. Movements are of stainless steel, and dials are constructed of aluminium or laminated plastic.
    f. Materials for connection shall take into account the pressure, temperature and service. Consult the piping specification for materials.
6. Markings
    a. ASME – The back of the gauge shall bear the ASME stamp.
    b. Scale and pointer shall be black on a white or polished SS background. Graduations shall be in 10 kPa increments for spans of up to 1000 kPag. For much larger spans consider 20 kPa increments and then 50 kPa.

7. Accuracy
    a. Accuracy of 1% or better, and repeatability of 0.5% of maximum scale reading shall be specified.
8. Rangeability
    a. The normal operating range shall fall between 30% and 70% of the scale.
9. Mounting
    a. Pressure gauges shall be mounted directly at the pipe providing there is adequate access for viewing.

PART 3 EXECUTION

3.1 EXAMINATION

A. Examine areas and conditions for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Examine instruments and ancillaries before installation. Reject any showing visible flaws or damage that could affect installability or performance.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. All instruments shall be installed according to vendor recommendations and generally accepted best practices

B. Comply with National Electrical Code / NFPA 70, and all relevant State and Local Code and Practice Requirements.

C. Comply with all requirements under Division 16 Electrical Specifications in this Package.

D. Wiring Method: Install cables in raceways and cable trays except within consoles, cabinets, desks, and counters. Conceal raceway and cables except in unfinished spaces.

1. Comply with requirements for cable trays specified in Division 16 Section "Cable Trays."
2. Comply with requirements for raceways and boxes specified in Division 16 Section "Raceways and Boxes."

E. Wiring Method: Conceal conductors and cables in accessible ceilings, walls, and floors where possible.

F. Wiring within Enclosures: Bundle, lace, and train conductors to terminal points with no excess and without exceeding manufacturer's limitations on bending radii. Provide and use lacing bars and distribution spools.

3.3 CONNECTIONS

A. Comply with requirements for piping specified in Division 15 mechanical specifications. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Install piping adjacent to machine to allow service and maintenance.

3.4 IDENTIFICATION

A. Identify system components, wiring, cabling, and terminals. Comply with requirements for identification specified in Division 16 Section "Electrical Identification."

1. All devices shall have a tag with the full instrument tag number including plant, unit, area and device. Tag material shall be 316 SS, minimum thickness .025 " (0.635mm), either firmly affixed with non rusting rivets or with a SS wire 16 gauge or heavier.

3.5 FIELD QUALITY CONTROL

A. Perform tests and inspections.

1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing and commissioning.

B. All installed instrumentation will be considered defective if it does not pass tests and inspections.

C. Prepare test and inspection reports.

3.6 DEMONSTRATION

A. Engage a factory-authorized service representative to train OWNER's maintenance personnel to adjust, operate, and maintain all installed instrumentation.

3.7 INSTRUMENT SCHEDULE

A. A detailed Instrument List and individual data sheets are attached to the back of this section.

END OF SECTION

REV	ISA	LOOP	I.D.	PROCESS AREA	DESCRIPTION	INST TYPE	DI	DO	AI	AO	RTD	MANUFACTURER	MODEL N°	RANGE	UNITS
1	LSH	100	LSH-100	OXID. / PRECIP.	LEVEL SWITCH HIGH - HEAD TANK	SWITCH									
1	FIT	100	FIT-100	OXID. / PRECIP.	FLOW METER - OXIDATION TANK FEED	INDICATOR / TRANSMITTER									
1	AIT	110	AIT-110	OXID. / PRECIP.	ORP SENSOR - OXIDATION TANK	INDICATOR / TRANSMITTER									
1	AIT	120	AIT-120	OXID. / PRECIP.	pH SENSOR - CO-PRECIPITATION TANK	INDICATOR / TRANSMITTER									
1	PI	910	PI-910	SLUDGE HAND.	PRESSURE INDICATOR - AIR COMPRESSOR ACCUMULATOR VESSEL	INDICATOR									
1	LIT	220	LIT-220	SLUDGE HAND.	LEVEL SENSOR - SLUDGE TANK	INDICATOR / TRANSMITTER									
1	LSH	220	LSH-220	SLUDGE HAND.	LEVEL SWITCH HIGH - SLUDGE TANK	SWITCH									
1	PI	235	PI-235	SLUDGE HAND.	PRESSURE INDICATOR - FILTER PRESS FEED	INDICATOR									
1	LSL	250	LSL-250	SLUDGE HAND.	LEVEL SWITCH LOW - PROCESS SUMP	SWITCH									
1	LSH	250	LSH-250	SLUDGE HAND.	LEVEL SWITCH HIGH - PROCESS SUMP	SWITCH									
1	LS	290	LS-290	SLUDGE HAND.	LEVEL SWITCH - SLOPE TO SUMP	SWITCH									
1	LIT	310	LIT-310	ADDITIVES	LEVEL SENSOR - KMnO4 STORAGE TANK	INDICATOR / TRANSMITTER									
1	LSH	310	LSH-310	ADDITIVES	LEVEL SWITCH HIGH - KMnO4 STORAGE TANK	SWITCH									
1	PI	310	PI-310	ADDITIVES	PRESSURE INDICATOR - KMnO4 DOSING PUMP HEADER	INDICATOR									
1	LIT	320	LIT-320	ADDITIVES	LEVEL SENSOR - LIME SLURRY STORAGE TANK	INDICATOR / TRANSMITTER									
1	LSH	320	LSH-320	ADDITIVES	LEVEL SWITCH HIGH - LIME SLURRY STORAGE TANK	SWITCH									
1	PI	320	PI-320	ADDITIVES	PRESSURE INDICATOR - DISCHARGE SIDE OF LIME DOSING PUMP	INDICATOR									
1	LIT	330	LIT-330	ADDITIVES	LEVEL SENSOR - POLYMER STORAGE TANK	INDICATOR / TRANSMITTER									
1	LSH	330	LSH-330	ADDITIVES	LEVEL SWITCH HIGH - POLYMER STORAGE TANK	SWITCH									
1	PI	330A	PI-330A	ADDITIVES	PRESSURE INDICATOR - DISCHARGE SIDE OF POLYMER DOSING PUMP #1	INDICATOR									
1	PI	330B	PI-330B	ADDITIVES	PRESSURE INDICATOR - DISCHARGE SIDE OF POLYMER DOSING PUMP #2	INDICATOR									
1	LS	390	LS-390	ADDITIVES	LEVEL SWITCH - DEDICATED LIME AND KMnO4 CONTAINMENT	SWITCH									
			-												
1	LIT	410	LIT-410	POLISHING	LEVEL SENSOR - ACID STORAGE TANK	INDICATOR / TRANSMITTER									
1	AIT	420	AIT-420	POLISHING	pH SENSOR - pH ADJUST TANK	INDICATOR / TRANSMITTER									
1	LIT	420	LIT-420	POLISHING	LEVEL SENSOR - pH ADJUST TANK	INDICATOR / TRANSMITTER									
1	LSH	420	LSH-420	POLISHING	LEVEL SWITCH - pH ADJUST TANK	SWITCH									
1	PI	420	PI-420	POLISHING	PRESSURE INDICATOR - CARTRIDGE FILTER FEED	INDICATOR									
1	DPIT	430A	DPIT-430A	POLISHING	DIFFERENTIAL PRESSURE SENSOR - CARTRIDGE FILTER #1	INDICATOR / TRANSMITTER									
1	DPIT	430B	DPIT-430B	POLISHING	DIFFERENTIAL PRESSURE SENSOR - CARTRIDGE FILTER #2	INDICATOR / TRANSMITTER									
1	PI	430	PI-430	POLISHING	PRESSURE INDICATOR - CARTRIDGE FILTER DISCHARGE HEADER	INDICATOR									
1	DPIT	440A	DPIT-440A	POLISHING	DIFFERENTIAL PRESSURE SENSOR - ADSORPTION COLUMN #1	INDICATOR / TRANSMITTER									
1	DPIT	440B	DPIT-440B	POLISHING	DIFFERENTIAL PRESSURE SENSOR - ADSORPTION COLUMN #2	INDICATOR / TRANSMITTER									
1	PI	441	PI-441	POLISHING	PRESSURE INDICATOR - ADSORPTION COLUMN #1 DISCHARGE	INDICATOR									
1	PI	442	PI-442	POLISHING	PRESSURE INDICATOR - ADSORPTION COLUMN #2 DISCHARGE	INDICATOR									
1	FIT	490	FIT-490	POLISHING	FLOW METER - ADSORPTION COLUMNS DISCHARGE HEADER	INDICATOR / TRANSMITTER									
1	FSH	990	FSH-990	POLISHING	FLOW RATE - EYE WASH STATION										
			-												
1	PI	510-01	PI-510-01	EXTRAC. / MONIT.	PRESSURE INDICATOR - LANDFILL WELL SUMP	INDICATOR									
1	FIQ	510-01	FIQ-510-01	EXTRAC. / MONIT.	FLOW TOTALIZER - LANDFILL WELL SUMP	INDICATOR									
1	PI	510-02	PI-510-02	EXTRAC. / MONIT.	PRESSURE INDICATOR - LANDFILL WELL SUMP (1-1/2" PIPE)	INDICATOR									
1	FIQ	510-02	FIQ-510-02	EXTRAC. / MONIT.	FLOW TOTALIZER - LANDFILL WELL SUMP	INDICATOR									
1	PI	510-03	PI-510-03	EXTRAC. / MONIT.	PRESSURE INDICATOR - LANDFILL WELL SUMP	INDICATOR									
1	FIQ	510-03	FIQ-510-03	EXTRAC. / MONIT.	FLOW TOTALIZER - LANDFILL WELL SUMP	INDICATOR									
1	PI	510-04	PI-510-04	EXTRAC. / MONIT.	PRESSURE INDICATOR - LANDFILL WELL SUMP	INDICATOR									
1	FIQ	510-04	FIQ-510-04	EXTRAC. / MONIT.	FLOW TOTALIZER - LANDFILL WELL SUMP	INDICATOR									
1	PI	510-05	PI-510-05	EXTRAC. / MONIT.	PRESSURE INDICATOR - LANDFILL WELL SUMP	INDICATOR									
1	FIQ	510-05	FIQ-510-05	EXTRAC. / MONIT.	FLOW TOTALIZER - LANDFILL WELL SUMP	INDICATOR									
1	PI	510-06	PI-510-06	EXTRAC. / MONIT.	PRESSURE INDICATOR - LANDFILL WELL SUMP	INDICATOR									
1	FIQ	510-06	FIQ-510-06	EXTRAC. / MONIT.	FLOW TOTALIZER - LANDFILL WELL SUMP	INDICATOR									
1	PI	510-07	PI-510-07	EXTRAC. / MONIT.	PRESSURE INDICATOR - LANDFILL WELL SUMP (1-1/2" PIPE)	INDICATOR									
1	FIQ	510-07	FIQ-510-07	EXTRAC. / MONIT.	FLOW TOTALIZER - LANDFILL WELL SUMP	INDICATOR									
1	PI	510-08	PI-510-08	EXTRAC. / MONIT.	PRESSURE INDICATOR - LANDFILL WELL SUMP	INDICATOR									
1	FIQ	510-08	FIQ-510-08	EXTRAC. / MONIT.	FLOW TOTALIZER - LANDFILL WELL SUMP	INDICATOR									
1	PI	510-09	PI-510-09	EXTRAC. / MONIT.	PRESSURE INDICATOR - LANDFILL WELL SUMP (1-1/2" PIPE)	INDICATOR									
1	FIQ	510-09	FIQ-510-09	EXTRAC. / MONIT.	FLOW TOTALIZER - LANDFILL WELL SUMP	INDICATOR									

LEVEL TRANSMITTER - ULTRASONIC

GENERAL	TAG NUMBER		**LIT - 220**	**LIT - 310**	**LIT - 320**	**LIT - 330**
	SERVICE		Sludge Handling	Additivies	Additivies	Additives
	P & ID		02	03	03	03
	EQUIPMENT No.		TK - 220	TK - 310	TK - 320	TK - 330
	VESSEL DIMENSIONS					
PROCESS	FLUID / MATERIAL		Water/Sludge	$KMnO_4$ Solution	Lime Slurry	Polymer
	TEMP. (DEG.C.)	NORM / MAX	15 / 30	15 / 30	15 / 30	15 / 30
	APPLICATION - WET / DUSTY		wet	wet	wet	wet
	DISTANCE	BIN FULL				
		BIN EMPTY				
TRANSDUCER	HOUSING MATERIAL		*	*	*	*
	FACING MATERIAL		*	*	*	*
	MOUNTING		1" NPT	1" NPT	1" NPT	1" NPT
	CABLE LENGTH		10'	10'	10'	10'
	TEMP. COMPENSATION		incl	incl	incl	incl
	CONE ANGLE		*	*	*	*
ELECTRONICS UNIT	ENCLOSURE		NEMA 4X	NEMA 4X	NEMA 4X	NEMA 4X
	MOUNTING		1" NPT or *	1" NPT or *	1" NPT or *	1" NPT or *
	CONDUIT CONN. SIZE		1" NPT or *	1" NPT or *	1" NPT or *	1" NPT or *
	POWER SUPPLY		24VDC	24VDC	24VDC	24VDC
	INDICATOR		field indication not required	field indication not required	field indication not required	field indication not required
	OUTPUT SIGNAL		4-20 mA	4-20 mA	4-20 mA	4-20 mA
	CALIBRATED RANGE					
	SCALE RANGE					
	ACCURACY		1%	1%	1%	1%
	MEASURING RANGE					
SWITCH	TYPE		n/a	n/a	n/a	n/a
	CONTACT FORM		n/a	n/a	n/a	n/a
	RATING		n/a	n/a	n/a	n/a
	SET POINT ADJUST. RANGE		n/a	n/a	n/a	n/a
	SET POINT No. 1		n/a	n/a	n/a	n/a
	SET POINT No. 2		n/a	n/a	n/a	n/a
ACCESS.	S.S. PLATE STAMPED c/w TAG No.		incl	incl	incl	incl
	RANGE TRACKING					
	AIMING KIT					
	APPROVAL / ENCLOSURE		NEC / NFPA 70	NEC / NFPA 70	NEC / NFPA 70	NEC / NFPA 70
	CLASS / DIVISION / GROUP		unclassified	unclassified	unclassified	unclassified
	MANUFACTURER		*	*	*	*
	MODEL NUMBER	TRANSDUCER	*	*	*	*
		ELECTRONICS	*	*	*	*
	NOTE No.					

NOTES:

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REV. 1

LEVEL TRANSMITTER - ULTRASONIC

GENERAL	TAG NUMBER		**LIT - 410**	**LIT - 420**		
	SERVICE		Effluent Polishing	Effluent Polishing		
	P & ID		04	04		
	EQUIPMENT No.		TK - 410	TK - 420		
	VESSEL DIMENSIONS					
PROCESS	FLUID / MATERIAL		H_2SO_4	Water		
	TEMP. (DEG.C.)	NORM / MAX	15 / 30	15 / 30		
	APPLICATION - WET / DUSTY		wet	wet		
	DISTANCE	BIN FULL				
		BIN EMPTY				
TRANSDUCER	HOUSING MATERIAL		*	*		
	FACING MATERIAL		*	*		
	MOUNTING		1" NPT	1" NPT		
	CABLE LENGTH		10'	10'		
	TEMP. COMPENSATION		incl	incl		
	CONE ANGLE		*	*		
ELECTRONICS UNIT	ENCLOSURE		NEMA 4X	NEMA 4X		
	MOUNTING		1" NPT or *	1" NPT or *		
	CONDUIT CONN. SIZE		1" NPT or *	1" NPT or *		
	POWER SUPPLY		24VDC	24VDC		
	INDICATOR		field indication not required	field indication not required		
	OUTPUT SIGNAL		4-20 mA	4-20 mA		
	CALIBRATED RANGE					
	SCALE RANGE					
	ACCURACY		1%	1%		
	MEASURING RANGE					
SWITCH	TYPE		n/a	n/a		
	CONTACT FORM		n/a	n/a		
	RATING		n/a	n/a		
	SET POINT ADJUST. RANGE		n/a	n/a		
	SET POINT No. 1		n/a	n/a		
	SET POINT No. 2		n/a	n/a		
ACCESS.	S.S. PLATE STAMPED c/w TAG No.		incl	incl		
	RANGE TRACKING					
	AIMING KIT					
	APPROVAL / ENCLOSURE		NEC / NFPA 70	NEC / NFPA 70		
	CLASS / DIVISION / GROUP		unclassified	unclassified		
	MANUFACTURER		*****	*****		
	MODEL NUMBER	TRANSDUCER	*****	*****		
		ELECTRONICS	*****	*****		
	NOTE No.					

NOTES:

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REV. 1

MAGNETIC FLOWMETER

GENERAL	TAG NUMBER		**FIT - 100**	**FIT - 490**		
	SERVICE		Oxidation/Precipitation	Effluent Polishing		
	P & ID		01	01		
	LINE No. AND SCH.					
	LINE	SIZE / SPEC	1-1/2" PVC	2" PVC		
PROCESS	FLUID		Water	Water		
	FLOW (gpm)	NORM / MAX	40 / 100	40 / 100		
	PRESS. (psi)	NORM / MAX	15 / 100	15 / 100		
	TEMP. (DEG. C.)	MIN/NOR/MAX	10 / 20 / 35	10 / 20 / 35		
	S.G. @ OPER. TEMP.		as water	as water		
	VISCOSITY @ OPER. TEMP.		as water	as water		
	MIN. LQID COND. / VELOCITY (m / s)					
	MAGNETITE %		0	0		
	SOLIDS	FLOW / %SOLIDS	min particulate	min particulate		
FLOWMETER	NOMINAL LINE SIZE		1 to 2"			
	END CONN. / FLANGE MAT'L.		ANSI flange	ANSI flange		
	METERING TUBE MAT'L. / SCH.		*	*		
	METERING TUBE LINING MAT'L.		*	*		
	ELECTRODE MATERIAL		*	*		
	METER RANGE		*	*		
	ENCLOSURE		NEMA 4X	NEMA 4X		
	POWER SUPPLY		24VDC	24VDC		
	SIGNAL CABLE LENGTH		10'	10'		
	FIELD EXITATION					
	TAG No.		as above	as above		
TRANSMITTER	LOCATION		local	local		
	OUTPUT		4-20 mA	4-20 mA		
	OUTPUT METER SCALE RANGE					
	CALIBRATED RANGE		0-100 gpm	0-100 gpm		
	POWER SUPPLY		24VDC	24VDC		
	CONDUIT CONNECTION		*	*		
	MOUNTING		*	*		
	ENCLOSURE		*	*		
ACCESS	S.S. PLATE STAMPED c/w TAG No.		incl.	incl.		
	GROUNDING RINGS		incl.	incl.		
	MOUNTING SET FOR TRANSMITTER		incl.	incl.		
	APPROVAL / ENCLOSURE		NEC / NFPA 70	NEC / NFPA 70		
	CLASS / DIVISION / GROUP		unclassified	unclassified		
	MANUFACTURER		*	*		
	MODEL NUMBER	FLOWMETER	*	*		
		TRANSMITTER	*	*		
	NOTE No.					

NOTES:

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REV. 1

LEVEL SWITCH - FLOAT TYPE

GENERAL	TAG NUMBER		**LSH - 100**	**LSH - 220**	**LSL - 250**	**LSH - 250**
	SERVICE		Oxidation/Precipitation	Sludge Handling	Sludge Handling	Sludge Handling
	P & ID		01	02	02	02
	VESSEL / EQUIPMENT		TK - 100	TK - 220	TK - 250	TK - 250
	VESSEL DIMENSIONS					
PROCESS	FLUID / MATERIAL		Water	Water/Sludge	Water	Water
	TEMP. (DEG. C)	NORM / MAX	10-30 °C	10-30 °C	10-30 °C	10-30 °C
	SG @ OPER. TEMP.					
	MATERIAL SIZE:					
	MAX (mm)					
	80% PASSING (mm)					
PROBE	TYPE		vertical hanging float	vertical hanging float	vertical hanging float	vertical hanging float
	MATERIAL		*	*	*	*
	CABLE TYPE		*	*	*	*
	CABLE LENGTH		10'	10'	10'	10'
	Process Connection		1" NPT	1" NPT	1" NPT	1" NPT
	Insertion Length		*	*	*	*
	MODEL		*	*	*	*
CONTROL UNIT	ENCLOSURE		NEMA 4X	NEMA 4X	NEMA 4X	NEMA 4X
	MOUNTING		*	*	*	*
	POWER SUPPLY		24VDC or 4-20mA loop	24VDC or 4-20mA loop	24VDC or 4-20mA loop	24VDC or 4-20mA loop
	RESISTANCE RELAY		*	*	*	*
	ADJ. TIME DELAY RELAY		*	*	*	*
	CONDUIT CONN. SIZE		per Div 16 Specifications	per Div 16 Specifications	per Div 16 Specifications	per Div 16 Specifications
	OUTPUT SW.	TYPE	Digital	Digital	Digital	Digital
		CONT. FORM	*	*	*	*
		RATING	*	*	*	*
	AMBIENT ELECTRONIC RATING		*	*	*	*
	SENSING ELEMENT RATING		*	*	*	*
ACCESSORIES	JUNCTION BOX		incl.	incl.	incl.	incl.
	TERMINAL STRIP					
	CORD GRIP					
	S.S. PLATE STAMPED c/w TAG No.		incl.	incl.	incl.	incl.
	Electronic Protection Option					
	APPROVAL / ENCLOSURE		NEC / NFPA 70	NEC / NFPA 70	NEC / NFPA 70	NEC / NFPA 70
	CLASS / DIVISION / GROUP		unclassified	unclassified	unclassified	unclassified
	MANUFACTURER		*	*	*	*
	MODEL NUMBER		*	*	*	*
	NOTE No.		*	*	*	*

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REV. 1

LEVEL SWITCH - FLOAT TYPE

GENERAL	TAG NUMBER		**LS - 290**	**LSH - 310**	**LSH - 320**	**LSH - 330**
	SERVICE		Sludge Handling	Additives	Additives	Additives
	P & ID		02	03	03	03
	VESSEL / EQUIPMENT		Containment Slope	TK - 310	TK - 320	TK - 330
	VESSEL DIMENSIONS					
PROCESS	FLUID / MATERIAL		Water/Sludge	$KMnO_4$ Solution	Lime Slurry	Polymer
	TEMP. (DEG. C)	NORM / MAX	10-30 °C	10-30 °C	10-30 °C	10-30 °C
	SG @ OPER. TEMP.					
	MATERIAL SIZE:					
	MAX (mm)					
	80% PASSING (mm)					
PROBE	TYPE		vertical hanging float	vertical hanging float	vertical hanging float	vertical hanging float
	MATERIAL		*	*	*	*
	CABLE TYPE		*	*	*	*
	CABLE LENGTH		10'	10'	10'	10'
	Process Connection		1" NPT	1" NPT	1" NPT	1" NPT
	Insertion Length		*	*	*	*
	MODEL		*	*	*	*
CONTROL UNIT	ENCLOSURE		NEMA 4X	NEMA 4X	NEMA 4X	NEMA 4X
	MOUNTING		*	*	*	*
	POWER SUPPLY		24VDC or 4-20mA loop	24VDC or 4-20mA loop	24VDC or 4-20mA loop	24VDC or 4-20mA loop
	RESISTANCE RELAY		*	*	*	*
	ADJ. TIME DELAY RELAY		*	*	*	*
	CONDUIT CONN. SIZE		per Div 16 Specifications	per Div 16 Specifications	per Div 16 Specifications	per Div 16 Specifications
	OUTPUT SW.	TYPE	Digital	Digital	Digital	Digital
		CONT. FORM	*	*	*	*
		RATING	*	*	*	*
	AMBIENT ELECTRONIC RATING		*	*	*	*
	SENSING ELEMENT RATING		*	*	*	*
ACCESSORIES	JUNCTION BOX		incl.	incl.	incl.	incl.
	TERMINAL STRIP					
	CORD GRIP					
	S.S. PLATE STAMPED c/w TAG No.		incl.	incl.	incl.	incl.
	Electronic Protection Option					
	APPROVAL / ENCLOSURE		NEC / NFPA 70	NEC / NFPA 70	NEC / NFPA 70	NEC / NFPA 70
	CLASS / DIVISION / GROUP		unclassified	unclassified	unclassified	unclassified
	MANUFACTURER		*	*	*	*
	MODEL NUMBER		*	*	*	*
	NOTE No.		*	*	*	*

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REV. 1

LEVEL SWITCH - FLOAT TYPE

GENERAL	TAG NUMBER		**LSH - 390**	**LSH - 420**		
	SERVICE		Additives	Effluent Polishing		
	P & ID		03	04		
	VESSEL / EQUIPMENT		Lime and $KMnO_4$ Containment	TK - 420		
	VESSEL DIMENSIONS					
PROCESS	FLUID / MATERIAL		Lime Slurry	Water		
	TEMP. (DEG. C)	NORM / MAX	10-30 °C	10-30 °C		
	SG @ OPER. TEMP.					
	MATERIAL SIZE:					
	MAX (mm)					
	80% PASSING (mm)					
PROBE	TYPE		vertical hanging float	vertical hanging float		
	MATERIAL		*	*		
	CABLE TYPE		*	*		
	CABLE LENGTH		10'	10'		
	Process Connection		1" NPT	1" NPT		
	Insertion Length		*	*		
	MODEL		*	*		
CONTROL UNIT	ENCLOSURE		NEMA 4X	NEMA 4X		
	MOUNTING		*	*		
	POWER SUPPLY		24VDC or 4-20mA loop	24VDC or 4-20mA loop		
	RESISTANCE RELAY		*	*		
	ADJ. TIME DELAY RELAY		*	*		
	CONDUIT CONN. SIZE		per Div 16 Specifications	per Div 16 Specifications		
	OUTPUT SW.	TYPE	Digital	Digital		
		CONT. FORM	*	*		
		RATING	*	*		
	AMBIENT ELECTRONIC RATING		*	*		
	SENSING ELEMENT RATING		*	*		
ACCESSORIES	JUNCTION BOX		incl.	incl.		
	TERMINAL STRIP					
	CORD GRIP					
	S.S. PLATE STAMPED c/w TAG No.		incl.	incl.		
	Electronic Protection Option					
	APPROVAL / ENCLOSURE		NEC / NFPA 70	NEC / NFPA 70		
	CLASS / DIVISION / GROUP		unclassified	unclassified		
	MANUFACTURER		*	*		
	MODEL NUMBER		*	*		
	NOTE No.		*	*		

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No	DATE	BY	CHK	APP	REVISION
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INSTRUMENT DATA SHEET

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REV. 1

PRESSURE DIFFERENTIAL TRANSMITTER

GENERAL	TAG NUMBER		**DPIT - 430A**	**DPIT - 430B**	**DPIT - 440A**	**DPIT - 440B**
	SERVICE		Effluent Polishing	Effluent Polishing	Effluent Polishing	Effluent Polishing
	P & ID		04	04	04	04
	LINE / EQUIPMENT		Cartridge Filter #1	Cartridge Filter #2	Adsorption Column #1	Adsoprtion Column #2
	LINE	SIZE / SPEC				
PROCESS	FLUID		Water	Water	Water	Water
	PRESS. (PSI)	NORM / MAX	25 / 150	25 / 150	15 / 75	15 / 75
	TEMP. (DEG. C)	NORM / MAX	15 / 30	15 / 30	15 / 30	15 / 30
	S.G. @ OPER. TEMP.		as water	as water	as water	as water
	VISCOSITY@OP TEMP mPa-s/cps					
	DELTA P (psi)		~0-30	~0-30	~0-15	~0-15
	FLOW (gpm)		static	static	static	static
	MEASUREMENT FUNCTION		vessel DP	vessel DP	vessel DP	vessel DP
BODY	MATERIAL		316SS or *	316SS or *	316SS or *	316SS or *
	PRESSURE RATING		150 psi	150 psi	150 psi	150 psi
	PROCESS CONN.		1" NPT or *	1" NPT or *	1" NPT or *	1" NPT or *
ELEMENT	TYPE		*	*	*	*
	MATERIAL		*	*	*	*
	RANGE		0-60 psi	0-60 psi	0-30 psi	0-30 psi
	CAPILLARY	MATERIAL	316SS or *	316SS or *	316SS or *	316SS or *
		LENGTH	10'	10'	10'	10'
		ARMOUR				
	PROCESS CONN.		1" NPT or *	1" NPT or *	1" NPT or *	1" NPT or *
TRANSMITTER	TYPE		*	*	*	*
	OUTPUT		4-20 mA	4-20 mA	4-20 mA	4-20 mA
	SUPPLY		24VDC or loop	24VDC or loop	24VDC or loop	24VDC or loop
	MOUNTING		field	field	field	field
	ELECTRICAL CONN.		*	*	*	*
	PNEUMATIC CONN.		n/a	n/a	n/a	n/a
	CALIBRATED RANGE		0-60 psi	0-60 psi	0-30 psi	0-30 psi
ACCESSORIES	INDICATOR	INTEG. / REM.	integ	integ	integ	integ
		SCALE				
	S.S. PLATE STAMPED c/w TAG No.		incl	incl	incl	incl
	3-VALVE MANIFOLD		incl	incl	incl	incl
	ELEVATION / SUPPRESSION KIT					
	MOUNTING BRACKET		incl	incl	incl	incl
	APPROVAL / ENCLOSURE		NEC / NFPA 70	NEC / NFPA 70	NEC / NFPA 70	NEC / NFPA 70
	CLASS / DIVISION / GROUP		unclassified	unclassified	unclassified	unclassified
	MANUFACTURER		*	*	*	*
	MODEL NUMBER		*	*	*	*
	NOTE No.		*	*	*	*

NOTES:

1. "*" as per vendor recommendation for the service conditions in "PROCESS"
2. if possible select same device for all services for ease of maintenance inventory control

No	DATE	BY	CHK	APP	REVISION
1	2011-04-26	MK	LD		1

amec

INSTRUMENT DATA SHEET

CLIENT: B&L Landfill - Woodwaste Site

LOCATION: Pierce County, Washington

PROJECT: Groundwater Recovery and Treatment System

PROJECT No.

SE10160010

DATA SHEET No.

1

REV. 1

pH ANALYZER

GENERAL	TAG NUMBER		**AIT - 120**	**AIT - 420**		
	SERVICE		Oxidation/Precipitation	Effluent Polishing		
	P & ID		01	04		
	LINE / EQUIPMENT		TK - 120	TK - 420		
	LINE	SIZE / SPEC				
PROCESS	FLUID		Water	Water		
	PRESS.(kPa)	NORM / MAX	atm	atm		
	TEMP.(DEG. C.)	NORM / MAX	15 / 30	15 / 30		
	S.G. @ OPER. TEMP.		as water	as water		
	DENSITY % SOLIDS		negligible	negligible		
	pH VALUE	NOR / MAX / MIN	7 / 12 / 2	7 / 12 / 2		
	SOLIDS SIZE (MICROMETERS)		negligible	negligible		
HOLDER	SUBMERSION / INSERTION		submersion	submersion		
	CONSTRUCTION MATERIAL		*	*		
	PROCESS CONNECTION SIZE		1" NPT or *	1" NPT or *		
	INSERTION LENGTH		18"	18"		
ELECTRODE	MEAS. ELECTRODE MATERIAL		*	*		
	REF. ELECTRODE	TYPE	*	*		
		JUNCTION	*	*		
	TEMP. COMPENSATION		*	*		
	SEALED ASSEMBLY		*	*		
	PREAMPLIFIER		*	*		
	CABLE LENGTH		10'	10'		
	PROCESS CONNECTION SIZE		1" NPT or *	1" NPT or *		
	MAX PRESSURE / TEMPERATURE		atm / 30 °C	atm / 30 °C		
TRANSMITTER	INDICATING / BLIND		indicating	indicating		
	MOUNTING		field suitable	field suitable		
	HOUSING MATERIAL		*	*		
	CALIBRATED RANGE		2-12 or *	2-12 or *		
	SCALE RANGE		0-14 or *	0-14 or *		
	OUTPUT		4-20 mA	4-20 mA		
	POWER SUPPLY		24VDC or loop	24VDC or loop		
	CONDUIT CONNECTION SIZE		1" NPT	1" NPT		
	TEMPERATURE COMPENSATION		incl.	incl.		
ACC.	S.S. PLATE STAMPED c/w TAG No.		incl.	incl.		
	SENSOR CLEANER					
	APPROVAL / ENCLOSURE		NEC / NFPA 70	NEC / NFPA 70		
	CLASS / DIVISION / GROUP		unclassified	unclassified		
	MANUFACTURER		*	*		
	MODEL NUMBER	ELECTRODE	*	*		
		TRANSMITTER	*	*		
	NOTE No.					

NOTES:

1. "*" as per vendor recommendation for the service conditions in "PROCESS"
2. if possible select same device for all services for ease of maintenance inventory control
3. These devices are to be mounted in agitated tanks and should be appropriately protected with rigid conduit, mounting cage etc.

No	DATE	BY	CHK	APP	REVISION
1	2011-04-26	MK	LD		1

amec

INSTRUMENT DATA SHEET

CLIENT: B&L Landfill - Woodwaste Site

LOCATION: Pierce County, Washington

PROJECT: Groundwater Recovery and Treatment System

PROJECT No.

SE10160010

DATA SHEET No.

1

REV. 1

REDOX/ORP ANALYZER

GENERAL	TAG NUMBER		**AIT - 110**			
	SERVICE		Oxidation/Precipitation			
	P & ID		01			
	LINE / EQUIPMENT		TK - 110			
	LINE	SIZE / SPEC				
PROCESS	FLUID		Water			
	PRESS.(kPa)	NORM / MAX	atm			
	TEMP.(DEG.C.)	NORM / MAX	15 / 30			
	S.G. @ OPER. TEMP.		as water			
	DENSITY % SOLIDS		negligible			
	UNIT = mv	NOR / MAX / MIN				
	SOLIDS SIZE (MICROMETERS)		negligible			
HOLDER	SUBMERSION / INSERTION		submersion			
	CONSTRUCTION MATERIAL		*			
	PROCESS CONNECTION SIZE		1" NPT or *			
	INSERTION LENGTH		18"			
ELECTRODE	MEAS. ELECTRODE MATERIAL		*			
	REF. ELECTRODE	TYPE	*			
		JUNCTION	*			
	TEMP. COMPENSATION		*			
	SEALED ASSEMBLY		*			
	PREAMPLIFIER		*			
	CABLE LENGTH		10'			
	PROCESS CONNECTION SIZE		1" NPT or *			
	MAX PRESSURE / TEMPERATURE		atm / 30 °C			
TRANSMITTER	INDICATING / BLIND		indicating			
	MOUNTING		field suitable			
	HOUSING MATERIAL		*			
	CALIBRATED RANGE		2-12 or *			
	SCALE RANGE		0-14 or *			
	OUTPUT		4-20 mA			
	POWER SUPPLY		24VDC or loop			
	CONDUIT CONNECTION SIZE		1" NPT			
	TEMPERATURE COMPENSATION		incl.			
ACC.	S.S. PLATE STAMPED c/w TAG No.		incl.			
	SENSOR CLEANER					
	APPROVAL / ENCLOSURE		NEC / NFPA 70			
	CLASS / DIVISION / GROUP		unclassified			
	MANUFACTURER		*****			
	MODEL NUMBER	ELECTRODE	*****			
		TRANSMITTER	*****			
	NOTE No.					

NOTES:

1. "*" as per vendor recommendation for the service conditions in "PROCESS"
2. These devices are to be mounted in agitated tanks and should be appropriately protected with rigid conduit, mounting cage etc.

No	DATE	BY	CHK	APP	REVISION
1	2011-04-26	MK	LD		1

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INSTRUMENT DATA SHEET

CLIENT: B&L Landfill - Woodwaste Site

LOCATION: Pierce County, Washington

PROJECT: Groundwater Recovery and Treatment System

PROJECT No.

SE10160010

DATA SHEET No.

1

REV. 1

FLOW SWITCH - IN LINE

GENERAL	TAG NUMBER		**FSH-990**			
	SERVICE		Safety Shower			
	P & ID		4			
	LINE No.					
	LINE	SIZE / SPEC	1-1/4" GALV			
PROCESS	FLUID		WARM FRESH WATER			
	FLOW (USGPM)	NORM / MAX	20			
	PRESS. (psig)	NORM / MAX	80 / 150			
	TEMP. (DEG. C.)	NORM / MAX	15			
	S.G. @ OPER. TEMP.		1.0			
	VISCOSITY @ OPER. TEMP.					
BODY	MATERIAL		SS 316 (BODY ONLY)			
	PRESSURE RATING		150#			
	PROC. CONNECTION		1", 150#, RF or 1" FNPT			
ELEMENT	TYPE		PLATINUM RTDs (NOTE 1)			
	MATERIAL		SS 316			
	FUNCTION		TEMP. DIFFERENTIAL			
	INSERTION "U" DIM		MFR. STD.			
SWITCH	TYPE		SPDT			
	CONTACT FORM		"C"			
	RATING		5A, 120V, NON-INDUCTIVE			
	CONDUIT CONN. SIZE		MFR. STD.			
	SET POINT ADJUST. RANGE		YES			
	SET POINT		FIELD ADJUSTABLE			
	ADJUSTABLE RESPONSE TIME		YES			
	POWER SUPPLY		120V AC 60 Hz			
ACCESSORIES	S.S. PLATE STAMPED c/w TAG No.		YES			
	APPROVAL / ENCLOSURE		CSA / NEMA 4X			
	CLASS / DIVISION / GROUP		NON-HAZARDOUS			
	MANUFACTURER		*			
	MODEL NUMBER		*			
	NOTE No.		1			

NOTES:

1. FLOW SWITCH SHALL BE **THERMAL DISPERSION TYPE**.
2. THE THERMAL DISPERSION TYPE FLOW SWITCH SHALL BE IN - LINE (SPOOL) TYPE, BODY - SS 316, FLANGES - CS.

No	DATE	BY	CHK	APP	REVISION
01	2011-05-26	LD	GP		FOR QUOTATION

amec

INSTRUMENT DATA SHEET

CLIENT: B&L Landfill - Woodwaste Site

LOCATION: Pierce County, Washington

PROJECT: Groundwater Recovery and Treatment System

PROJECT No.

SE10160010

DATA SHEET No.

1

REV. 1

Client:	B&L Woodwaste Site	**DATA SHEET**	amec
Project:	Groundwater Recovery and Treatment System	**PRESSURE GAUGE**	
Plant/Area:		Tag No:	**various; see table**
WO #		Service:	various; see table
RFQ/ P.O. No. SE10160010.4102		Doc. No: ENG-DAT-000041	Sheet 1 of 1 Rev. 1

No.						Rev
1	GAUGE	Dial Size		4 1/2"		
2		Dial Color - Black Figures		white		
3		Case	CRN	phenolic	N	
4		Ring Type		aluminum or ss		
5		Weep Hole		*		
6		Blowout Protection		*		
7		Mounting-local/surf./flush		local FNPT		
8		Zero Adjustment Type		vendor calibrated		
9		Element Type		bourdon tube		
10		Element Material		316 SS		
11		Movement		quadrant and pinion		
12		Socket Material				
13		Overrange Protection				
14		Pressure Connection		1/4" or 1/2" MNPT		
15		Connection Orientation		for clear viewing		
16		Accuracy		1%		
17	Notes	All instruments to be supplied with SS tags c/w Tag numbers				
18		Gauges to be operable for ambient temperatures of -41°C to +40° C				
19		Pressure gauges shall conform with ASME B40.1M				
20		Gauges requiring diaphragm seal to be noted in Remarks				
21		* as per vendor recommendation for the service conditions in "PROCESS"				
22		1/4" or 1/2" branch isolation to be included w/ each gauge				

No.						Rev
66	GAUGE	Overpressure Pin		N		
67		Lens Material		*		
68		Siphon	(Y/N)	*		
69		Snubber	(Y/N)	*		
70		Movement Damping	(Y/N)	*		
71		Filled Case Material		Y		
72		Manufacturer	Model Number	*		
73		Outline Dimensions				
74		Diaphragm Seal/ or Capillary if Req'd	Type	*		
75			Material	*		
76			Filling Fluid	*		
77			Capillary Length	*		
78			Purge Connection	*		
79			Process Connection			
80		NACE Service		N		
81		MTR		N		
82	Notes					
83						
84						
85						
86						
87						

23	Tag No.			P&ID Dwg. No.	Fluid	Line No. and Spec.	Dial Range psig	Operating		Max/Design Press. (psig)	Model No.	Remarks (Pulsation Dampner, Seal, Press. Compensation, etc.)	Rev
24								Pressure	Temperature				
25	PI	910		2	air	accumulator vessel	0-250	0-150	amb	250	*	c/w accumulator(?)	
26	PI	235		2	sludge	2" CS victaulic	0-250	0-150	amb	250	*	diaphragm seal	
27	PI	310		3	KMnO4	1/2" rigid poly tubing	0-100	0-60	amb	150	*	diaphragm seal	
28	PI	320		3	lime	1" CS Victaulic	0-100	0-60	amb	150	*	diaphragm seal	
29	PI	330A		3	polymer	1/2" rigid poly tubing	0-100	0-60	amb	150	*	diaphragm seal	
30	PI	330B		3	polymer	1/2" rigid poly tubing	0-100	0-60	amb	150	*	diaphragm seal	
31	PI	420		4	water	2" PVC	0-100	0-60	amb	150	*		
32	PI	430		4	water	2" PVC	0-100	0-60	amb	150	*		
33	PI	441		4	water	2" PVC	0-100	0-60	amb	150	*		
34	PI	442		4	water	2" PVC	0-100	0-60	amb	150	*		
35	PI	510	1	5	water	1" PVC	0-100	0-60	amb	150	*		
36	PI	510	2	5	water	1-1/2" PVC	0-100	0-60	amb	150	*		
37	PI	510	3	5	water	1" PVC	0-100	0-60	amb	150	*		
38	PI	510	4	5	water	1" PVC	0-100	0-60	amb	150	*		
39	PI	510	5	5	water	1" PVC	0-100	0-60	amb	150	*		
40	PI	510	6	5	water	1" PVC	0-100	0-60	amb	150	*		
41	PI	510	7	5	water	1-1/2" PVC	0-100	0-60	amb	150	*		
42	PI	510	8	5	water	1" PVC	0-100	0-60	amb	150	*		
43	PI	510	9	5	water	1-1/2" PVC	0-100	0-60	amb	150	*		
44	PI	510	10	5	water	1" PVC	0-100	0-60	amb	150	*		
45	PI	510	11	5	water	1" PVC	0-100	0-60	amb	150	*		
46	PI	520	12	5	water	1" PVC	0-100	0-60	amb	150	*		
47	PI	520	13	5	water	1" PVC	0-100	0-60	amb	150	*		
48	PI	520	14	5	water	1" PVC	0-100	0-60	amb	150	*		
49	PI	520	15	5	water	1" PVC	0-100	0-60	amb	150	*		
50	PI	520	16	5	water	1" PVC	0-100	0-60	amb	150	*		
51	PI	520	17	5	water	1" PVC	0-100	0-60	amb	150	*		
52	PI	520	18	5	water	1" PVC	0-100	0-60	amb	150	*		
53	PI	520	19	5	water	1" PVC	0-100	0-60	amb	150	*		
54	PI	520	20	5	water	1" PVC	0-100	0-60	amb	150	*		
55	PI	520	21	5	water	1" PVC	0-100	0-60	amb	150	*		
56													
57													
58													
59													
60													
61													
62													
63													
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REVISION LOG

REV.	DESCRIPTION	DATE	BY	CHK'D	APP'D
1	Issued for Tender	05/26/11	LD	GP	

Client:	B&L Woodwaste Site	**DATA SHEET**	
Project:	Groundwater Recovery and Treatment System	**TURBINE FLOW METER**	
Plant/Area:		Tag No:	**FIQ-510R, FIQ-520R** (21 units total)
WO #		Service:	contaminated well water
RFQ/P.O.No.	SE10160010.4102	Doc. No:	ENG-DAT-000053 Sheet 1 of 1 Rev. 1

									Rev
1	GENERAL	Tag Number				FIQ-510R, FIQ-520R (21 units total)			
2		P & ID No.				5			
3		Service				contaminated well water			
4		Ambient Temperature				5 - 30 degC			
5		Line No.	Equipment No.						
6		Line Schedule	Pipe Spec						
7		Line orientation	Flow direction			horizontal			
8	METER	Model No.				*			
9		Manufacturer				*			
10		Maximum Design Pressure	kPa			1034.2 (=150 psi)			
11		Maximum Design Temp.	°C			50 degC			
12		End Connections	Type			PVC, zero clearance preferred			
13		Size	Rating			1"			
14		Body Rating	kPa			1034.2 (=150 psi)			
15		Nominal Flow Range	Units			0-15 (11 x 510R), 0-6 (10 x 520R) USGPM			
16		Accuracy	%			1			
17		Linearity	%			1			
18		Repeatability							
19		K Factor, Cycles per Unit Volume				*			
20		Number of Rotors				*			
21		Angle of Rotor(s)	Bearings Type			*	*		
22		Turndown				*			
23		Max. Speed				*			
24		Min. Output Voltage				n/a field display only			
25		Pickup Type				*			
26		MTR	CRN				n/a		
27		NDE Requirements				none			
28		Materials	Body	Support					
29			Shaft	Bushing	Gland				
30			Rotor	Bearing(s)					
31			Flanges						
32		Area Classification				n/a			
33		Enclosure NEMA Rating				4			
34		Outline Dimensions							
35		Certification	Approvals						
36		Intrinsically Safe				no			
37		Insertion Type	Length			no			
38	PROCESS	Fluid	Phase			contam. well water	liquid		
39		Units:	Press.	Flow	Temp	psi	Usgpm	°C	
40		Units:	Visc	Length	Density	cP	m	gm/cm3	
41		Pressure:	Min	Norm	Max.		60 psi	150 psi	
42		Temp:	Min	Norm	Max.	0	15	30	
43		Flow:	Min	Norm	Max.	0	3 or 8	6 or 15	
44		Fluid Charac-teristics	Clean / Dirty			dirty, upstream filter			
45			Steady / Pulse			steady			
46			% Solids			< 100 ppm TSS			
47			Corrosive			no			
48		Vapour Pressure				as water			
49		Molecular weight				as water			
50		Specific Heat Ratio				as water			
51		Operating Specific Gravity				as water			
52		Compressibility @ Norm Temp				as water			
53		Viscosity @ Norm Temp				as water			
54		Reynold's Number							
55		NACE Service				no			
56									

							Rev
68	LOCAL DISPLAY	Part Number			*		
69		Model No.			*		
70		Manufacturer			*		
71		Number of Digits			*		
72		Enclosure Class			*		
73		Drive Mechanism			*		
74		Mounting			*		
75		Enclosure NEMA Rating			4X		
76		Local Counter	# Digits	Resetable	*	Y	
77		Totalizer	Type		Y		
78		Mounting					
79		**provide local display integral to unit**					
80							
81	PREAMP	Tag Number					
82		Output Wave					
83		Frequency					
84		Voltage (peak to peak)					
85		Power Supply	Volt	Frequency	**assume 120V power at install location**		
86		Signal Coupling Mechanism					
87		Connecting Wires/Plugs					
88		Enclosure NEMA Rating					
89		Electrical Connection(s) Size					
90							
91							
92	METER RUN	Connections	Size	Rating	1" thr zero clearance		
93			Schedule		80		
94			Material		PVC		
95			Upstream Length		*		
96			Downstream Length		*		
97		Downstream Connections	Press. Connection		*		
98			Type	Size			
99			Temp. Connection				
100			Type	Size			
101			Well : U	T			
102							
103							
104							
105							
106	TRANSMITTER	Tag No. (if different from Preamp)					
107		Integral / Remote			**local display only**		
108		Calibration Range					
109		Electrical Conn. Size					
110		Enclosure NEMA Rating					
111		Mounting					
112		Output Signal	load Impedance				
113		Power Supply	Voltage	Frquency			
114	ACCESSORIES	Protocol					
115		Adjust Range	Span	Zero			
116							
117							
118							
119		Strainer Upstream			include as option		
120		Straighten'g Vanes	Datasheet Number				
121		Automatic Oiler					
122		Diagnostic Software					
123							

57	NOTES	1. All instruments shall be supplied with a SS tag c/w tag #.	
58		2. * as per vendor recommendation for the service conditions in "PROCESS"	
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67			

REVISION LOG

REV		DESCRIPTION	DATE	BY	CHECKED	APPROVED
1		Issued for Tender	26-May-11	LD	GP	

DIVISION 14
CONVEYING SYSTEMS

NOT USED

DIVISION 15
MECHANICAL

Section 15010 – Basic Mechanical Requirements
Section 15044 – Pressure Testing of Piping
Section 15060 – Pipe and Pipe Fittings – General
Section 15070 – Carbon Steel Piping Systems
Section 15080 – High Density Polyethylene Pipe
Section 15090 – Pipe and Pipe Fittings – PVC
Section 15100 – Valves – General
Section 15140 – Piping Supports and Anchors

SECTION 15010
BASIC MECHANICAL REQUIREMENTS

PART 1 GENERAL

1.1 WORK INCLUDED

A. This division covers the work necessary for the complete mechanical system. Design and furnish all materials, labor, and equipment in accordance with these Specifications and the accompanying Drawings and as required for a fully operational facility.

B. This section covers the basic requirements applying to all sections included in Division 15. The following individual Division 15 specification sections will supplement this section.

1.2 REFERENCES

A. Perform all work, furnish and install all materials and equipment in full accordance with the latest applicable rules, regulations, requirements, and specifications of the codes and agencies identified herein. If codes or standards are not specified for a particular application, the CONTRACTOR shall follow standard industrial practice, being sure that the materials or methods used shall conform to local codes and shall result in a final installation that will perform reliably for the purpose or use intended. The following list summarizes the organizations whose codes and standards are specifically required in these specifications.

1. International Building Code (IBC), International Code Council.
2. International Mechanical Code, International Conference of Building Officials International Code Council.
3. Uniform Plumbing Code (UPC, International Association of Plumbing and Mechanical Officials.
4. International Fire Code (IFC), International Code Council.
5. State Building Code (Washington, SBC).
6. Washington State Energy Code, State Building Code Council.
7. Pierce County Code.
8. American Concrete Institute (ACI 318).
9. AISC – American Institute for Steel Construction.
10. ANSI – American National Standards Institute.
11. API – American Petroleum Institute.
12. ASA - American Standard Code for Pressure Piping.
13. Minimum Design Loads for Buildings and Other Structures (ASCE 7) by ASCE (American Society of Civil Engineers).

14. ASHRAE Applications Handbook – American Society of Heating, Refrigerating and Air Conditioning Engineers.
15. ASME – American Society of Mechanical Engineers.
16. ASTM – American Society for Testing and Materials.
17. AWS – American Welding Society.
18. AWWA - American Water Works Association.
19. EPA – U.S. Environmental Protection Agency.
20. FM – Factory Mutual Systems Loss Prevention Standards.
21. Hydraulic Institute Standards.
22. IEEE – Institution of Electrical and Electronic Engineers.
23. MBMA – Metal Building Manufacturer's Association.
24. NAAMM – National Association of Architectural Metal Manufacturers.
25. NACE – National Association of Corrosion Engineers.
26. NEC – National Electrical Code.
27. NEMA – National Electrical Manufacturers Association.
28. NFPA – National Fire Protection Agency.
29. NSF - National Sanitation Foundation.
30. North American Specification for the Design of Cold-Formed Steel Structural Members by AISI and CSA.
31. OSHA – Occupational Safety & Health Administration.
32. PPI – Plastics Pipe Institute.
33. SSPC – Steel Structures Painting Council.
34. UL – Underwriters Laboratories Inc.
35. Local laws and ordinances.
36. State of Washington laws and regulations.
37. Local fire marshall.
38. State and/or federal safety regulations.

B. The Mechanical Contractor shall obtain all permits and arrange all inspections required by codes applicable to this section and shall submit written evidence to the OWNER'S REPRESENTATIVE that required permits, inspections, and code requirements have been secured.

1.3 PROJECT/SITE CONDITIONS

A. All equipment furnished and installed shall be designed and installed to local ambient weather conditions, and seismic conditions.

1.4 WARRANTY

A. All equipment to be furnished under this item shall be guaranteed for a period of one (1) year from the date of acceptance thereof against defective materials, of design, and workmanship. Acceptance shall be defined as the time when start-up and field testing show that the equipment operates satisfactorily and meets all Specifications herein as determined by the OWNER'S REPRESENTATIVE.

1.5 QUALITY ASSURANCE

A. The use of a manufacturer's name and model or catalog number is only for the purpose of establishing the standard of quality and general configuration desired. Products of other manufacturers will be considered in accordance with Section 01600, Material and Equipment.

1.6 COORDINATION

A. Layout and Coordination by the CONTRACTOR:

1. Before starting work, carefully examine the project site and all Drawings so as to become thoroughly familiar with conditions governing work on this project. The General Contractor shall be responsible for continual coordination of the mechanical work with other trades so as to avoid conflicts in installation.
2. Make determination of the exact location of utility services prior to the submission of bid.
3. Verify all indicated elevations, building measurement, rough-in dimensions, and equipment locations, before proceeding with any of the work.
4. Install all valves and equipment to provide access to all parts requiring inspection and service.
5. Notify the OWNER’S REPRESENTATIVE of any conflict or discrepancy in Drawings and/or Specifications.
6. Do not proceed with any questionable items of work until clarification has been made by the OWNER’S REPRESENTATIVE.
7. Beams, girders, footings, or columns shall not be cut or drilled for mechanical items unless approved by the OWNER’S REPRESENTATIVE.
8. Casing of pipes into concrete is prohibited except where specifically indicated.

B. Electrical Coordination:

1. The General Contractor will be responsible for:
    a. All motor starters and disconnect switches except as modified herein.
    b. All power, conduit, and wiring from the electrical distribution equipment to all remote mechanical equipment and connections to the equipment.
    c. All motor control centers, power distribution panels, and lighting panels.

C. Equipment Manufacturer's Responsibility and Services:

1. A manufacturer's representative for equipment shall be provided as necessary to assist the General Contractor during installation, and to provide written certification that the equipment has been installed in accordance with the manufacturer's directions as approved.
2. The manufacturer's representative shall provide the initial start-up of equipment in the presence of the OWNER’S REPRESENTATIVE and OWNER.
   a. Provide a prestart check of all piping, valves, control devices, control panels, and equipment.
   b. Calibrate and adjust equipment and controls for operation at the specified design conditions.
   c. Provide a record of all start-up events, noting problems and their resolution. Record all setpoints operational controls and devices.
3. Upon the completion of equipment start-up, provide instructional time with the OWNER'S personnel to review the operations and maintenance manuals and perform each step necessary for start-up, shutdown, troubleshooting, and routine maintenance. The instructional time shall be scheduled through the OWNER.
4. Upon completion of the inspections, start-up, testing, and checkout procedures, the equipment manufacturer shall submit written notice to the CONTRACTOR, OWNER, and the OWNER’S REPRESENTATIVE that the units are ready for beneficial use by the OWNER.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Insofar as is practical, the equipment specified herein shall be factory-assembled. Parts and assemblies that are, of necessity, shipped unassembled, shall be packaged and tagged in a manner that will protect the equipment from damage and facilitate the final assembly in the field. Generally, machined and unpainted parts shall be protected from damage by the elements with an application of a strippable protective coating.

B. The equipment and materials specified herein shall be delivered f.o.b. factory with freight allowed to the jobsite and include full-value insurance coverage while in transit.

C. The CONTRACTOR shall inspect the equipment and materials for damage upon delivery and shall immediately report damage to the OWNER and replace or repair such damage to the satisfaction of the OWNER.

D. Handle materials as recommended by the manufacturer, with approved equipment in a manner that will prevent damage.

E. Store material indoors and in a secure area off the ground in an orderly manner that will allow easy inspection and inventory.

F. Store materials subject to temperature or humidity damage in a controlled environment as recommended by the manufacturer and approved by the OWNER'S REPRESENTATIVE.

G. Materials and Equipment Furnished by the OWNER: The Mechanical Contractor shall take delivery of OWNER- furnished materials and equipment, inspect for damage in the presence of the OWNER, store, and protect as approved by the OWNER'S REPRESENTATIVE prior to installation. The Mechanical Contractor shall furnish all labor, supervision, tools, equipment, and any incidental materials that may be necessary to properly install and test OWNER-furnished items.

1.8 SUBMITTALS

A. Required with the Bid:

1. Equipment submittals with the bid may be required by individual specification sections.
2. When the CONTRACTOR proposes a substitution of materials in accordance with Section 01600, Material and Equipment, submit complete specifications, drawings, catalog cuts, and literature of the equipment for evaluation by the OWNER/OWNER'S REPRESENTATIVE.
3. Identify all exceptions to the applicable requirements and Specifications provided in these Contract Documents.

B. Required After Execution of Contract:

1. Submittals shall be made in accordance with Section 01300, Submittals. In addition, the following information shall be provided:
    a. Complete specifications, drawings, catalog cuts, and descriptive literature which shall include make, model, dimensions, weight of equipment, and electrical schematics.
    b. Complete performance data that will indicate full compliance with the Specifications.
    c. All exceptions to the applicable requirements and Specifications provided in these Contract Documents.
    d. Detailed information on structural, mechanical, electrical, or other changes or modifications necessary to adapt their materials to the arrangement or details shown on the Drawings.
    e. Recommended procedure for the protection and handling of materials and equipment prior to installation.

    f. Recommended manufacturer's installation procedures and instructions.
    g. List of recommended spare parts for equipment specified in the following sections of this Division 15.
    h. Operating and Maintenance Manuals and Maintenance Summary Forms shall be submitted for the equipment specified in the following sections of this Division 15.
    i. Corrected or supplemental technical data to the information furnished with the bid.
  2. The following Division 15 specification sections may contain additional specific submittal requirements.

PART 2 PRODUCTS

2.1 MATERIALS

A. Unless otherwise indicated, provide all first-quality, new materials and equipment, free from any defects, in first-class condition, and suitable for the space provided.

B. Standardization: Like items of materials provided hereunder shall be the end products of one manufacturer in order to achieve standardization for appearance, maintenance, and replacement.

C. Unless otherwise indicated, provide materials and equipment which are the standard products of manufacturers regularly engaged in the production of such materials and equipment. Provide the manufacturer's latest standard design that conforms to these Specifications.

D. Provide materials and equipment with the manufacturer's standard finish, unless otherwise noted. Provide one quart of paint for touchup and one spray can for touchup, if available.

PART 3 EXECUTION

3.1 INSPECTION

A. The CONTRACTOR shall inspect his work area, identifying conflicts with the structure and/or other contractors' work which may conflict with the installation of the mechanical systems.

B. The CONTRACTOR shall inspect his work to ensure the installation and workmanship are in accordance with acceptable industry standards for the work being done and with these Specifications.

C. All materials, equipment, and workmanship shall be subject to inspection at any time by the OWNER or his representatives. Correct any work, materials, or equipment not in accordance with these Contract Documents or found to be deficient or defective.

3.2 SAFETY CONSIDERATIONS

A. All mechanical equipment shall be installed with suitable access clearances for maintenance or removal of replaceable parts and components, and with necessary couplings or flanges to perform the maintenance or removal without removing the connecting appurtenances.

B. No water piping shall be installed immediately over or within a 1-meter plan view clearance of any electrical panel, motor starter, or mechanical control panel. Where piping must be located within these zones, either install piping inside a PVC conduit or shield the electrical device to prevent direct water access to electrical equipment.

C. Where equipment requiring periodic maintenance cannot be reached by normal access because of interference with ductwork, piping, or other mechanical obstructions created by conflicts or changes made during construction, or by substitution of equipment, the CONTRACTOR shall provide an alternate safe means of access. These may include construction of platforms with ladder ends and safety railings as required to meet OSHA standards for safe maintenance procedures.

3.3 CLEANING, START-UP, AND ADJUSTING

A. The Mechanical Contractor shall be responsible for proper operation of all systems, and services provided under this section. He shall coordinate start-up procedures, calibration, and system check-out with all subcontractors involved. Any system operational problems shall be diagnosed; all correctional procedures shall be initiated with the various subcontractors as required to bring out the system into compliance with the design, and the problem then shall be rechecked to verify that the system operates normally. Any remaining difficulties shall be brought to the attention of the OWNER’S REPRESENTATIVE.

B. Thoroughly clean all parts of the installation at the completion of the work. The CONTRACTOR shall clean up and remove from the premises all refuse material, crates, and rubbish arising from his work. Remove, clean, and reinstall all filters. Belt-drive tensions and alignments shall be checked. All motors and bearings shall be lubricated in accordance with the manufacturer's service manuals prior to equipment start-up. Provide a lubrication schedule for every item of equipment furnished under this section. The schedule shall include the type of lubricant and the application frequency.

END OF SECTION

SECTION 15044
PRESSURE TESTING OF PIPING

PART 1 GENERAL

1.1 DESCRIPTION

A. This section specifies the hydrostatic and leakage testing of pressure piping for pumping stations, water treatment plants, and other facilities.

1.2 SUBMITTALS

A. Submit test bulkhead locations and design calculations, pipe attachment details, and methods to prevent excessive pipe wall stresses.

B. Submit six copies of the test records to the OWNER'S REPRESENTATIVE upon completion of the testing.

1.3 TEST PRESSURES

A. Test pressures for the various services and types of piping are shown in the piping schedule in the Drawings.

1.4 TESTING RECORDS

A. Provide records of each piping installation during the testing. These records shall include:

1. Date of test.
2. Identification of pipeline, or pipeline section, tested or retested.
3. Identification of pipeline material.
4. Identification of pipe specification.
5. Test fluid.
6. Test pressure.
7. Remarks: Leaks identified (type and location), types of repairs, or corrections made.
8. Certification by CONTRACTOR that the leakage rate measured conformed to the specifications.

PART 2 MATERIALS

2.1 VENTS AND DRAINS FOR ABOVEGROUND PIPING

A. Install vents on the high points of aboveground piping, whether shown in the drawings or not. Install drains on low points of aboveground piping, whether shown in the drawings or not. Provide a valve at each vent or drain point.

Valves shall be ¾ inch for piping 3 inches and larger, and ½ inch for piping smaller than 3 inches. Valves shall be as specified in Section 15100 Valves - General, unless otherwise shown in the drawings.

2.2 MANUAL AIR-RELEASE VALVES FOR BURIED PIPING

A. Provide temporary manual air-release valves for pipeline test. Construct the pipe outlet in the same manner as for a permanent air valve and after use, seal with a blind flange, pipe cap, or plug and coat the same as the adjacent pipe.

2.3 TEST BULKHEADS

A. Design and fabricate test bulkheads per Section VIII of the ASME Boiler and Pressure Vessel Code. Materials shall comply with Part UCS of said code. Design pressure shall be at least 2.0 times the specified test pressure for the section of pipe containing the bulkhead. Limit stresses to 70% of yield strength of the bulkhead material at the bulkhead design pressure. Include air-release and water drainage connections.

2.4 TESTING FLUID

A. Testing fluid shall be potable water.

B. Supply of potable water shall be obtained by CONTRACTOR and CONTRACTOR’S full expense.

2.5 TESTING EQUIPMENT

A. Provide pressure gauges, pipes, bulkheads, pumps and meters to perform the hydrostatic testing.

PART 3 EXECUTION

3.1 TESTING PREPARATION

A. Pipes shall be in place and anchored before commencing pressure testing.

B. Conduct pressure tests on exposed and aboveground piping after the piping has been installed and attached to the pipe supports, hangers, anchors, expansion joints, valves, and meters.

C. For buried piping, the pipe may be partially backfilled and the joints left exposed for inspection for an initial leakage test. Perform the final test, however, after completely backfilling and compacting the trench.

D. Provide any temporary piping needed to carry the test fluid do the piping that is to be tested. After the test has been completed and demonstrated to comply with the specifications, disconnect and remove temporary piping. Do not remove exposed vent and drain valves at the high and low points in the tested piping; remove any temporary buried valves and cap the associated outlets. Plug taps or connections to the existing piping from which the test fluid was obtained.

E. Provide temporary drain lines needed to carry testing fluid away from the pipe being tested. Remove such temporary drain lines after completing the pressure testing. Drain the pipes after they have been tested.

3.2 CLEANING

A. Before conducting hydrostatic tests, flush pipes with water to remove dirt and debris. Maintain a flushing velocity of at lest 3 fps for water testing. Flush pipes for time period as given by the formula:

$$T = \frac{2L}{3}$$

in which:

T = flushing time (seconds)
L = pipe length (feet)

3.3 TESTING AND DISINFECTION SEQUENCE FOR POTABLE WATER PIPING

A. Perform required chlorination after hydrostatic testing, except when pipeline being tested is connected to a potable waterline.

B. Locate and install test bulkheads, valves, connections to existing pipelines, and other appurtenances in a manner to provide an air gap separation between existing potable water pipelines and the pipeline being tested. Disinfect water and pipeline being tested before hydrostatic testing when connected to a potable waterline.

3.4 LENGTH OF TEST SECTION FOR BURIED PIPING

A. The maximum length of test section for buried pipe of 12 inches or smaller in diameter is 3,500 feet; for buried pipe larger than 12 inches, 1 mile. Provide test bulkheads where the distance between inline valves exceeds these limits.

3.5 INITIAL PIPELINE FILLING FOR HYDROSTATIC TESTING

A. Maximum rate of filling shall not cause water velocity in pipeline to exceed 1 fps. Filling may be facilitated by removing automatic air valves and releasing air manually.

3.6 TESTING NEW PIPE WHICH CONNECTS TO EXISTING PIPE

A. Prior to testing new pipelines which are to be connected to existing pipelines, isolate the new line from the existing line by means of pipe caps, spectacle flanges, or blind flanges. After the new line has been successfully tested, remove caps or flanges and connect to the existing piping.

3.7 HYDROSTATIC TESTING OF ABOVEGROUND OR EXPOSED PIPING

A. Open vents at high points of the piping system to purge air while the pipe is being filled with water. Venting during system filling may also be provided by temporarily loosening flanges. Subject the piping system to the test pressure indicated on the piping schedule in the drawings. Maintain the test pressure for a minimum of four hours. Examine joints, fittings, valves, and connections for leaks. The piping system shall show zero leakage or weeping. Correct leaks and retest until zero leakage is obtained.

3.8 HYDROSTATIC TESTING OF BURIED PIPING

A. Where any section of the piping contains concrete thrust blocks or encasement, do not make the pressure test until at least 10 days after the concrete has been poured. When testing mortar-lined or PVC piping, fill the pipe to be tested with water and allow it to soak for at least 48 hours to absorb water before conducting the pressure test.

B. Apply and maintain the test pressure by means of a hydraulic force pump.

C. Maintain the test pressure for the following duration by restoring it whenever it falls an amount of 5 psi:

Pipe Diameter (inches)	Hours
18 and less	4
20 to 36	8
Greater than 36	24

D. After the test pressure is reached, use a meter to measure the additional water added to maintain the pressure. This amount of water is the loss due to leakage in the piping system. The allowable leakage rate is defined by the formula:

$$L = \frac{HND(P)^{1/2}}{C}$$

in which:

H = specified test period (hours)

L = allowable leakage (gallons)
N = number of rubber-gasketed joints in the pipe tested
D = diameter of the pipe (inches)
P = specified test pressure (psig)
C = 7,400

E. Piping subject to the National Fire Codes shall be tested per NFPA 24. Such piping shall be tested hydrostatically at not less than 200 psi pressure for two hours or at 50 psi in excess of the maximum static pressure when the maximum static pressure is in excess of 150 psi. The amount of leakage in piping shall be measured at the specified test pressure by pumping from a calibrated container. The amount of leakage at the joints shall not exceed 2 quarts per hour per 100 gaskets or joints irrespective of pipe diameter.

F. The allowable leakage for buried piping having threaded, brazed, or welded (including solvent welded) joints shall be zero.

G. Repair and retest any pipes showing leakage rates greater than that allowed in the above criteria.

3.9 REPETITION OF TEST

A. if the actual leakage exceeds the allowable, locate and correct the faulty work and repeat the test. Restore the work and all damage resulting from the leak and its repair. Eliminate visible leakage.

3.10 BULKHEAD AND TEST FACILITY REMOVAL

A. After a satisfactory test, remove the testing fluid, remove test bulkheads and other test facilities, and restore the pipe coatings.

END OF SECTION

SECTION 15060
PIPE AND PIPE FITTINGS - GENERAL

PART 1 GENERAL

1.1 WORK INCLUDED

A. This section covers the work necessary to design, furnish and install, complete all piping systems, complete. The work shall include, but not be limited to, all pipe, thrust blocks, tubing, hangers, supports, restraints, isolators, pipe cleaning, testing and sterilization. In addition, this section covers the installation and testing of all valves, instruments, controls, and other devices related to the piping system.

1.2 DELIVERY, STORAGE, AND HANDLING

A. Delivery, storage, and handling shall be in compliance with Section 15010, Basic Mechanical Requirements. In addition, the following requirements shall be adhered to:

1. Deliver piping materials and fittings to the project site with manufacturer's labels intact and legible.

1.3 SUBMITTALS

A. Submittals during construction shall be made in accordance with Section 01300, Submittals, and Section 15010, Basic Mechanical Requirements. In addition, the following information shall be provided:

1. Catalogue information describing pipe, tubing and fittings, valves, and specialties.
2. Piping Drawings, showing routing and connection details.
3. Catalogue information and design data for vibration isolators, where used.

PART 2 PRODUCTS

2.1 GENERAL

A. The materials to be used for the piping systems are listed by service in the Piping Schedule provided in the Drawings.

B. All piping components shall be new, clean, and nonsurplus.

C. All pipe materials stored on the jobsite shall be separated by class and clearly labeled to indicate the pipe material.

2.2 RECORD DRAWINGS

A. The CONTRACTOR shall maintain an official record set of all piping Drawings in his field office. All organized and catalogued corrections and necessary changes shall be accurately noted in red on these Drawings. All buried, cast-in-place, and otherwise obstructed from plain view items shall be accurately surveyed following their placement to determine final location and elevation. As a minimum, provide monthly submissions of record drawings showing progress to date. Within 30 days of the completion of the project, a duplicate record set (reproducible sepias or mylar slicks plus AutoCAD electronic file) of the piping record drawings shall be provided to the OWNER'S REPRESENTATIVE.

2.3 PIPING SCHEDULE

A. The piping schedule provided in the Drawings, identifies each service required to construct the piping systems, complete.

2.4 BRANCH FITTINGS

A. All secondary branches off the primary lines shall be made with reducing tee fittings. When the secondary pipe size is less than or equal to one-half the primary pipe size, weldolets may be used on carbon steel piping.

2.5 FOOTING, SLAB, FLOOR, WALL AND ROOF PENETRATION MATERIALS

A. General: Stainless steel pipe sleeves shall be used on all standard wall penetrations. The annular space between the sleeve and pipe shall be filled with watertight sealant.

B. Fire-Rated Pipe Penetrations: All piping that penetrates fire-rated walls, or ceilings shall be fitted with insulated and encased pipe sleeves from approved manufacturers. The annular space between the sleeve and pipe shall be filled with appropriate fire-rated watertight sealant .

2.6 INSULATING FLANGES, COUPLINGS, AND UNIONS

A. Insulating flanges, couplings, or unions from approved manufacturers shall be provided wherever copper and ferrous metal piping are connected.

2.7 PIPING SUPPORT SYSTEMS

A. The CONTRACTOR is responsible for the design and installation of all Piping Supports and Anchors.

2.8 AIR VENTS AND LOW POINT DRAINS

A. Provide vents and drains at all high and low points in the piping system, even if they are not shown on the drawings. Provide drain valves at main shut-off valves, and at equipment.

B. Vent the high point and drain the low point with ¾ inch ball valves on those pipelines 2.5 inch and larger and ½ inch ball valves on those pipelines 2 inch and smaller. Valve types shall be to match the existing system, or as approved by the Engineer. All drain valves shall be provided with hose end connections. Each drain or vent valve shall be capped with a screwed cap.

PART 3 EXECUTION

3.1 CLEANING PRIOR TO FABRICATION

A. All pipe, fittings, valves, and other appurtenances shall be cleaned prior to being placed within a piping system.

3.2 PIPING FABRICATION

A. General:

1. The CONTRACTOR shall employ only labor that has been qualified to capably perform the specified activities required to accomplish the work in a satisfactory manner.
2. If the CONTRACTOR has developed alternative techniques or intends to apply alternative methods considered equivalent to those indicated herein, a proposal on such techniques or methods shall be submitted in writing to the OWNER’S REPRESENTATIVE and OWNER for approval at least 14 days before being used.
3. Any deviations from the Specifications and Drawings require prior written approval of the OWNER’S REPRESENTATIVE.

3.3 BURIED PIPE INSTALLATION

A. The CONTRACTOR MUST design and install thrust blocks on all buried piping.

3.4 BUILDING PIPING INSTALLATION

A. All piping shall be installed parallel to horizontal and vertical building lines except if specifically noted otherwise on the plan drawings. Uniform slope between bottom-of-pipe elevations defined on the plan drawings shall be maintained. Chrome escutcheon finish plates shall be provided where piping passes through walls, floors, or ceilings in finished areas and cabinet work.

B. All valves, balance fittings, flow indicators, and water specialties shall be installed according to the manufacturer's instructions and with sufficient clearance and access for ease of operation and maintenance. Unions or flanges shall be installed in such a way that all threaded connections can be serviced. Isolation valves shall be provided to allow removal of such devices for maintenance and repair. Provide a minimum length of straight run piping upstream and downstream of flow measuring devices, as recommended by the flow meter MANUFACTURER.

C. Piping shall be installed without springing or forcing the pipe in a manner which would set up stresses in the pipe, valves, or connected equipment.

D. Where piping connects to equipment, it shall be supported by a pipe support and not by the equipment. Stiff leg support of vibration isolated piping is not approved.

E. Prepare connections to equipment with flanges or unions.

F. The CONTRACTOR and his subcontractors shall coordinate their work with all other trades, vendors and manufacturers to provide a complete and operable system.

G. All drains shall be sloped continuously, without pockets at a minimum 1/8 inch per foot unless otherwise noted on the Drawings.

H. All coils shall be provided with valved drains with hose end connections.

3.5 PIPING EXPANSION AND FLEXIBILITY

A. Allow for pipe expansion in mains, runouts, and risers by means of natural flexibility in piping swing joints or by expansion loops.

B. All piping shall be installed with sufficient flexibility to avoid use of flexible couplings or expansion joints.

3.6 WALL AND ROOF PENETRATIONS

A. It shall be the CONTRACTOR’S responsibility to verify the size and location of all building and structure penetrations prior to finishing. The CONTRACTOR shall be responsible for finishing all wall and roof penetrations.

B. Support all pipes in walls to prevent contact with the reinforcing steel.

3.7 PIPING SUPPORT SYSTEMS

A. The Design/Build CONTRACTOR is responsible for the design of the piping support systems as required and subject to the approval of the OWNER’S REPRESENTATIVE.

3.8 PRESSURE TESTING

A. General:

1. The pressure testing requirements defined herein apply to ALL piping systems.
2. Testing shall be performed by the CONTRACTOR on all piping after erection but **before any burial**. Furnish all necessary equipment and material and make all taps in the pipe, as required. The OWNER'S designated representative will monitor the tests. Test pressures shall be as specified in the Drawings.
3. Piping normally open to the atmosphere, such as drains and vents, shall be tested by filling the system with potable water and checking all joints for leakage after the test duration specified in the Drawings.
4. The following piping and equipment shall not be subjected to hydrostatic and pneumatic pressure testing:
    a. Rotating machinery, such as pumps, and compressors.
    b. Pressure relieving devices, such as pressure relief valves.
    c. Vessels that do not satisfy impact requirements at the piping test temperature, and all vessels regardless of rating when using gas pressure for testing.
    d. Locally mounted pressure indicating gauges, where the test pressure would exceed their scale range.
    e. In line instrumentation.

B. Testing Buried Piping:

1. Conduct final acceptance tests on buried piping **after** the trench has been completely backfilled. The CONTRACTOR may, if field conditions permit, as determined by the OWNER'S REPRESENTATIVE, partially backfill the trench and leave the joints open for inspection and conduct an initial service leak test. The final acceptance test shall not, however, be conducted until **all backfilling** has been completed.
2. Where any section of pipe is provided with concrete reaction blocking or thrust blocks, do not make the pressure test until at least five days have elapsed after the concrete thrust blocking is installed. If high-early cement is used for the concrete thrust blocking, the time may be cut to two days.

C. Test Procedures:

1. Two pressure gauges shall be installed per each testing system. Gauges used for testing shall be installed as close as possible to the low point of the piping system.
2. All vents, and other connections that can serve as vents, shall be open during filling so that all air is vented prior to applying test pressure to a system.

3. If the maximum operating conditions of piping attached to a vessel are the same as those of the vessel, then the piping and the vessel may be tested together. However, if the vessel has different maximum operating conditions, then it must be isolated and tested separately.
4. Examination for leakage shall be made at all joints and connections. The piping system shall show no visual evidence of weeping or leaking. Any visible leakage shall be corrected at the CONTRACTOR'S sole expense.
5. If the pressure falls after the pressurizing system is shut off, the source of pressure loss must be determined and corrected. The system must be able to hold the test pressure for a minimum test duration of one (1) hour.
6. Piping designed for vapor or gas which is specified to be hydrostatically tested shall be provided with additional temporary supports, if necessary, to support the weight of the test liquid.
7. If the ambient air temperature is less than 40 degrees F at the time of the pressure testing, the test medium must be heated to 70 degrees F minimum.

D. Special Requirements for Pneumatic Testing:

1. The CONTRACTOR shall recognize the hazards associated with pneumatic testing and shall take all necessary precautions to protect test personnel and OWNER'S operating personnel. All piping to be tested shall be secured to prevent damage to adjacent piping and equipment in the event of a joint failure. Any appurtenances instruments or devices that could be damaged by the test shall be removed from the piping or suitably isolated prior to applying the test. Prior to starting the test, the CONTRACTOR shall notify the OWNER'S REPRESENTATIVE.
2. A preliminary pneumatic test not to exceed 25 psig shall be applied to the piping system prior to final leak testing, as a means of locating major leaks. Examination for leakage, detected by soap bubbles, shall be made at all joints and connections. After all visible leaks have been corrected, the pressure in the system shall gradually be increased to not more than 1/2 of the test pressure, after which the pressure shall be increased in steps of approximately 1/10 of the test pressure until the required test pressure has been reached. The pneumatic test pressure shall be continuously maintained for a minimum duration of four (4) hours and for such additional time as may be necessary to conduct a soap bubble examination for leakage. The piping system, exclusive of possible localized instances at pump or valve packing, shall show no evidence of leakage. Any visible leakage shall be corrected at the CONTRACTOR'S sole expense.

E. Testing Media:

1. Clean fresh potable water shall be used for hydrostatic testing.
2. In general, oil-free clean dry air shall be used for pneumatic testing.

3. Water used for testing austenitic stainless steel materials shall be essentially free from chlorine (not to exceed 100 ppm). After testing, all water shall be drained immediately. Care shall be taken not to pull a vacuum during draining-open all vents.

F. Test Repairs:

1. Materials such as gaskets, bolting, etc., damaged during tests and flushing shall be replaced.
2. New gaskets shall be used each time a flanged joint is made up.
3. Any welded joint that is defective shall be repaired. Repaired components shall be re-examined by the original method to determine freedom from defects, and all repaired joints shall be retested. Costs for such repair an retesting shall be the responsibility of the CONTRACTOR.

G. Test Records:

1. Records shall be made by the CONTRACTOR for each piping installation and submitted to the OWNER’S REPRESENTATIVE for record. These records shall include the following items:
    - a. Date of test.
    - b. Description and identification of piping tested.
    - c. Test fluid.
    - d. Test pressure.
    - e. Test duration.
    - f. Remarks, to include such items as:
        - 1) Leaks (type, location).
        - 2) Repairs made on leaks.
    - g. Signature and date of person witnessing the test.
    - h. Certification by CONTRACTOR’S Mechanical Engineer.

3.9 FINAL CLEANING OF PIPING SYSTEMS

A. All piping shall be cleaned according to these specifications.

B. Following assembly and testing and prior to final acceptance, liquid pipelines shall be flushed with water and all accumulated construction debris and other foreign matter removed. Flushing velocities shall be a minimum of 2.5 ft /sec. Cone strainers shall be inserted in the connections to attached equipment and left there until cleaning has been accomplished to the satisfaction of the OWNER’S REPRESENTATIVE. Accumulated debris shall be removed through drains 2 inch and larger or by dropping valves.

C. Flush gas piping systems clean of foreign substance with clean, dry, filtered nitrogen. Lines shall be free of all contaminants. Reconnect final connections to equipment and install inline instruments after approval of the system by the OWNER or his designated representatives.

3.10 ACCEPTANCE

A. All piping systems shall be tested in the presence of the OWNER or his representative as specified hereinbefore. The OWNER'S REPRESENTATIVE reserves the right to have any section of the piping system, which he suspects may be faulty, cut out of the system by the CONTRACTOR for inspection and pressure testing. Should the joint prove to be sound, the OWNER will reimburse the CONTRACTOR on a time and material basis. Should the joint prove to be faulty, the destructive test will continue joint by joint until sound joints are found. Replacement of faulty work and/or materials will be at no cost to the OWNER.

END OF SECTION

SECTION 15070
CARBON STEEL PIPING SYSTEMS

PART 1 GENERAL

1.1 WORK INCLUDED

A. This Section shall be used in association with Section 15060 Pipe and Pipe Fittings - General, and related piping Drawings and Specifications. The following requirements cover the shop and field fabrication and installation of carbon steel piping and fittings specified herein.

1.2 REFERENCES

A. ANSI B16.5-81, Pipe Flanges and Flanged Fittings.

B. ASTM A47-77, Malleable Iron Castings.

C. ASTM A53-83, Pipe, Steel, Black, and Hot-Dipped, Zinc- Coated Welded and Seamless.

D. ASTM A120-83, Pipe, Steel, Black, and Hot-Dipped, Zinc- Coated (Galvanized) Welded and Seamless for Ordinary Uses.

E. ASTM A181-83, Forgings, Carbon Steel, for General-Purpose Piping.

F. ASTM A193-83, Alloy-Steel and Stainless Steel Bolting Materials for High Temperature Service.

G. ASTM A194-83, Carbon and Alloy Steel Nuts for Bolts for High Pressure and High Temperature Service.

H. ASTM A234-83, Piping Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and Elevated Temperatures.

I. ASTM A307-83, Carbon Steel Externally Threaded Standard Fasteners.

J. AWWA C207-78, Standard for Steel Pipe Flanges for Waterworks Services - Sizes 4 inches through 144 inches.

K. AWWA C606-81, Standard for Grooved and Shouldered Type Joints.

PART 2 PRODUCTS

2.1 GENERAL

A. Material requirements are specified in the Pipe Specifications on the Drawings.

PART 3 EXECUTION

3.1 GENERAL

A. The general execution requirements are specified in Section 15060, Pipe and Pipe Fittings - General. The following specific requirements also apply for piping under this Specification.

B. All carbon steel pipe and fittings received for installation shall be clean and free of paint, oil, rust, scale, slag, or other materials detrimental to welding.

3.2 WELDERS AND WELDING OPERATORS

A. Welders and welding operators shall be qualified at the CONTRACTOR'S expense by an approved testing laboratory before performing any welding. Qualification tests shall be in accordance with Section IX of the ASME Code.

3.3 FILLER MATERIALS

A. The deposited weld metal shall conform to the ASTM Specifications below and shall have essentially the same alloy content as the metal being joined and be of essentially the same tensile strength:

1. ASTM A233 for carbon steel covered electrodes.
2. ASTM A558 for bare mild steel electrodes and fluxes for submerged arc welding.
3. ASTM, A559 for mild steel electrodes for gas metal arc welding. The tensile strength of the MIG weld deposit must be essentially the same as the tensile strength of the steel being welded.

B. Store welding rods in a warm, dry area per manufacturer's recommendation.

3.4 BACKING RINGS AND INSERTS

A. Backing strips or rings shall not be used.

3.5 JOINT PREPARATION AND ALIGNMENT

A. Weld bevels shall be suitable for the welding process used and the contour shall permit complete fusion throughout the joint. Bevels shall conform to those used in the procedure qualification; however, when not specified, they shall be in accordance with the requirements of ANSI B31.3 latest edition. Pipe having a nominal thickness less than 3/16- inch may have a slight chamfer or may be square depending upon the fabricator's preference.

B. Weld bevels shall be made by machining, grinding, or thermal cutting, and the surfaces shall be reasonably smooth and true.

C. Adjacent sections of welded pipe that are joined by butt welding shall have the longitudinal weld seams positioned so they do not match (minimum 30 degrees apart).

D. Wherever possible, the position of the longitudinal weld seam shall be so that branch connections (couplings, stubs, etc.) do not fall on the seam.

E. Where the ends of piping components are to be joined by welding and the internal surface misalignment exceeds 1/16 inch, that component, with the wall extending internally, shall be internally trimmed (see Figure 327.3.1B of ANSI B31.3) so that the adjoining internal surfaces are flush. However, the resulting thickness of the welded joint shall not be less than the minimum design thickness plus any corrosion allowance.

F. Materials that require preheating for welding shall be preheated at the same temperature for thermal cutting or gouging.

G. All surfaces to be welded shall be clean and free from paint, oil, dirt, scale, and other materials detrimental to welding.

H. Fit-up shall be made by tack welding or using lugs.

I. Tack welds shall be made by a qualified welder under a qualified welding procedure. Tack welds that are part of the root pass shall be made with the same electrodes as to be used for the first pass. Tack welds that have cracked shall be removed by grinding.

J. The clear distance between centerlines of adjacent girth butt welds shall not be less than four times the pipe wall thickness, or 1-inch, whichever is greater.

K. End connections of shop fabricated spool pieces shall be provided as follows. Any exception to the following will be indicated on the piping drawing and approved by the OWNER’S REPRESENTATIVE prior to fabrication.

1. Where field welding is required to join the ends of two pieces of fabricated pipe, or a piece of pipe and a welding fitting or flange, the shop fabricator shall furnish both adjacent ends beveled for field welding and fabricated to the Drawing dimensions.
2. Where field fit-up is required to allow for adjustment in the field, one spool piece at the fit-up weld shall have a plain end 6 inches longer than the dimension indicated on the piping Drawing. The adjacent spool piece shall have a beveled end and be fabricated to the dimension indicated.
3. Where field welds occur at stub-ins to a field fabricated straight-run, the shop fabricator shall furnish the spool end contoured and ready for welding. Should a reinforcement fitting (i.e., weldolet) be required, it shall be included in the shop spool.

L. Remove the raised face of steel flanges when mating to flat faced cast-iron flanges or use flat faced steel flanges if available. In both cases a full faced gasket is required.

M. Weld neck flanges shall be used with weld fittings.

3.6 WELDING PROCESS

A. All welding shall be in accordance with the latest editions of the applicable codes and standards. See the Pipe Specification on the Drawings.

B. All field welds shall be made by the shielded metal arc process. Shop welding and fabrication shall be made in accordance with the submitted welding procedure qualifications, as approved by the OWNER'S REPRESENTATIVE.

C. No welding shall be performed if there is impingement of any rain, snow, sleet, or high wind on the weld area, or if the ambient temperature is below 32 degrees F. If the ambient is less than 32 degrees F, local preheating to a temperature warm to the hand is required.

3.7 WELD CONTOUR AND FINISH

A. Welding requirements shall be as follows:

1. Each layer of deposited weld metal shall be thoroughly cleaned prior to the deposition of each additional layer of weld metal, including the final pass, with a power-driven wire brush. Surface defects which affect the soundness of weld shall be ground out.
2. Cracks will not be permitted.

3.8 GROOVED END PIPING

A. Installation of grooved end piping shall be as specified in Section 15060, Pipe and Pipe Fittings - General and in accordance with the manufacturer's printed instructions.

3.9 INSULATION

A. Insulation shall be as specified on the Drawings.

3.10 SUPPORTS AND HANGERS

A. Supports and hangers shall be as specified in Section 15140, Piping Supports and Anchors.

3.11 TESTING

A. All lines shall be tested as specified in Section 15060, Pipe and Pipe Fittings - General, and as called out in the Piping and Valve Schedule.

3.12 CLEANING

A. Cleaning shall be as specified in Section 15060, Pipe and Pipe Fittings - General.

END OF SECTION

SECTION 15080
HIGH DENSITY POLYETHYLENE PIPE

PART 1 GENERAL

1.1 WORK INCLUDED

A. This section covers the work necessary to furnish complete, the high density polyethylene pipe and fittings specified herein, provide HDPE pipe installation specifications, provide HDPE pipe installation training as required to the OWNER’s installation contractor and OWNER’S REPRESENTATIVE and provide site inspection as required to certify the HDPE pipe installation.

1.2 RELATED WORK

A. This section shall be used in conjunction with the following other specifications and related Contract Documents to establish the total requirements for the equipment covered under this section.

   1. Division 0 – Instructions to Bidders
   2. Division 1 – General Requirements
   3. Division 15 – Mechanical Requirements
   4. All Contract Drawings

B. In the event of conflict regarding this section and any other section, the provisions of this section shall govern.

1.3 REFERENCES

A. ASTM D 1248-84, Polyethylene Plastics Molding and Extrusion Materials.

B. ASTM D 3350-84, Polyethylene Plastics Pipe and Fittings Materials.

C. ASTM F 714-85, Polyethylene (PE) Plastic Pipe (SDR-PR) Based on Outside Diameter.

D. ASTM D 3035, Standard Specifications for Polyethylene (PE) Plastic Pipe (SDR-PR). Based on controlled outside diameter.

E. AWWA C901, Standard for polyethylene (PE) pressure pipe and tubing, ½ inch through three inch, for water service.

F. AWWA C906, Standard for polyethylene (PE) pressure pipe and fittings, 4 inch through 63 inch, for water distribution and transmission.

G. Plastic Pipe Institute, Handbook of PE Pipe (2nd edition)

PART 2 PRODUCTS

2.1 GENERAL

A. Material requirements are specified in the Piping Schedule shown in the Drawings.

2.2 FLANGES

A. Flanges shall be compatible with standard 150 pound, ANSI B16.5 steel flanges. Flanges shall be complete with one-piece, molded polyethylene stub ends, and ductile iron flange ring, field ready for fusion welding to pipeline.

2.3 GASKETS

A. Flange gaskets shall be flat ring, 1/8 inch thick ethylene propylene rubber (EPR), pre-punched to match 18 inch, 150 pound ANSI B16.5 flanges.

2.4 TRENCH EXCAVATION AND BACKFILL SPECIFICATIONS

A. Trenching and backfilling shall be in accordance with the pipe manufacturer's recommendations, Section 02200, Earthwork, Section 02434, Yard Piping, and the Plastic Pipe Institute Handbook of PE Pipe (2nd edition).

2.5 PIPE BASE AND PIPE ZONE INSTALLATION SPECIFICATIONS

A. Pipe base and pipe zone installation shall be in accordance with the pipe manufacturer's recommendations.

2.6 PIPE INSTALLATION SPECIFICATIONS

A. Pipe installation shall be in accordance with the PPI Handbook of PE Pipe, and the manufacturer's recommendations.

2.7 PIPE FUSION SPECIFICATIONS

A. Pipe fusing shall be in accordance with pipe manufacturer's recommendations and Plastic Pipe Institute Technical Report 33 (PPI, TR-33), Generic Butt Fusion Joining Procedure for Field Joining of Polyethylene Pipe.

2.8 PIPE TESTING SPECIFICATIONS

A. All lines shall be pressure tested as specified in Section 15060 – Pipe and Pipe Fittings – General, and Section 15044 – Pressure Testing of Piping, and in accordance with the pipe manufacturer’s recommendations.

PART 3 EXECUTION

3.1 GENERAL

A. The CONTRACTOR shall certify, in writing, that the installer is qualified to install the HDPE pipe in accordance with the manufacturer’s recommendations, and any applicable codes in the State of Washington, or in the United States.

3.2 TRANSPORTATION

A. Care shall be taken during handling and transportation of the HDPE pipe that it is not cut, kinked, or otherwise damaged. Pipe shall be transported as per AWWA C901 or C906, PPI Handbook of PE Pipe, and the manufacturer’s recommendations.

3.3 STORAGE

A. Pipes shall be stored on level ground, preferably turf or sand, free of sharp objects which could damage the pipe. Stacking of the polyethylene pipe shall be limited to a height that will not cause deformation of the bottom layers of pipes under anticipated temperature conditions. Where necessary due to ground conditions, the pipe shall be stored on wooden sleepers, spaced suitably and of such widths as not to allow deformation of the pipe at the point of contact with the sleeper or between supports.

B. Pipe shall be stored as per AWWA Manual of Practice M55 Chapter 7, PPI Handbook of PE Pipe, and the manufacturer’s recommendations.

3.4 HANDLING PIPE

A. The handling of pipe shall be in such a manner that the pipe is not damaged by dragging it over sharp and cutting objects. Ropes, fabric, or rubber-protected slings and straps shall be used when handling pipes. Chains, cables, or hooks inserted into the pipe ends shall not be used. Two slings spread apart shall be used for lifting each length of pipe. Pipe or fittings shall not be dropped onto rocky or unprepared ground.

B. Pipe shall be handled as per AWWA Manual of Practice M55 Chapter 7, PPI Handbook of PE Pipe, and the manufacturer’s recommendations.

3.5 DAMAGED PIPE

A. If any gouges, scrapes, or other damage to the pipe results in loss of 10% of the pipe wall thickness, cut out that section or do not use.

3.6 INSPECTION

A. Inspection shall be performed in the presence of the pipe manufacturer, the OWNER'S REPRESENTATIVE, the OWNER, and the CONTRACTOR to ensure installation has been completed in accordance with the manufacturer's specifications.

END OF SECTION

SECTION 15090
PIPE AND PIPE FITTINGS – PVC

PART 1 GENERAL

1.1 DESCRIPTION

A. This section shall be used in association with Section 15060 Pipe and Pipe Fittings – General, and related piping Drawings and Specifications. The following requirements cover the materials, installation, and testing of polyvinyl chloride (PVC) pipe and fittings for use in process piping.

1.2 REFERENCES

A. ASME B31.3, Chemical Plant and Petroleum Refinery Piping.

B. ASTM D1785, Polyvinyl Chloride (PVC) Plastic Pipe, Schedules 40, 80, and 120.

C. ASTM D2464, Threaded Polyvinyl Chloride (PVC) Plastic Pipe Fittings, Schedule 80.

D. ASTM D2466, Polyvinyl Chloride (PVC) Plastic Pipe Fittings, Schedule 40.

1.3 SUBMITTALS

A. Submit shop drawings in accordance with the General Conditions.

B. Submit materials list for review. Submit manufacturer's recommended method of installing buried pipe. Show alignments and offsets for "snaking" buried pipe.

PART 2 MATERIALS

2.1 GENERAL

A. Material requirements are described hereinafter and further specified in the piping schedule in the Drawings.

2.2 PIPE

A. Pipe shall be Schedule 40, Type I, Grade 1 (Class 12454-B), conforming to ASTM D1784 and D1785.

2.3 NIPPLES

A. Short nipples shall be the same as the PVC pipe.

2.4 FITTINGS

A. Fittings shall be Schedule 40 and shall conform to ASTM D2464 for threaded fittings and ASTM D2467 for socket-type fittings.

2.5 FLANGES

A. PVC flanges shall be made of the same material as the pipe. Flanges shall match the dimensions of ANSI B16.5, Class 150, steel flanges. PVC flanges that connect to metal flanges shall be Van Stone type flanges. When two PVC flanges are connected, one shall be a Van Stone type flange.

2.6 UNIONS

A. Unions shall have socket-type ends, Viton O-rings, and shall be Schedule 40. Material shall be Type I, Grade 1 PVC, per ASTM D1784.

2.7 JOINTS

A. Pipe and fitting joints shall be socket welded except where threaded and flanged joints are required to connect to unions, valves, and equipment.

B. Solvent cement for socket joints shall comply with ASTM D2564.

2.8 GASKETS FOR FLANGES

A. Gaskets for flanged joints shall be full faced, 1/8 inch thick, made of EPR having a hardness of 50 to 70 durometer. When the mating flange has a raised face, provide a flat ring gasket filler between the PVC flange gasket and the adjacent flange.

2.9 BOLTS AND NUTS FOR FLANGES

A. Bolts and nuts for flanges type 316 stainless steel conforming to ASTM A193, Grade B8M, for bolts and ASTM A1294, Grade 8M, for nuts.

B. Provide a washer under each nut and under each bolthead. Washers shall be of the same material as the nuts.

2.10 LUBRICANT FOR STAINLESS STEEL BOLTS AND NUTS

A. Lubricant shall be TRX-Synlube by Ramco, Anti-Seize by Ramco, Husk-It by Husky Lube O'Seal, or approved equal.

2.11 WYE STRAINERS

A. PVC wye strainers shall be manufactured of the same material as the pipe, with 30-mesh screens and Viton seals. Connecting ends shall be the socket type, solvent welded. Provide one spare screen for each strainer.

PART 3 EXECUTION

3.1 GENERAL

A. All pipe, fittings, valves, and materials shall be stored in a sheltered location, out of direct sunlight and between 40-90 degrees F. Pipe, fittings, and valves shall be stored and handled in such a manner as to prevent damage and/or contamination. Any materials that become damaged must be replaced with new, clean material.

B. Do not install PVC pipe when the temperature is below 40°F or above 90°F. Store loose pipes on racks with a maximum support spacing of 3 feet. Provide shades for pipe stored outdoors or installed outdoors until the pipe is filled with water or backfilling is complete.

C. Store fittings indoors in their original cartons.

D. Store solvent cement indoors or, if outdoors, shade from direct sunlight exposure. Do not use solvent cements which have exceeded the shelf life marked on the storage container.

E. Before installation, check pipe and fittings for cuts, scratches, gouges, buckling, kinking, or splitting on pipe ends. Remove any pipe section containing defects by cutting out the damaged section as s complete cylinder.

3.2 INSTALLATION

A. Do not drag PVC pipe over the ground, drop it onto the ground, or drop objects on it. Cut pipe ends square and remove all burrs, chips, and filings before joining pipe or fittings. Bevel solvent welded pipe ends as recommended by the piper manufacturer.

3.3 SOLVENT WELDED JOINTS

A. Prior to solvent welding, remove fittings and couplings from their cartons and expose them to the air at the same temperature conditions as the pipe for at least one hour.

B. Wipe away loose dirt and moisture from the ID and OD of the pipe end and the ID of the fitting before applying solvent cement. Do not apply solvent cement to wet surfaces.

C. Make up solvent welded joints per ASTM D2855.

D. Allow at least eight hours of drying time before moving solvent welded joints or subjecting the joints to any internal or external loads or pressures.

3.4 FLANGED JOINTS

A. Lubricate bolt threads before installation.

B. Tighten bolts on PVC flanges by tightening the nuts diametrically opposite each other using a torque wrench. Complete tightening shall be accomplished in stages and the final torque values shall be per the manufacturer's recommendations.

3.5 THREADED JOINTS

A. Cut threaded ends on PVC to the dimensions of ANSI B1.20.1. Ends shall be square cut. Follow the pipe manufacturer's recommendations regarding pipe hold-down methods, saw cutting blade size, and saw cutting speed.

B. Pipe or tubing cutters shall be specifically designed for use on PVC pipe. Use cutters manufactured by Reed Manufacturing Company, Ridge Tool Company, or approved equal.

C. If a hold-down vise is used when the pipe is cut, insert a rubber sheet between the vise jaws and the pipe to protect from scratching the pipe.

D. Thread cutting dies shall be clean and sharp and shall not be used to cut materials other than plastic.

E. Apply Teflon thread compound or Teflon tape lubricant to threads before screwing on the fitting.

3.6 INSTALLING UNIONS

A. Provide unions on exposed piping as follows:

1. Provide a union at every change in direction (horizontal and vertical).
2. Provide a union 6 to 12 inches downstream of valves.
3. Provide a union every 20 feet in straight pipe runs.
4. Where shown on the drawings.

3.7 INSTALLING ABOVEGROUND PIPE

A. Install pipe on pipe hangers and supports as indicated in the Drawings, as a minimum. Install pipe without springing, forcing, or stressing the pipe or the adjacent valves and equipment to which the pipe is connected.

3.8 HYDROSTATIC TESTING

A. Test pressures are shown in the piping schedule shown in the drawings.

B. Perform hydrostatic testing for leakage in accordance with Section 15044 Pressure Testing of Piping.

END OF SECTION

SECTION 15100
VALVES – GENERAL

PART 1 GENERAL

1.1 WORK INCLUDED

A. This Section provides the general requirements for the following types of valves:

1. Manual.
2. Control (modulating and on/off).
3. Self-contained control valves (regulators).

B. The specific general requirements included in this Section are:

1. Related specifications.
2. Acceptable manufacturers.
3. General product requirements.
4. General installation requirements.
5. Testing.

1.2 RELATED SPECIFICATIONS

A. This Specification shall be used in conjunction with the following other specifications and related Contract Documents to form the complete requirements for valves.

1. Section 15010 - Basic Mechanical Requirements.
2. Piping and Valve Schedule as specified on Drawings.

PART 2 PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Acceptable manufacturers are listed in the applicable Detailed Valve Specifications.

2.2 GENERAL

A. All valves shall be complete with all necessary operating handwheels, chain wheels, extension stems, floor stands, worm and gear operators, operating nuts, chains, and wrenches which are required for the proper completion of the work included under this Section.

B. All valves shall have the name of the manufacturer and the nominal size of the valve on the body or bonnet or shown on a permanently attached plate in die-stamped letters.

PART 3 EXECUTION

3.1 GENERAL

A. Before installation, carefully clean valves of all foreign materials, and inspect valves in OPEN and CLOSED positions.

3.2 INSTALLATION

A. Prior to installing flanged valves, the flange faces shall be thoroughly cleaned. After cleaning, insert the gasket and bolts and tighten the nuts progressively and uniformly.

B. Thoroughly clean threads of screwed joints by wire brushing, swabbing, or other acceptable methods. Apply suitable joint compound or Teflon tape to threads prior to making joints.

C. Do not tighten valve stem packing glands beyond "hand tight" unless a leak is detected during testing and then only enough to stop the leak.

D. Do not thread pipe or nipples into valves beyond the make-up distances of American NPT.

E. Install all valves in the closed position.

F. Flat face wrenches, not pipe wrenches, are to be used on copper alloy and plastic valves.

3.3 TESTING

A. Valves shall be tested at the same time that the adjacent pipeline is tested. Joints shall show no visible leakage under test. Repair joints that show signs of leakage prior to final acceptance. If there are any special parts of control systems or operators that might be damaged by the pipeline test, they shall be properly protected. The CONTRACTOR shall repair or replace to the satisfaction of the OWNER’S REPRESENTATIVE any valve damaged by the testing.

END OF SECTION

VALVE LIST

PROJECT: SE10160010.4102
AREA:

Valve Tag #	Spec. #	Valve Type	Process Fluid	Size in.	Valve Rating	Valve Body Mat.	Design Temp. °F	Design Pressure psi	Drawing #	Remarks	Purchase Order Number	REV
EV - 100	V-0251	Solenoid	Water	2"		PVC	per line spec	per line spec	P&ID - 01			
EV - 101	V-0251	Solenoid	Water	2"		PVC	per line spec	per line spec	P&ID - 01			
EV - 102	V-0251	Solenoid	Water	2"		PVC	per line spec	per line spec	P&ID - 01			
HV - 103	V-1251	Gate	Water	1-1/2"		PVC	per line spec	per line spec	P&ID - 01			
HV - 108	V-1251	Gate	Water	1-1/2"		PVC	per line spec	per line spec	P&ID - 01			
HV - 109	V-4251	Ball	Water	1"		PVC	per line spec	per line spec	P&ID - 01			
HV-119	V-4251	Ball	Water	2"		PVC	per line spec	per line spec	P&ID - 01			
HV-129	V-4251	Ball	Water	2"		PVC	per line spec	per line spec	P&ID - 01			
HV - 138	V-0231	Pinch	Water/Sludge	4"		Carbon Steel	per line spec	per line spec	P&ID - 01			
FV - 120		Three Way Control	Lime Slurry	1"		Carbon Steel	per line spec	per line spec	P&ID - 01			
EV - 391	V-0251	Solenoid	Water	1"		PVC	per line spec	per line spec	P&ID - 01			
HV-100A	V-4251	Ball	Water	1"		PVC	per line spec	per line spec	P&ID - 01			
HV- 101A	V-4251	Ball	Water	1"		PVC	per line spec	per line spec	P&ID - 01			
HV- 102A	V-4251	Ball	Water	1"		PVC	per line spec	per line spec	P&ID - 01			
HV-100B	V-1251	Gate	Water	2"		PVC	per line spec	per line spec	P&ID - 01			
HV-101B	V-1251	Gate	Water	2"		PVC	per line spec	per line spec	P&ID - 01			
HV-102B	V-1251	Gate	Water	2"		PVC	per line spec	per line spec	P&ID - 01			
BPV - 910		Back Pressure	Air	1"		Galv.	per line spec	per line spec	P&ID - 02			
HV - 920	V-1211	Gate	Air	1"		Galv.	per line spec	per line spec	P&ID - 02			
HV - 930	V-1211	Gate	Air	1"		Galv.	per line spec	per line spec	P&ID - 02			
HV - 940	V-1211	Gate	Air	1"		Galv.	per line spec	per line spec	P&ID - 02			
BPV - 920		Back Pressure	Air	1"		Galv.	per line spec	per line spec	P&ID - 02			
BPV - 930		Back Pressure	Air	1"		Galv.	per line spec	per line spec	P&ID - 02			
BPV - 940		Back Pressure	Air	1"		Galv.	per line spec	per line spec	P&ID - 02			
EV - 920	V-0211	Solenoid	Air	1"		Galv.	per line spec	per line spec	P&ID - 02			
EV - 930	V-0211	Solenoid	Air	1"		Galv.	per line spec	per line spec	P&ID - 02			

VALVE LIST

PROJECT: SE10160010.4102

AREA:

Valve Tag #	Spec. #	Valve Type	Process Fluid	Size in.	Valve Rating	Valve Body Mat.	Design Temp. °F	Design Pressure psi	Drawing #	Remarks	Purchase Order Number	REV
DV - 220	V-0231	Pinch	Water/Sludge	2"		Steel (Victaulic)	per line spec	per line spec	P&ID - 02			
EV - 221	V-0251	Solenoid	Water/Sludge	2"		PVC	per line spec	per line spec	P&ID - 02			
EV - 229	V-0251	Solenoid	Water/Sludge	2"		PVC	per line spec	per line spec	P&ID - 02			
HV - 231	V-0231	Pinch	Water/Sludge	2"		Steel (Victaulic)	per line spec	per line spec	P&ID - 02			
HV - 232	V-0231	Pinch	Water/Sludge	2"		Steel (Victaulic)	per line spec	per line spec	P&ID - 02			
HV-235	V-1231	Gate	Water/Sludge	2"		Steel (Victaulic)	per line spec	per line spec	P&ID - 02			
HV - 239	V-1251	Gate	Water/Sludge	1-1/2"		PVC	per line spec	per line spec	P&ID - 02			
HV-241	V-1251	Gate	Water/Sludge	1-1/2"		PVC	per line spec	per line spec	P&ID - 02			
EV - 390		Solenoid	Water	1"		Galv.	per line spec	per line spec	P&ID - 03			
HV - 392	V-1211	Gate	Water	1"		Galv.	per line spec	per line spec	P&ID - 03			
HV - 393	V-1211	Gate	Water	1"		Galv.	per line spec	per line spec	P&ID - 03			
HV - 311	V-4251	Ball	$KMnO_4$ Soln	1/2"		PVC	per line spec	per line spec	P&ID - 03			
HV - 314	V-4251	Ball	$KMnO_4$ Soln	1/2"		PVC	per line spec	per line spec	P&ID - 03			
HV - 315	V-4251	Ball	$KMnO_4$ Soln	1/2"		PVC	per line spec	per line spec	P&ID - 03			
HV - 316	V-4251	Ball	$KMnO_4$ Soln	1/2"		PVC	per line spec	per line spec	P&ID - 03			
HV - 317	V-4251	Ball	$KMnO_4$ Soln	1/2"		PVC	per line spec	per line spec	P&ID - 03			
HV - 319	V-4251	Ball	$KMnO_4$ Soln	1/2"		PVC	per line spec	per line spec	P&ID - 03			
PRV - 310A	V-8251	Pressure Relief	$KMnO_4$ Soln	1/2"		PVC	per line spec	per line spec	P&ID - 03			
PRV - 310B	V-8251	Pressure Relief	$KMnO_4$ Soln	1/2"		PVC	per line spec	per line spec	P&ID - 03			
BPV - 310	V-0252	Back Pressure	$KMnO_4$ Soln	1/2"		PVC	per line spec	per line spec	P&ID - 03			
HV - 320	V-1231	Gate	Lime Slurry	1"		Steel (Victaulic)	per line spec	per line spec	P&ID - 03			
HV - 321	V-1231	Gate	Lime Slurry	1"		Steel (Victaulic)	per line spec	per line spec	P&ID - 03			
HV - 322	V-1231	Gate	Lime Slurry	1"		Steel (Victaulic)	per line spec	per line spec	P&ID - 03			
HV - 328	V-1231	Gate	Lime Slurry	1"		Steel (Victaulic)	per line spec	per line spec	P&ID - 03			
HV - 329	V-1231	Gate	Lime Slurry	1"		Steel (Victaulic)	per line spec	per line spec	P&ID - 03			
HV - 331	V-4251	Ball	Polymer	1/2"		PVC	per line spec	per line spec	P&ID - 03			

VALVE LIST

PROJECT: SE10160010.4102

AREA:

Valve Tag #	Spec. #	Valve Type	Process Fluid	Size in.	Valve Rating	Valve Body Mat.	Design Temp. °F	Design Pressure psi	Drawing #	Remarks	Purchase Order Number	REV
HV - 334	V-4251	Ball	Polymer	1/2"		PVC	per line spec	per line spec	P&ID - 03			
HV - 335	V-4251	Ball	Polymer	1/2"		PVC	per line spec	per line spec	P&ID - 03			
HV - 336	V-4251	Ball	Polymer	1/2"		PVC	per line spec	per line spec	P&ID - 03			
HV - 337	V-4251	Ball	Polymer	1/2"		PVC	per line spec	per line spec	P&ID - 03			
HV - 338	V-4251	Ball	Polymer	1/2"		PVC	per line spec	per line spec	P&ID - 03			
HV - 339	V-4251	Ball	Polymer	1/2"		PVC	per line spec	per line spec	P&ID - 03			
PRV - 330A	V-8251	Pressure Relief	Polymer	1/2"		PVC	per line spec	per line spec	P&ID - 03			
PRV - 330B	V-8251	Pressure Relief	Polymer	1/2"		PVC	per line spec	per line spec	P&ID - 03			
BPV - 330A	V-0252	Back Pressure	Polymer	1/2"		PVC	per line spec	per line spec	P&ID - 03			
BPV - 330B	V-0252	Back Pressure	Polymer	1/2"		PVC	per line spec	per line spec	P&ID - 03			
HV - 380	V-1231	Gate	Lime Slurry	3"		Steel (Victaulic)	per line spec	per line spec	P&ID - 03			
HV - 381	V-1231	Gate	Lime Slurry	1/2"		Steel (Victaulic)	per line spec	per line spec	P&ID - 03			
HV - 382	V-1231	Gate	Lime Slurry	1/2"		Steel (Victaulic)	per line spec	per line spec	P&ID - 03			
HV- 399	V-1251	Gate	Water	4"		PVC	per line spec	per line spec	P&ID - 03			
HV-395	V-1251	Gate	Water	1"		Galv.	per line spec	per line spec	P&ID - 03			
HV - 411		Ball	H_2SO_4	1/2"			per line spec	per line spec	P&ID - 04			
HV - 412		Ball	H_2SO_4	1/2"			per line spec	per line spec	P&ID - 04			
HV - 414		Ball	H_2SO_4	1/2"			per line spec	per line spec	P&ID - 04			
HV - 415		Ball	H_2SO_4	1/2"			per line spec	per line spec	P&ID - 04			
HV - 416		Ball	H_2SO_4	1/2"			per line spec	per line spec	P&ID - 04			
HV - 417		Ball	H_2SO_4	1/2"			per line spec	per line spec	P&ID - 04			
HV - 419		Ball	H_2SO_4	1/2"			per line spec	per line spec	P&ID - 04			
PRV - 410A		Pressure Relief	H_2SO_4	1/2"			per line spec	per line spec	P&ID - 04			
PRV - 410B		Pressure Relief	H_2SO_4	1/2"			per line spec	per line spec	P&ID - 04			
BPV - 410		Back Pressure	H_2SO_4	1/2"			per line spec	per line spec	P&ID - 04			
HV - 421	V-1251	Gate	Water	2"		PVC	per line spec	per line spec	P&ID - 04			

VALVE LIST

PROJECT: SE10160010.4102

AREA:

Valve Tag #	Spec. #	Valve Type	Process Fluid	Size in.	Valve Rating	Valve Body Mat.	Design Temp. °F	Design Pressure psi	Drawing #	Remarks	Purchase Order Number	REV
HV - 422	V-1251	Gate	Water	2"		PVC	per line spec	per line spec	P&ID - 04			
HV - 423	V-1251	Gate	Water	2"		PVC	per line spec	per line spec	P&ID - 04			
HV - 424	V-1251	Gate	Water	2"		PVC	per line spec	per line spec	P&ID - 04			
HV - 429	V-0231	Pinch	Water	2"		Steel	per line spec	per line spec	P&ID - 04			
PRV - 430A	vendor supplied	Pressure Relief	Water	vendor supplied					P&ID - 04			
PRV - 430B	vendor supplied	Pressure Relief	Water	vendor supplied					P&ID - 04			
HV - 431A	V-1251	Gate	Water	2"		PVC	per line spec	per line spec	P&ID - 04			
HV - 431B	V-1251	Gate	Water	2"		PVC	per line spec	per line spec	P&ID - 04			
HV - 433A		Ball	Water	1/2"		SS	per line spec	per line spec	P&ID - 04			
HV - 433B		Ball	Water	1/2"		SS	per line spec	per line spec	P&ID - 04			
HV - 434A		Ball	Water	1/2"		SS	per line spec	per line spec	P&ID - 04			
HV - 434B		Ball	Water	1/2"		SS	per line spec	per line spec	P&ID - 04			
HV - 432A	V-1251	Gate	Water	2"		PVC	per line spec	per line spec	P&ID - 04			
HV - 432B	V-1251	Gate	Water	2"		PVC	per line spec	per line spec	P&ID - 04			
PRV - 440A	vendor supplied	Pressure Relief	Water	vendor supplied					P&ID - 04			
PRV - 440B	vendor supplied	Pressure Relief	Water	vendor supplied					P&ID - 04			
HV - 441A	V-1251	Gate	Water	2"		PVC	per line spec	per line spec	P&ID - 04			
HV - 441B	V-1251	Gate	Water	2"		PVC	per line spec	per line spec	P&ID - 04			
HV - 442A	V-1251	Gate	Water	2"		PVC	per line spec	per line spec	P&ID - 04			
HV - 442B	V-1251	Gate	Water	2"		PVC	per line spec	per line spec	P&ID - 04			
HV - 443A	V-1251	Gate	Water	2"		PVC	per line spec	per line spec	P&ID - 04			
HV - 443B	V-1251	Gate	Water	2"		PVC	per line spec	per line spec	P&ID - 04			
HV - 444A		Ball	Water	1/2"		SS	per line spec	per line spec	P&ID - 04			
HV - 444B		Ball	Water	1/2"		SS	per line spec	per line spec	P&ID - 04			
HV - 445A		Ball	Water	1/2"		SS	per line spec	per line spec	P&ID - 04			
HV - 445B		Ball	Water	1/2"		SS	per line spec	per line spec	P&ID - 04			

VALVE LIST

PROJECT: SE10160010.4102

AREA:

Valve Tag #	Spec. #	Valve Type	Process Fluid	Size in.	Valve Rating	Valve Body Mat.	Design Temp. °F	Design Pressure psi	Drawing #	Remarks	Purchase Order Number	REV
HV - 446A	V-1251	Gate	Water	2"		PVC	per line spec	per line spec	P&ID - 04			
HV - 446B	V-1251	Gate	Water	2"		PVC	per line spec	per line spec	P&ID - 04			
HV - 449A	V-1251	Gate	Water	2"		PVC	per line spec	per line spec	P&ID - 04			
HV - 449B	V-1251	Gate	Water	2"		PVC	per line spec	per line spec	P&ID - 04			
HV - 490	V-4251	Ball	Water	1"		PVC	per line spec	per line spec	P&ID - 04			
HV - 491	V-4251	Ball	Water	1"		PVC	per line spec	per line spec	P&ID - 04			
HV - 498	V-1251	Gate	Water	2"		PVC	per line spec	per line spec	P&ID - 04			
HV - 499	V-1251	Gate	Water	2"		PVC	per line spec	per line spec	P&ID - 04			
CHK-499		TideFlex	Water	3"		HDPE	per line spec	per line spec	P&ID - 04			
HV - 510-01	V-4251	Ball	Water	1"		PVC	per line spec	per line spec	P&ID - 05			
CHK - 510-01	V-3251	Swing Check	Water	1"		PVC	per line spec	per line spec	P&ID - 05			
BPV - 510-01	V-0252	Back Pressure	Water	1"		PVC	per line spec	per line spec	P&ID - 05			
HV-515-01	V-4251	Ball	Water	1/2"		PVC	per line spec	per line spec	P&ID - 05			
HV - 510-02	V-4251	Ball	Water	1-1/2"		PVC	per line spec	per line spec	P&ID - 05			
CHK - 510-02	V-3251	Swing Check	Water	1-1/2"		PVC	per line spec	per line spec	P&ID - 05			
BPV - 510-02	V-0252	Back Pressure	Water	1-1/2"		PVC	per line spec	per line spec	P&ID - 05			
HV-515-02	V-4251	Ball	Water	1/2"		PVC	per line spec	per line spec	P&ID - 05			
HV - 510-03	V-4251	Ball	Water	1"		PVC	per line spec	per line spec	P&ID - 05			
CHK - 510-03	V-3251	Swing Check	Water	1"		PVC	per line spec	per line spec	P&ID - 05			
BPV - 510-03	V-0252	Back Pressure	Water	1"		PVC	per line spec	per line spec	P&ID - 05			
HV-515-03	V-4251	Ball	Water	1/2"		PVC	per line spec	per line spec	P&ID - 05			
HV - 510-04	V-4251	Ball	Water	1"		PVC	per line spec	per line spec	P&ID - 05			
CHK - 510-04	V-3251	Swing Check	Water	1"		PVC	per line spec	per line spec	P&ID - 05			
BPV - 510-04	V-0252	Back Pressure	Water	1"		PVC	per line spec	per line spec	P&ID - 05			
HV-515-04	V-4251	Ball	Water	1/2"		PVC	per line spec	per line spec	P&ID - 05			
HV - 510-05	V-4251	Ball	Water	1"		PVC	per line spec	per line spec	P&ID - 05			

VALVE LIST

PROJECT: SE10160010.4102

AREA:

Valve Tag #	Spec. #	Valve Type	Process Fluid	Size in.	Valve Rating	Valve Body Mat.	Design Temp. °F	Design Pressure psi	Drawing #	Remarks	Purchase Order Number	REV
CHK - 510-05	V-3251	Swing Check	Water	1"		PVC	per line spec	per line spec	P&ID - 05			
BPV - 510-05	V-0252	Back Pressure	Water	1"		PVC	per line spec	per line spec	P&ID - 05			
HV-515-05	V-4251	Ball	Water	1/2"		PVC	per line spec	per line spec	P&ID - 05			
HV - 510-06	V-4251	Ball	Water	1"		PVC	per line spec	per line spec	P&ID - 05			
CHK - 510-06	V-3251	Swing Check	Water	1"		PVC	per line spec	per line spec	P&ID - 05			
BPV - 510-06	V-0252	Back Pressure	Water	1"		PVC	per line spec	per line spec	P&ID - 05			
HV-515-06	V-4251	Ball	Water	1/2"		PVC	per line spec	per line spec	P&ID - 05			
HV - 510-07	V-4251	Ball	Water	1-1/2"		PVC	per line spec	per line spec	P&ID - 05			
CHK - 510-07	V-3251	Swing Check	Water	1-1/2"		PVC	per line spec	per line spec	P&ID - 05			
BPV - 510-07	V-0252	Back Pressure	Water	1-1/2"		PVC	per line spec	per line spec	P&ID - 05			
HV-515-07	V-4251	Ball	Water	1/2"		PVC	per line spec	per line spec	P&ID - 05			
HV - 510-08	V-4251	Ball	Water	1"		PVC	per line spec	per line spec	P&ID - 05			
CHK - 510-08	V-3251	Swing Check	Water	1"		PVC	per line spec	per line spec	P&ID - 05			
BPV - 510-08	V-0252	Back Pressure	Water	1"		PVC	per line spec	per line spec	P&ID - 05			
HV-515-08	V-4251	Ball	Water	1/2"		PVC	per line spec	per line spec	P&ID - 05			
HV - 510-09	V-4251	Ball	Water	1-1/2"		PVC	per line spec	per line spec	P&ID - 05			
CHK - 510-09	V-3251	Swing Check	Water	1-1/2"		PVC	per line spec	per line spec	P&ID - 05			
BPV - 510-09	V-0252	Back Pressure	Water	1-1/2"		PVC	per line spec	per line spec	P&ID - 05			
HV-515-09	V-4251	Ball	Water	1/2"		PVC	per line spec	per line spec	P&ID - 05			
HV - 510-10	V-4251	Ball	Water	1"		PVC	per line spec	per line spec	P&ID - 05			
CHK - 510-10	V-3251	Swing Check	Water	1"		PVC	per line spec	per line spec	P&ID - 05			
BPV - 510-10	V-0252	Back Pressure	Water	1"		PVC	per line spec	per line spec	P&ID - 05			
HV-515-10	V-4251	Ball	Water	1/2"		PVC	per line spec	per line spec	P&ID - 05			
HV - 510-11	V-4251	Ball	Water	1"		PVC	per line spec	per line spec	P&ID - 05			
CHK - 510-11	V-3251	Swing Check	Water	1"		PVC	per line spec	per line spec	P&ID - 05			
BPV - 510-11	V-0252	Back Pressure	Water	1"		PVC	per line spec	per line spec	P&ID - 05			

VALVE LIST

PROJECT: SE10160010.4102

AREA:

Valve Tag #	Spec. #	Valve Type	Process Fluid	Size in.	Valve Rating	Valve Body Mat.	Design Temp. °F	Design Pressure psi	Drawing #	Remarks	Purchase Order Number	REV
HV-515-11	V-4251	Ball	Water	1/2"		PVC	per line spec	per line spec	P&ID - 05			
HV - 520-12	V-4251	Ball	Water	1"		PVC	per line spec	per line spec	P&ID - 05			
CHK - 520-12	V-3251	Swing Check	Water	1"		PVC	per line spec	per line spec	P&ID - 05			
BPV - 520-12	V-0252	Back Pressure	Water	1"		PVC	per line spec	per line spec	P&ID - 05			
HV-525-12	V-4251	Ball	Water	1/2"		PVC	per line spec	per line spec	P&ID - 05			
HV - 520-13	V-4251	Ball	Water	1"		PVC	per line spec	per line spec	P&ID - 05			
CHK - 520-13	V-3251	Swing Check	Water	1"		PVC	per line spec	per line spec	P&ID - 05			
BPV - 520-13	V-0252	Back Pressure	Water	1"		PVC	per line spec	per line spec	P&ID - 05			
HV-525-13	V-4251	Ball	Water	1/2"		PVC	per line spec	per line spec	P&ID - 05			
HV - 520-14	V-4251	Ball	Water	1"		PVC	per line spec	per line spec	P&ID - 05			
CHK - 520-14	V-3251	Swing Check	Water	1"		PVC	per line spec	per line spec	P&ID - 05			
BPV - 520-14	V-0252	Back Pressure	Water	1"		PVC	per line spec	per line spec	P&ID - 05			
HV-525-14	V-4251	Ball	Water	1/2"		PVC	per line spec	per line spec	P&ID - 05			
HV - 520-15	V-4251	Ball	Water	1"		PVC	per line spec	per line spec	P&ID - 05			
CHK - 520-15	V-3251	Swing Check	Water	1"		PVC	per line spec	per line spec	P&ID - 05			
BPV - 520-15	V-0252	Back Pressure	Water	1"		PVC	per line spec	per line spec	P&ID - 05			
HV-525-15	V-4251	Ball	Water	1/2"		PVC	per line spec	per line spec	P&ID - 05			
HV - 520-16	V-4251	Ball	Water	1"		PVC	per line spec	per line spec	P&ID - 05			
CHK - 520-16	V-3251	Swing Check	Water	1"		PVC	per line spec	per line spec	P&ID - 05			
BPV - 520-16	V-0252	Back Pressure	Water	1"		PVC	per line spec	per line spec	P&ID - 05			
HV-525-16	V-4251	Ball	Water	1/2"		PVC	per line spec	per line spec	P&ID - 05			
HV - 520-17	V-4251	Ball	Water	1"		PVC	per line spec	per line spec	P&ID - 05			
CHK - 520-17	V-3251	Swing Check	Water	1"		PVC	per line spec	per line spec	P&ID - 05			
BPV - 520-17	V-0252	Back Pressure	Water	1"		PVC	per line spec	per line spec	P&ID - 05			
HV-525-17	V-4251	Ball	Water	1/2"		PVC	per line spec	per line spec	P&ID - 05			
HV - 520-18	V-4251	Ball	Water	1"		PVC	per line spec	per line spec	P&ID - 05			

VALVE LIST

PROJECT: SE10160010.4102

AREA:

Valve Tag #	Spec. #	Valve Type	Process Fluid	Size in.	Valve Rating	Valve Body Mat.	Design Temp. °F	Design Pressure psi	Drawing #	Remarks	Purchase Order Number	REV
CHK - 520-18	V-3251	Swing Check	Water	1"		PVC	per line spec	per line spec	P&ID - 05			
BPV - 520-18	V-0252	Back Pressure	Water	1"		PVC	per line spec	per line spec	P&ID - 05			
HV-525-18	V-4251	Ball	Water	1/2"		PVC	per line spec	per line spec	P&ID - 05			
HV - 520-19	V-4251	Ball	Water	1"		PVC	per line spec	per line spec	P&ID - 05			
CHK - 520-19	V-3251	Swing Check	Water	1"		PVC	per line spec	per line spec	P&ID - 05			
BPV - 520-19	V-0252	Back Pressure	Water	1"		PVC	per line spec	per line spec	P&ID - 05			
HV-525-19	V-4251	Ball	Water	1/2"		PVC	per line spec	per line spec	P&ID - 05			
HV - 520-20	V-4251	Ball	Water	1"		PVC	per line spec	per line spec	P&ID - 05			
CHK - 520-20	V-3251	Swing Check	Water	1"		PVC	per line spec	per line spec	P&ID - 05			
BPV - 520-20	V-0252	Back Pressure	Water	1"		PVC	per line spec	per line spec	P&ID - 05			
HV-525-20	V-4251	Ball	Water	1/2"		PVC	per line spec	per line spec	P&ID - 05			
HV - 520-21	V-4251	Ball	Water	1"		PVC	per line spec	per line spec	P&ID - 05			
CHK - 520-21	V-3251	Swing Check	Water	1"		PVC	per line spec	per line spec	P&ID - 05			
BPV - 520-21	V-0252	Back Pressure	Water	1"		PVC	per line spec	per line spec	P&ID - 05			
HV-525-21	V-4251	Ball	Water	1/2"		PVC	per line spec	per line spec	P&ID - 05			
	V-0253	Air/Vacuum Release	Water	2"		PVC	per line spec	per line spec		Typical of 3 air/vacuum valves (sides of ag. ditch and high point in East Landfill line)		
	V-0253	Air/Vacuum Release	Water	1-1/2"		PVC	per line spec	per line spec		High point of West Landfill line		

VALVE STANDARD (Imperial)

TYPE: Solenoid
Stainless Steel
SERVICE: Compressed Air

VALVE. NO.: **V-0211**
REV. NO.: 0
PROJECT NO.: **SE10160010.4102**

IMPERIAL PRESSURE/TEMPERATURE RATING				METRIC PRESSURE/TEMPERATURE RATING			
150	psig at	100	°F		kPa(g)		°C
	psig at		°F		kPa(g)		°C
	psig at		°F		kPa(g)		°C
	psig at		°F		kPa(g)		°C

END CONNECTION: Threaded
BONNET:
OPERATOR:
STEM: Stainless Steel
BODY: Stainless Steel
SEAT:

SEALS: PTFE
PLUG: Stainless Steel
BALL: --
DISC: PTFE
PACKING: --
POWER: 24V DC

SIZE																		
A																		
B																		
C																		
D																		

Dimensions are composite and for approximate clearance only. For construction, use manufacturer's catalogue or drawing.

CODES / REGULATIONS / NOTES:

1. The solenoid shall be capable of functioning in an ambient temperature ranging from 10°C to 35°C.
2. Minimum protection acceptable shall be NEMA 4X.

All staff members are responsible for ensuring that they are using the correct revision of this document.

OWNER APPROVAL:	DATE: April 20, 2011	DOC. NO.:

VALVE STANDARD (Imperial)

TYPE: Pinch
Carbon Steel
SERVICE: Water / Lime / Sludge

VALVE. NO.: **V-0231**
REV. NO.: 0
PROJECT NO.: **SE10160010.4102**

IMPERIAL PRESSURE/TEMPERATURE RATING				METRIC PRESSURE/TEMPERATURE RATING			
150	psig at	100	° F		kPa(g)		° C
	psig at		° F		kPa(g)		° C
	psig at		° F		kPa(g)		° C
	psig at		° F		kPa(g)		° C

END CONNECTION: Flanged or Victaulic
BONNET: Bolted
OPERATOR: Wheel
STEM: Carbon Steel
BODY: Carbon Steel
SEAT: Carbon Steel

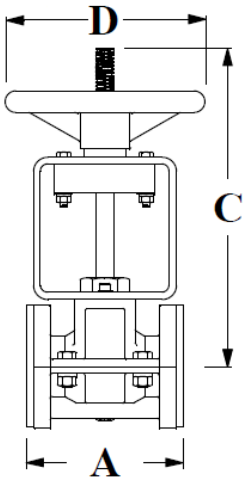
SEALS: Viton
PLUG: --
BALL: --
DISC: --
PACKING: --

SIZE	$^{1}/_{2}$	$^{3}/_{4}$	1	$1^{1}/_{2}$	2	$2^{1}/_{2}$	3											
A	$4^{1}/_{4}$	$5^{1}/_{2}$	$5^{1}/_{2}$	$6^{1}/_{2}$	7	$7^{1}/_{2}$	12											
B																		
C	$6^{7}/_{8}$	7	$9^{5}/_{8}$	10	$10^{5}/_{16}$	$13^{11}/_{16}$	14											
D	6	6	7	7	7	8	8											

Dimensions are composite and for approximate clearance only. For construction, use manufacturer's catalogue or drawing.

CODES / REGULATIONS / NOTES:

1. All specifications and standards shall conform to the latest edition



All staff members are responsible for ensuring that they are using the correct revision of this document.

OWNER APPROVAL:	DATE:	DOC. NO.:
	April 20, 2011	

VALVE STANDARD (Imperial)

TYPE: Solenoid
PVC
SERVICE: Water / Sludge

VALVE. NO.: **V-0251**
REV. NO.: 0
PROJECT NO.: **SE10160010.4102**

IMPERIAL PRESSURE/TEMPERATURE RATING				METRIC PRESSURE/TEMPERATURE RATING	
150	psig at	100	°F	kPa(g)	°C
	psig at		°F	kPa(g)	°C
	psig at		°F	kPa(g)	°C
	psig at		°F	kPa(g)	°C

END CONNECTION: True union socket weld or flange
BONNET:
OPERATOR: Solenoid
STEM: PVC
BODY: PVC
SEAT: EPDM

SEALS: EPDM
PLUG: --
BALL: --
DISC: PVC
PACKING: --
POWER: 24V DC

SIZE	1/4	3/8	1/2	3/4	1	1 1/4	1 1/2	2										
A	3 1/4	3 1/4	3 1/4	3 1/2	5	5	5 1/4	6										
B	6 5/8	6 5/8	8 5/8	8 5/8	10	10 1/16	13 3/4	15 1/2										
C	3 1/2	3 1/2	4	4 3/4	6	6	7	8										
D																		

Dimensions are composite and for approximate clearance only. For construction, use manufacturer's catalogue or drawing.

CODES / REGULATIONS / NOTES:

1. The solenoid shall be capable of functioning in an ambient temperature ranging from 10°C to 35°C.
2. Minimum protection acceptable shall be NEMA 4X.

All staff members are responsible for ensuring that they are using the correct revision of this document.

OWNER APPROVAL:	DATE:	DOC. NO.:
	April 20, 2011	

VALVE STANDARD (Imperial)

TYPE: Backpressure Valve
PVC

VALVE. NO.: **V-0252**

SERVICE: Water, KMnO4

REV. NO.: 0

PRESSURE: 30 psig or per vendor recommendation

PROJECT NO.: **SE10160010.4102**

END CONNECTION: True union socket weld or threaded
BONNET:
SPRING:
BODY: PVC
DIAPHRAGM: EPDM

SEAT: EPDM
SCREWED CAP:
DISC: PVC
O Ring EPDM
BOLTS/NUTS

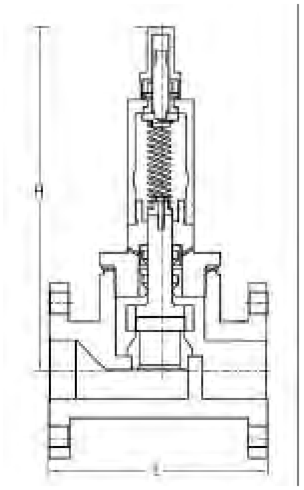
SIZE	$^{1}/_{2}$	$^{3}/_{4}$	1	$1^{1}/_{2}$	2													
L	3.36	3.74	4.33	7.48	7.87													
H	9.30	9.4	9.4	12.7	13.0													

Dimensions are composite and for approximate clearance only. For construction, use manufacturer's catalogue or drawing.

CODES / REGULATIONS / NOTES:

Note:

1. All specifications and standards shall conform to the latest edition.



All staff members are responsible for ensuring that they are using the correct revision of this document.

OWNER APPROVAL:	DATE: April 20, 2011	DOC. NO.:

amec

VALVE STANDARD (Imperial)

TYPE: Air/Vacuum Release
PVC
SERVICE: Water
PRESS.: Vacuum or air pocket

VALVE. NO.: **V-0253**
REV. NO.: 0
PROJECT NO.: **SE10160010.4102**

END CONNECTION: True union socket weld
BONNET: --
SPRING: --
BODY: PVC
DIAPHRAGM: EPDM

SEAT: EPDM
SCREWED CAP:
DISC:
O Ring EPDM
BALL: PVC

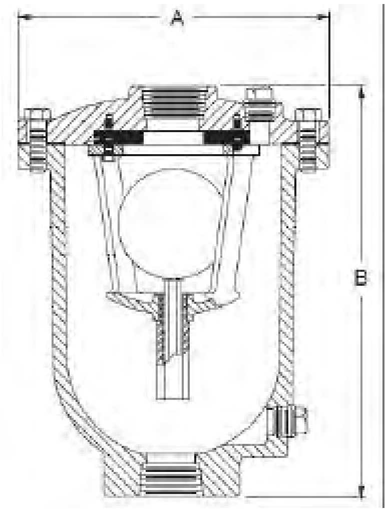
SIZE	$^{1}/_{2}$	1	2															
A	$5^{1}/_{8}$	7	9															
B	$7^{1}/_{16}$	9	12															

Dimensions are composite and for approximate clearance only. For construction, use manufacturer's catalogue or drawing.

CODES / REGULATIONS / NOTES:

Note:

1. The discharge of the safety valve should be directed into a safe location to contain contaminated groundwater.



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OWNER APPROVAL:	DATE: April 20, 2011	DOC. NO.:

amec

VALVE STANDARD (Imperial)

TYPE:	Gate Galv Iron	VALVE. NO.:	**V-1211**
SERVICE:	Air, Water	REV. NO.:	0
CLASS:	125	PROJECT NO.:	**SE10160010.4102**

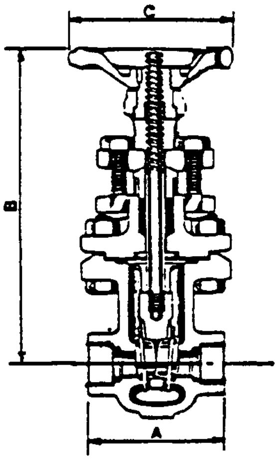
IMPERIAL PRESSURE/TEMPERATURE RATING				METRIC PRESSURE/TEMPERATURE RATING	
200	psig at	-20 to 150	° F	kPa(g)	° C
175	psig at	250	° F	kPa(g)	° C
150	psig at	350	° F	kPa(g)	° C
125	psig at	450	° F	kPa(g)	° C

END CONNECTION:	Threaded	SEALS:	--
BONNET:	Bolted	PLUG:	--
OPERATOR:	Lever handle	BALL:	--
STEM:	Steel	DISC:	Cast Iron
BODY:	Cast Iron	PACKING:	Teflon
SEAT:	Cast Iron		

SIZE	$\frac{1}{4}$	$\frac{3}{8}$	$\frac{1}{2}$	$\frac{3}{4}$	1	$1\frac{1}{4}$	$1\frac{1}{2}$	2	$2\frac{1}{2}$	3	4							
A	$2\frac{7}{8}$	$2\frac{7}{8}$	3	$3\frac{1}{4}$	$3\frac{7}{8}$	$4\frac{1}{8}$	$4\frac{1}{4}$	5	$5\frac{3}{8}$	$5\frac{3}{4}$	$5\frac{5}{8}$							
B	$5\frac{3}{8}$	$5\frac{3}{8}$	$6\frac{9}{16}$	$7\frac{11}{16}$	9	$10\frac{5}{8}$	12	$14\frac{5}{16}$	$17\frac{7}{16}$	$19\frac{13}{16}$	$22\frac{1}{4}$							
C	$2\frac{1}{2}$	$2\frac{1}{2}$	$2\frac{3}{4}$	3	$3\frac{1}{4}$	$4\frac{1}{8}$	$4\frac{1}{8}$	$5\frac{15}{16}$	6	7	$7\frac{1}{2}$							
D																		

Dimensions are composite and for approximate clearance only. For construction, use manufacturer's catalogue or drawing.

CODES / REGULATIONS / NOTES:



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OWNER APPROVAL:	DATE: April 20, 2011	DOC. NO.:

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VALVE STANDARD (Imperial)

TYPE:	Gate Carbon Steel	VALVE. NO.:	**V-1231**
SERVICE:	Water / Lime / Sludge	REV. NO.:	0
		PROJECT NO.:	**SE10160010.4102**

IMPERIAL PRESSURE/TEMPERATURE RATING				METRIC PRESSURE/TEMPERATURE RATING			
150	psig at	100	° F		kPa(g)		° C
	psig at		° F		kPa(g)		° C
	psig at		° F		kPa(g)		° C
	psig at		° F		kPa(g)		° C

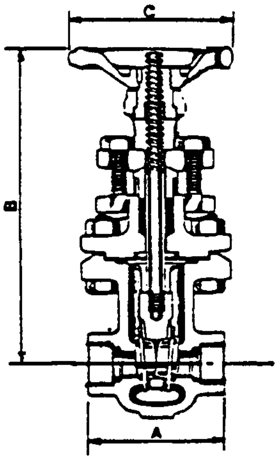
END CONNECTION:	Flanged or Victaulic	SEALS:	Viton
BONNET:	Bolted	PLUG:	--
OPERATOR:	Wheel	BALL:	--
STEM:	Carbon Steel	DISC:	Carbon Steel
BODY:	Carbon Steel	PACKING:	--
SEAT:	Carbon Steel		

SIZE	$^{1}/_{4}$	$^{3}/_{8}$	$^{1}/_{2}$	$^{3}/_{4}$	1	$1^{1}/_{4}$	$1^{1}/_{2}$	2										
A	$2^{1}/_{8}$	$2^{1}/_{8}$	3	$3^{1}/_{2}$	4	$4^{1}/_{2}$	5	$5^{3}/_{4}$										
B	$6^{1}/_{2}$	$6^{1}/_{2}$	$8^{1}/_{4}$	$8^{5}/_{8}$	$9^{7}/_{16}$	$10^{7}/_{8}$	$12^{1}/_{8}$	$14^{1}/_{4}$										
C	3	3	$3^{1}/_{2}$	4	$4^{1}/_{2}$	5	6	7										
D																		

Dimensions are composite and for approximate clearance only. For construction, use manufacturer's catalogue or drawing.

CODES / REGULATIONS / NOTES:

1. All wetted materials shall be compatible with lime (10 °C – 30 °C).
2. All specifications and standards shall conform to the latest edition



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OWNER APPROVAL:	DATE:	DOC. NO.:
	April 20, 2011	

VALVE STANDARD (Imperial)

TYPE:	Check Swing PVC	VALVE. NO.:	**V-3251**
SERVICE:	Water	REV. NO.:	0
		PROJECT NO.:	**SE10160010.4102**

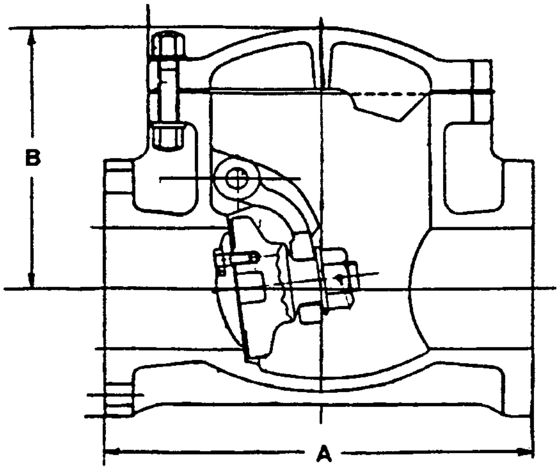
IMPERIAL PRESSURE/TEMPERATURE RATING				METRIC PRESSURE/TEMPERATURE RATING			
150	psig at	100	°F		kPa(g)		°C
	psig at		°F		kPa(g)		°C
	psig at		°F		kPa(g)		°C
	psig at		°F		kPa(g)		°C

END CONNECTION:	True union socket weld	SEALS:	EPDM
BONNET:	--	PLUG:	--
OPERATOR:	--	BALL:	--
STEM:	PVC	DISC:	PVC
BODY:	PVC	PACKING:	--
SEAT:	EPDM		

SIZE	$^3/_4$	1	$1^1/_2$	2	$2^1/_2$	3	4										
A	5.5	6.3	7.1	7.9	9.5	10.3	11.8										
B	3.5	4.7	5.4	6.5	6.6	6.7	8.4										
C																	
D																	

Dimensions are composite and for approximate clearance only. For construction, use manufacturer's catalogue or drawing.

CODES / REGULATIONS / NOTES:



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VALVE STANDARD (Imperial)

TYPE:	Ball PVC	VALVE. NO.:	**V-4251**
SERVICE:	Water, KMnO4	REV. NO.:	0
		PROJECT NO.:	**SE10160010.4102**

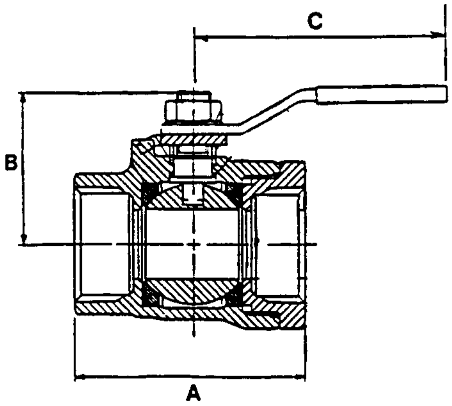
IMPERIAL PRESSURE/TEMPERATURE RATING				METRIC PRESSURE/TEMPERATURE RATING			
150	psig at	100	^{o}F		kPa(g)		^{o}C
	psig at		^{o}F		kPa(g)		^{o}C
	psig at		^{o}F		kPa(g)		^{o}C
	psig at		^{o}F		kPa(g)		^{o}C

END CONNECTION:	True union socket weld	SEALS:	EPDM
BONNET:	--	PLUG:	--
OPERATOR:	Lever	BALL:	PVC
STEM:	PVC	DISC:	--
BODY:	PVC	PACKING:	--
SEAT:	EPDM		

SIZE	$^{1}/_{4}$	$^{3}/_{8}$	$^{1}/_{2}$	$^{3}/_{4}$	1	$1^{1}/_{4}$	$1^{1}/_{2}$	2	3									
A	$2^{7}/_{16}$	$2^{7}/_{16}$	$2^{5}/_{8}$	$2^{15}/_{16}$	$3^{3}/_{8}$	$3^{15}/_{16}$	$4^{1}/_{8}$	$4^{3}/_{4}$	$6^{3}/_{4}$									
B	$1^{5}/_{16}$	$1^{5}/_{16}$	$1^{3}/_{8}$	$1^{3}/_{4}$	$2^{1}/_{16}$	$2^{5}/_{8}$	$2^{5}/_{8}$	$3^{3}/_{16}$	$4^{1}/_{8}$									
C	$3^{13}/_{16}$	$3^{13}/_{16}$	$3^{13}/_{16}$	$3^{13}/_{16}$	$3^{13}/_{16}$	$3^{13}/_{16}$	5	5	--									
D																		

Dimensions are composite and for approximate clearance only. For construction, use manufacturer's catalogue or drawing.

CODES / REGULATIONS / NOTES:



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OWNER APPROVAL:	DATE:	DOC. NO.:
	April 20, 2011	

VALVE STANDARD (Imperial)

TYPE: Pressure Relief Valve
PVC
SERVICE: Water, KMnO4
PRESS.: 135 psig

VALVE. NO.: **V-8251**
REV. NO.: 0
PROJECT NO.: **SE10160010.4102**

END CONNECTION: True union socket weld
BONNET: --
SPRING: --
BODY: PVC
DIAPHRAGM: EPDM

SEAT: EPDM
SCREWED CAP:
DISC:
O Ring EPDM

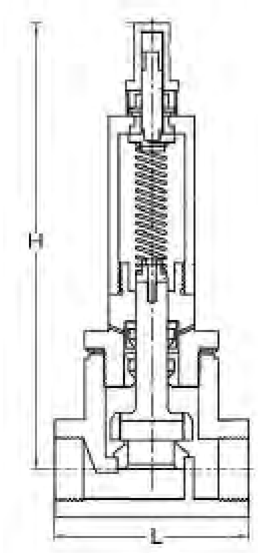
SIZE	$^{1}/_{2}$	$^{3}/_{4}$	1	1$^{1}/_{2}$	2													
L	3.36	3.74	4.33	5.51	7.09													
H	9.30	9.40	9.40	12.70	13.00													

Dimensions are composite and for approximate clearance only. For construction, use manufacturer's catalogue or drawing.

CODES / REGULATIONS / NOTES:

Note:

1. All specifications and standards shall conform to the latest edition
2. Teflon tape is suggested for pipe threads (0.004" thick).
3. The discharge of the safety valve should be directed into a safe location



OWNER APPROVAL:	DATE: April 20, 2011	DOC. NO.:

SECTION 15140
PIPING SUPPORTS AND ANCHORS

PART 1 GENERAL

1.1 WORK INCLUDED

A. This Section covers the work necessary to furnish and install pipe hangers, supports and associated anchors.

B. Items Included:

1. Related specifications.
2. Submittals.
3. Definitions.
4. Acceptable manufacturers and types.
5. Installation.
6. Support spacing and locations.

1.2 RELATED WORK

A. This Section shall be used in conjunction with the following other specifications and related Contract Documents to establish the total requirements for piping supports and anchors.

1. Section 15010 - Basic Mechanical Requirements.
2. NFPA 13 - Standard for the Installation of Sprinkler Systems.
3. NFPA 14 - Standard for the Installation of Standpipe and Hose Systems.
4. Project Drawings.

B. In the event of conflict regarding piping support and anchor requirements between this Section and any other section, the provisions of this Section shall govern.

1.3 SUBMITTALS

A. Submittals shall be provided in accordance with Section 15010 Basic Mechanical Requirements, and the requirements of this Section.

B. Provide hanger and support framing and attachment methods.

C. Provide load capacities for each hanger and support system proposed.

1.4 DEFINITIONS

A. Hot Pipes: Pipe systems with operating temperature greater than 80 degrees F.

PART 2 PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Pipe Hangers and Supports: Grinnell, Elcen or Kin-Line.

B. Pipe Hanger Isolation Shields: Pipe Shields Incorporated or Insul-Shield.

C. Metal Framing Systems: Elcen, Unistrut, or Superstrut.

2.2 GENERAL

A. All hangers, rods, clamps, protective shields, metal framing support components, and hanger accessories shall be electro-galvanized or cadmium-plated unless noted otherwise.

B. Provide oversized hangers for all insulated piping to accommodate pipe shields specified herein.

2.3 PIPE HANGERS AND SUPPORTS

A. Individual hangers for Pipe Sizes 1/2 to 1-1/2 Inch: Malleable iron, adjustable swivel, split ring, Grinnell Figure 104.

B. Individual hangers for Pipe Sizes 2 to 4 Inches: Cold Pipe Sizes 6 Inches and Over: Carbon steel, adjustable, clevis type, Grinnell Figure 260.

C. Individual Hangers for Hot Pipe Sizes 6 Inches and Over: Adjustable steel yoke, cast iron roll, double hanger, Grinnell Figure 181, black only.

D. Multiple or Trapeze Hangers: Steel channels with hanger rods; cast iron roll and stand for hot pipe sizes 6 inches and over, intermediate pipe guides and pipe clamps for all other lines.

E. Intermediate Pipe Guides: For piping 6 inches and smaller shall be Kin-Line Figure 417; Elcen, Figure 655. For piping 8 inches or larger submit proposed intermediate guide for review by the Owner’s Representative.

F. Wall Support for Pipe Sizes to 3 Inches: Steel channel with pipe clamp.

G. Wall Support for Pipe Sizes 4 Inches and Over: Welded steel bracket and wrought steel clamp.

H. Vertical Support: Steel riser clamp. Grinnell Figure 261, and steel channels with pipe clamps.

I. Floor Support for Pipe Sizes to 4 Inches and All Cold Pipe Sizes: Cast iron adjustable pipe saddle, locknut nipple, floor flange, and concrete pier or steel support. Grinnell Figure 264, black only.

J. Floor Support for Hot Pipe Sizes 6 Inches and Over: Adjustable cast iron roll and stand, steel screws, and concrete pier or steel support.

K. Copper Pipe Support: Carbon steel ring, adjustable, copper plated. Grinnell Figure CT-99, CT-65, or plastic coated Grinnell Figure CT-99C.

L. Shield for Insulated Piping 2 Inches and Smaller: 18 gauge galvanized steel shield over insulation in 180 degree segments, minimum 12 inches long at pipe support. Grinnell Figure 167.

M. Shield for Insulated Piping 2-1/2 Inches and Larger (Except Cold Water Piping): Pipe covering protective saddles. Insul-Shield or Pipe Shields, Inc. Model CS and CS-CW pipe shields with waterproof high-density crushproof insulation encased in a galvanized metal cover.

N. Shields for Insulated Cold Water Piping 2-1/2 Inches and Larger: Hard block nonconducting saddles in 90 degree segments, 12 inch minimum length, block thickness same as insulation thickness.

2.4 HANGER RODS

A. Steel Hanger Rods: Threaded both ends, or continuous threaded. Grinnell Figure 140 or 146.

2.5 CONCRETE INSERTS

A. Inserts: Malleable iron nut, carbon steel shell and expander plug for threaded connection with lateral adjustment, top slot for reinforcing rods, lugs for attaching to forms; size inserts to suit threaded hanger rods. Grinnell Figure 281.

2.6 FABRICATION

A. Design hangers without disengagement of supported pipe.

B. Provide copper plated hangers and supports for copper piping. Where copper plating is not available on support components, provide sheet Neoprene or other approved insulating material.

2.7 FINISH

A. Prime coat exposed black steel hangers and supports. Hangers and supports located in crawl spaces, pipe shafts, and suspended ceiling spaces are not considered exposed.

PART 3 EXECUTION

3.1 GENERAL

A. No attempt has been made to show all required pipe supports in all locations, either on the Drawings or in the Details. The absence of pipe supports and details on any Drawing shall not relieve the Contractor of the responsibility for furnishing and installing them as required.

B. Pipe support system components shall withstand with dead loads imposed by the weight of the pipes filled with water and shall have a minimum safety factor of five.

C. All piping shall be supported in a manner which will prevent undue stress on any valve, fitting, or piece of equipment. In addition, pipe supports shall be provided at changes in direction or elevation, adjacent to flexible couplings, and where otherwise shown. Pipe supports and hangers shall not be installed in equipment access areas.

D. Where horizontal piping is arranged with two or more parallel lines, trapeze hangers may be used in lieu of individual hangers. Trapeze assembly shall consist of structure attachments as previously specified with rod size dependent upon the total weight supported, spacing of assemblies determined by the minimum pipe size included in the group supported. Trapeze horizontal shall be a structural angle or channel section of sufficient size to prevent measurable sag between rods, all lines attached to the horizontal with intermediate pipe guides and U-bolts or one-hole clamps. Pre-engineered support equipment may be used when selected and installed in accordance with the manufacturer's recommendations.

E. No copper pipe shall contact a pipe support or hanger of dissimilar metal. Hangers and supports for copper pipe shall be copper-plated, plastic coated, or copper pipe shall be isolated with insulating Neoprene strips, or as approved.

F. No piping shall be supported from the pipe above.

G. Oversized pipe hangers shall be used on all insulated piping to allow insulation to run continuous through the hanger, or to allow clearance for pipe shields. Metallic pipes shall have no contact with hangers, clamps, brackets, or any other pipe support mechanism where sound and vibration control is required on pumped systems.

H. Horizontal piping hanger support rods shall attach to steel beams with center-loading I-clamps, to concrete with inserts or flanges fastened with flush shells, to wood not less than 2-1/2 inch thick with lag screws and angle clips.

I. Provide sufficient pipe support spacing to allow for a 25 percent expansion.

3.2 VIBRATION ISOLATION

A. In accordance with federal and local State of Washington regulations and guidelines.

3.3 INSERTS

A. Provide inserts for suspending hangers from reinforced concrete slabs and sides of reinforced concrete beams.

B. Provide hooked rod to concrete reinforcement section for inserts carrying pipe over 4 inches.

C. Where concrete slabs form finished ceiling, provide inserts flush with slab surface.

D. Where inserts are omitted, drill through concrete slab from below and provide thru-bolt with recessed square steel plate and nut. X-ray locate existing reinforcing rods before drilling.

3.4 PIPE HANGERS AND SUPPORTS

A. Support individual horizontal piping as follows:

Pipe Size	Max. Hanger Spacing	Hanger Diameter
1/2 to 1-1/4 inch	6'-0"	3/8"
1-1/2 to 2 inch	8'-0"	3/8"
2-1/2 to 3 inch	10'-0"	1/2"
4 to 6 inch	10'-0"	5/8"
8 to 12 inch	14'-0"	7/8"
14 inch and Over	20'-0"	1"
C.I. Bell and Spigot (or No-Hub) and at Joints	5'-0"	Same as steel pipe

B. Hanger rod sizing for copper pipe shall be same as for steel pipe. Hanger spacing shall be 2 feet less per size than for steel pipe, with 1 inch and smaller supported every 5 feet.

C. Hanger rod sizing for plastic pipe shall be the same for steel pipe. Spacing of hangers shall be as specified in the applicable Detail Piping Specification.

D. Install hangers to provide a minimum 1/2 inch space between finished covering and adjacent work.

E. Place a hanger within 12 inches of each horizontal elbow, and on both sides of valves weighing 20 pounds or more.

F. Use hangers with 1-1/2 inch minimum vertical adjustment.

G. Support horizontal cast iron pipe adjacent to each hub, with 5 feet maximum spacing between hangers.

H. Support vertical piping at every floor. Support vertical cast iron pipe at each floor at hub.

I. Where several pipes can be installed in parallel and at same elevation, provide multiple or trapeze hangers.

J. Support riser piping independently of connected horizontal piping.

END OF SECTION

DIVISION 16
ELECTRICAL

Section 16015 – Cleaning, Inspection, and Testing of Electrical Equipment
Section 16116 – Underground Ducts and Raceways for Electrical Systems
Section 16118 – Raceway and Boxes for Electrical Systems
Section 16119 – Hangers and Supports for Electrical Systems
Section 16121 – Low-Voltage Electrical Power Conductors and Cables
Section 16122 – Control-Voltage Electrical Power Cables
Section 16195 – Identification for Electrical Systems
Section 16451 – Grounding and Bonding for Electrical Systems
Section 16462 – Low Voltage Transformers
Section 16470 – Panelboards
Section 16481– Low-Voltage Controllers
Section 16482 – PLC Control Panel

SECTION 16015
CLEANING, INSPECTION, AND TESTING OF ELECTRICAL EQUIPMENT

PART 1 GENERAL

1.1 SCOPE

A. The work under this section includes the required cleaning, repair, adjustment, calibration, maintenance and testing of electrical equipment, as specified herein. This applies only to new electrical and existing electrical equipment being furnished, modified, worked on or serviced by this contractor for this project.

1.2 RELATED WORK

A. Applicable provisions of Division 1 govern work under this Section.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION

3.1 GENERAL INSPECTION AND CLEANING OF ALL ELECTRICAL EQUIPMENT

A. Inspect for physical damage and abnormal mechanical and electrical conditions.

B. Any item found to be out of tolerance, or in any other way defective as a result of the required testing, shall be reported to the DSF. Procedure for repair and/or replacement will be outlined. After appropriate corrective action is completed the item shall be re-tested.

C. Compare equipment nameplate information with the latest single line diagram and report any discrepancies.

D. Verify proper auxiliary device operation and indicators.

E. Check tightness of accessible bolted electrical joints. Use torque wrench method.

F. Make a close examination of equipment and remove any shipping brackets, insulation, packing, etc. that may not have been removed during original installation.

G. Make a close examination of equipment and remove any dirt or other forms of debris that may have collected in existing equipment or in new equipment during installation.

H. Clean All Equipment:

1. Vacuum inside of panelboards, switchboards, switchgear, transformer core and coils, horizontal and vertical busducts, MCC's, fire alarm panels, comm/data, security panel, etc.
2. Loosen attached particles and vacuum them away.
3. Wipe all insulators with a clean, dry, lint free rag.
4. Clean insulator grooves.
5. Re-vacuum inside surfaces as directed by the DSF Construction Representative or Inspector

I. Inspect equipment anchorage.

J. Inspect equipment and bus alignment.

K. Check all heater elements for operation and control.

L. Lubricate nonelectrical equipment per manufacturer's recommendations.

3.2 GROUNDING SYSTEMS

A. Inspect the ground system for adequate termination at all devices.

3.3 LIGHTNING/SURGE ARRESTERS

A. Inspect for physical damage such as chipped or fractured porcelain. Wipe clean.

B. Perform a ground continuity test to ground system.

C. Verify the proper mounting and adequate clearance.

D. Verify the voltage of the units with system one line diagram. Report any discrepancies.

E. Verify that the electronic surge protection is connected properly and status lights are normal.

3.4 INSTRUMENT TRANSFORMERS

A. Inspect for physical damage.

B. Inspect nameplate information for compatibility with one-line drawings.

C. Verify the transformers' connections with the system requirements.

D. Verify tightness of all bolted connections and assure adequate clearances exist from primary circuits to secondary circuit wiring and to grounds.

E. Verify that all required grounding and shorting connections exist and that those connections have good contact; i.e. sufficient surface area, good cleanliness, and proper pressure.

F. Test the proper operation of transformer withdrawal mechanism and the grounding operation when applicable.

G. Verify proper primary and secondary fuses and required sizes.

3.5 PROTECTIVE RELAYS

A. All relays shall be inspected for physical damage.

B. Inspect cover gaskets and cover glass for presence of foreign material and moisture and then clean.

3.6 METERING AND INSTRUMENTATION

A. Examine all devices for broken parts, damage and wire connection tightness.

B. Meter selector switches shall be inspected for proper application and operation.

3.7 BATTERY SYSTEMS

A. Inspect for physical damage and evidence of corrosion. Clean units.

B. Measure system charging voltage and each individual cell voltage.

C. Measure the electrolyte specific gravity and level.

D. Verify and compare measured values with manufacturer's specifications.

3.8 DRY TYPE TRANSFORMERS

A. Test and adjust the cooling fans, controls and alarm functions.

B. Measure secondary voltage phase-to-phase and phase-to-ground after final energization and prior to loading.

C. Verify and/or connect transformer "XO" to ground, load side of "WYE" systems.

3.9 GROUND FAULT SYSTEMS

A. Inspect for physical damage.

B. Inspect the neutral main bonding connection to assure:

1. Zero sequence system is grounded upstream of sensor.
2. Ground strap systems are grounded downstream from the sensing device.
3. Ground connection is made ahead of the neutral disconnect link.

C. Monitor panels (if present) shall be manually operated for:

1. Trip tests
2. No trip tests
3. Nonautomatic reset

D. Ground fault device circuit nameplate identification shall be verified by device operation.

E. Insure control circuit has disconnectable fuse device with current limiting fuses.

3.10 SWITCHBOARDS (LOW VOLTAGE)

A. Visual and Mechanical Inspection:

1. Inspect for physical, electrical and mechanical conditions. Re-torque all bolted connections.
2. Compare equipment nameplate information with latest single line diagram and report discrepancies.
3. Inspect for proper alignment, anchorage and grounding
4. All doors, panels and sections shall be inspected for paint, dents, scratches, and fit.
5. Inspect cleanliness

B. Clean switchboard enclosure using the following methods:

1. Loosen attached particles and vacuum them away.
2. Wipe all porcelain with a clean, dry, lint-free rag.
3. Clean all insulator grooves.
4. Vacuum inside of switchgear enclosure
5. Lubricate per manufacturer's recommendations.

C. All active components shall be exercised and cleaned where possible.

D. All indicating devices shall be inspected for proper operation.

3.11 CABLES

A. Visual and Mechanical Inspections:

1. Inspect exposed sections for physical damage.

2. Verify cable is supplied and connected in accordance with single line diagram.
3. Inspect for shield grounding, cable support and termination.
4. If cables are terminated through window type C.T.'s make an inspection to verify that neutrals and grounds are properly terminated for normal operation of protective devices.
5. Inspect for visual jacket and insulation condition.
6. Visible cable bends shall be checked against ICEA or manufacturer's minimum allowable bending radii -- 12 times the diameter for tape shielded cables.
7. Inspect for proper fireproofing in common cable areas.
8. There shall be NO tests performed on existing cable without specific direction from the Consulting Engineer.

B. Electrical Tests -- Below 600 Volts:

1. All secondary cables from the substation transformers to the secondary switchboards shall be subjected to insulation tests using a 500 vdc megger.
2. Visually inspect cables, lugs, connectors and all other components for physical damage and proper connections
3. Check all cable connectors for tightness (with a torque wrench) and clearances. Torque test conductor and bus terminations to manufacturer's recommendations.
4. Check for proper grounding resistance at all services and at transformers. Resistance shall be 2 ohms maximum.
5. Above 600 volts:
    a. Above 600 volt testing will be performed under a separate contract.

3.12 PANELBOARDS

A. Torque all the connections per the manufacturers spec. Verify phase wires, color coding, separate neutral and mechanical bonding. Verify circuit breaker operation. Verify the directory.

3.13 LIGHT FIXTURES

A. Check the bonding and proper lamping. Verify that recessed fixtures are installed with hold down clips. Confirm operation of the fixture with the proper switch or sensor.

3.14 BATTERY PACK EMERGENCY LIGHTING

A. Verify the operation per the manufacturers spec and run all of the diagnostic steps. Confirm proper grounding and location.

3.15 UPS SYSTEM

A. Operate and test the system per the manufacturer's spec. Confirm the batteries and liquid level along with the transfer scheme.

3.16 GENERATORS

A. Run the generator through the standard tests as recommended by the manufacturer including the load bank test. Test the automatic start circuits and run the full diagnostic tests. Verify the fuel and the tank. Check for fuel and coolant leaks.

B. Provide full load testing utilizing a portable test bank for four hours continuous, minimum. During the first two hours, step increase the load from 0% to 100% in at least six equal steps. At the end of two hours, continue running test at 100% load. Record the following in 20 minute intervals throughout the four hour test: kilowatts, amperes, voltage, coolant temperature, room temperature, generator frequency (Hz), oil pressure, fuel consumption.

C. After the generator has cooled down from the four hour test, shut it down and then simulate a power failure including operation of the transfer switch, automatic cycle, and automatic shutdown and return to normal.

3.17 AUTOMATIC TRANSFER SWITCHES

A. Coordinate with the generator and the subsequent tests.

3.18 MOTOR STARTERS AND MOTOR CONTROL CENTERS

A. Verify the control circuits. Confirm the fusing and the grounding of the control transformers. Torque all of the connections. Confirm the overload elements and the circuit breakers (fuse) for proper sizing. Verify all grounding. Operate and test each motor starter for proper operation.

END OF SECTION

SECTION 16116
UNDERGROUND DUCTS AND RACEWAYS FOR ELECTRICAL SYSTEMS

PART 1 GENERAL

1.1 SCOPE

A. The work under this section includes underground cast-in-place concrete ductbanks for electrical power and signal distribution.

1.2 SUBMITTALS

A. Indicate material specifications, and provide product data on conduit, spacers, terminators, reinforcing steel and related components.

PART 2 PRODUCTS

2.1 CONDUIT

A. Size: 5” nominal for voltages above 600V, and 4” nominal for 600Vor lower and communication.

B. Material: High density polyethylene (HDPE) rated for electrical use or Rigid polyvinyl chloride (PVC) marked at uniform intervals to indicate the kind of material; type Schedule 40 heavy wall, type EB-20 (TC-6), or type EB-35 (TC-8). Type EB PVC conduit is designed for use only in concrete encased installation.

2.2 ELBOWS

A. Material to match conduit; minimum bend radius of 36 inches (915 mm).

2.3 SPACERS

A. Plastic, to maintain 3” minimum between conduits.

2.4 CONDUIT TERMINATION IN MANHOLES AND BUILDINGS

A. Bell Ends:

1. Manufactured bell ends of appropriate sizes at each end of conduit. When entering a new building or a new manhole a pre-manufactured PVC bell end system (as manufactured by Formex or similar) with conduit seals, provisions for roughing into the concrete and water stops is allowed.

B. Bushings:

1. Steel grounding bushings shall be used on all metal conduit entering a building or manhole.

C. Seals:

1. When entering an existing building or manhole below grade, the concrete shall be core drilled for the appropriate size conduit and seal. The seal shall be a mechanical interlocking assembly of modular rubber links properly sized to fit the pipe and tightened in place, in accordance with the manufacturer’s instruction.

2.5 PLUGS

A. Closure plugs or caps of same material as conduit on empty conduits at building entrances and at terminations in equipment pedestals to prevent the entrance of moisture and gases.

2.6 PULL TAPE

A. Polyester pull tape, ½” width, tensile strength of 1,250 lbs. and sequential footage markings along the entire length of the tape as manufactured by Greenlee, Carlon, Garvin Industries, or Neptco (Muletape). Install pull tape in each empty duct.

2.7 GROUNDING

A. Steel grounding bushings shall be grounded to manhole or junction box ground.

2.8 DRAINAGE ASSEMBLY

A. All ducts shall drain to an open end - preferably a manhole.

2.9 REINFORCING STEEL

A. Provide reinforcing steel the entire length of the duct system, four - #4 bars - one in each corner, minimum, or as shown on the drawings. Tie or dowel the reinforcement steel into the connecting walls of manholes, vaults and buildings, etc. to protect against vertical shearing.

PART 3 EXECUTION

3.1 EXCAVATIONS

A. Excavate trenches for ductbank to adequate width, depth, and proper slope as specified.

B. Install forms on sides of ductbank if trench is not of proper firmness to prevent cave-in.

C. The trench sidewall shall be less than 6 inches from the edge of the conduit being installed. Install forms if needed to limit the trench width.

D. Bottom of trench shall be undisturbed earth. If trench bottom is too low for proper grade, fill to proper level with sand and mechanically compact it.

E. Each excavated section from manhole to manhole and from manhole to building shall be completely excavated and graded before any duct is laid in that section.

3.2 PLACEMENT OF CONDUIT

A. Within five (5) feet of each building wall or manhole wall penetration, install heavy wall galvanized steel conduit within the concrete envelope to provide protection against vertical shearing. This requirement is waived if the reinforcing steel in the ductbank is poured or doweled into the wall to provide protection against vertical shearing.

B. When entering an existing building or manhole, core drill existing walls and waterproof using a mechanical seal of assembled rubber links properly sized for the pipe and tighten in place, in accordance with the manufacturer’s instruction, after the new conduit is installed.

C. Install flush bell ends on duct at manholes and buildings. When entering a new building or a new manhole, a pre-manufacture end bell system (by Formex or similar) with conduit seals is allowed.

D. Install spacers as recommended by conduit manufacturer and requirements stated above, but not to exceed a maximum of 6 ft-0 in. on center for PVC conduit and 8 ft-0 in. on center for steel conduit. Bottom spacers shall rest on 8" X 16" X 2" minimum concrete pads to prevent them from sinking into the ground and reducing the bottom concrete cover. Stagger conduit joints in concrete encasement 6 in. minimum horizontally.

E. Pitch conduit properly for drainage to manhole or pull box and to prevent low pockets or irregular dips between conduit ends. Minimum pitch to be 4 in. per 100 ft.

F. Install not more than one 90 degree bend or equivalent between manholes for primary conduit and two 90 degree bends or equivalent for signal conduit.

G. In ductbanks with both primary and signal conduit, primary conduit shall be straight and the signal conduit shall contain bends as necessary to accommodate the primary duct.

H. Install insulated grounding bushings on steel duct ends.

I. Install pull tape with measurement markings in each empty duct.

J. Install closure plugs or caps on empty conduits at building entrances and at terminations in equipment pedestals to prevent the entrance of moisture and gases.

3.3 PLACEMENT OF REINFORCING BARS

A. Install the bars - one in each corner minimum, overlap the joints 12” and tie into the connecting walls of manholes, vaults, and buildings, etc.

B. At new building and manhole walls, tie duct and manhole reinforcing steel together to provide a permanent connection.

C. At existing building and manhole walls, dowel reinforcement bar into the wall to provide protection against vertical shearing. Use epoxy adhesive to secure the dowels.

3.4 PLACEMENT OF CONCRETE

A. After ducts are in place and before the concrete is poured, the installation shall be inspected by the Engineer. Notify the Construction Representative at least two days before the time of inspection.

B. The CONTRACTOR shall supervise the placement of concrete in the ductbank.

C. Complete entire section of conduit from manhole to manhole or from manhole to building before encasement by concrete.

D. Top of concrete envelopes shall be not less than 24 inches below grade.

E. In placing concrete around the conduit, adjust delivery chute so the fall of the concrete into the trench is minimal.

F. Provide minimum of 3” (76 mm) of concrete cover over conduit at the top, bottom and sides of the duct bank. Provide troweled crowned top on the concrete to prevent water accumulation.

G. Place concrete continuously from manhole to manhole to building without interruption.

H. Extend concrete envelope to finish floor grade or interior wall surface in buildings and finish pad grade at equipment. Maintain moisture seal.

3.5 BACKFILL

A. Install detectable underground warning tape 12" below finish grade over all ductbanks. Tape shall be 2” wide minimum, 5 mil thickness, and contain a foil core. Tape color shall be red and labeled with the words "CAUTION-BURIED ELECTRIC LINE BELOW" as manufactured by Presco or similar.

B. Compact backfill around ductbank.

C. After completion of ductbank installation, return all ground and pavement surfaces to original condition or to condition as indicated on the drawings. This includes all sidewalks, curbs, streets, parking areas, lawns, shrubs, etc.

3.6 ACCESSORY INSTALLATION

A. Pull a mandrel/swab (diameter 1/4 in. smaller than conduit) through each conduit in completed ductbank to insure adequate opening of duct run.

B. Install pull tape in each empty duct.

C. Install closure plugs or caps on empty conduits at building entrances and at terminations in equipment pedestals to prevent the entrance of moisture and gases.

D. Ground all steel bushings to manhole or junction box ground.

3.7 CONSTRUCTION VERIFICATION ITEMS

A. CONTRACTOR is responsible for utilizing the construction verification checklists supplied under specification Section 01 91 01, or 01 91 02 in accordance with the procedures defined for construction verification checklists.

END OF SECTION

SECTION 16118
RACEWAY AND BOXES FOR ELECTRICAL SYSTEMS

PART 1 GENERAL

1.1 SCOPE

A. The work under this section includes conduits, surface raceways, multi-outlet assemblies, auxiliary gutters, wall duct, and boxes for electrical systems including wall and ceiling outlet boxes, floor boxes, and junction boxes.

1.2 RELATED WORK

A. Applicable provisions of Division 16 govern work under this section.

1. Section 16119 – Hangers and Supports for Electrical Systems.

1.3 SUBMITTALS

A. Surface Raceway System - submit product data and catalog sheets for all components.

B. Boxes - provide product data showing configurations, finishes, dimensions, and manufacturer's instructions.

PART 2 PRODUCTS

2.1 RIGID METAL CONDUIT AND FITTINGS

A. Conduit: Heavy wall, galvanized steel, schedule 40, threaded.

B. Fittings and Conduit Bodies: Use all steel threaded fittings and conduit bodies.

2.2 PVC COATED RIGID METAL CONDUIT

A. PVC Externally Coated Conduit: Rigid heavy wall, schedule 40, steel conduit with external 40 mil (0.1 mm) PVC coating. Conduit must be hot dipped galvanized inside and out including threads. The PVC coating bond to the galvanized steel conduit shall be stronger than the tensile strength of the coating itself.

B. Fittings and Conduit Bodies: Threaded type, material to match conduit. PVC coated fittings and couplings shall have specially formed sleeves to tightly seal to conduit PVC coating. The sleeves shall extend beyond the fitting or coupling a distance equal to the pipe outside steel diameter or two inches (50 mm) whichever is greater.

2.3 INTERMEDIATE METAL CONDUIT (IMC) AND FITTINGS

A. Conduit: Galvanized steel, threaded.

B. Fittings and Conduit Bodies: Use all steel threaded fittings and conduit bodies.

2.4 ELECTRICAL METALLIC TUBING (EMT) AND FITTINGS

A. Conduit: Steel, galvanized tubing.

B. Fittings: All steel, set screw, concrete tight. No push-on or indenter types permitted.

C. Conduit Bodies: All steel threaded conduit bodies.

2.5 FLEXIBLE METAL CONDUIT AND FITTINGS

A. Conduit: steel, galvanized, spiral strip.

B. Fittings and Conduit Bodies: All steel, galvanized, or malleable iron (except as allowed in Section 16510).

2.6 LIQUIDTIGHT FLEXIBLE METAL CONDUIT AND FITTINGS

A. Conduit: flexible, steel, galvanized, spiral strip with an outer Liquidtight, nonmetallic, sunlight-resistant jacket.

B. Fittings and Conduit Bodies: ANSI/NEMA FB 1, compression type. There shall be a metallic cover/insert on the end of the conduit inside the connector housing to seal the cut conduit end.

2.7 ELECTRICAL NONMETALLIC TUBING (ENT) AND FITTINGS

A. Conduit: ENT (smurf tube), UL listed and NEC recognized.

B. Fittings: One piece quick connect fittings for 1/2 inch to 1 inch size and schedule 40 cemented fittings for larger size. When installed in concrete, fittings shall be suitable for damp locations and shall be concrete–tight, stub-ups and stub-downs kits shall meet manufacturer’s recommendations.

2.8 RIGID NONMETALLIC CONDUIT AND FITTINGS

A. Conduit: Schedule 40 PVC minimum, Listed, sunlight resistant, rated for 90^0 C conductors.

B. Fittings and Conduit Bodies: NEMA TC 2, Listed.

2.9 CONDUIT SUPPORTS

A. See section 16119.

2.10 AUXILIARY GUTTERS (WIREWAYS)

A. Description: Oil-tight and dust- tight type wireway without knockouts.

B. Size: As required.

C. Finish: Rust inhibiting primer coat with gray enamel finish.

2.11 OUTLET BOXES

A. Sheet Metal Outlet Boxes: galvanized steel, with stamped knockouts.

B. Luminaire and Equipment Supporting Boxes: Rated for weight of equipment supported; include 3/8 inch male fixture studs where required.

C. Concrete Ceiling Boxes: Concrete type.

D. Cast Boxes: Cast ferroalloy, or aluminum type deep type, gasketed cover, threaded hubs.

2.12 PULL AND JUNCTION BOXES

A. Pull boxes and junction boxes shall be minimum 4 inch square (100 mm) by 2 1/8th inches (54 mm) deep for use with 1 inch (25 mm) conduit and smaller. On conduit systems using 1 1/4 inch (31.75 mm) conduit or larger, pull and junction boxes shall be sized per NEC but not less than 4 11/16 inch square (117 mm).

B. For telecommunication, fiber optic, security, and other low voltage cable installations the NEC box size requirements shall apply. All boxes, used on telecommunication, security, other low voltage and fiber optic systems with conduits of 1 1/4" and larger, shall be sized per the NEC conduit requirements. For determining box size, the conduit is the determining factor not the wire size.

C. Sheet Metal Boxes: code gauge galvanized steel, screw covers, flanged and spot welded joints and corners.

D. Sheet Metal Boxes Larger than 12 Inches (300 mm) in any dimension shall have a hinged cover or a chain installed between box and cover.

E. Cast Metal Boxes for Outdoor and Wet Location Installations: Type 4 and Type 6, flat-flanged, surface-mounted junction box, UL listed as raintight.

Galvanized cast iron or aluminum box and cover with ground flange, neoprene gasket, and stainless steel cover screws.

F. Fiberglass or Concrete Handholes with weatherproof cover of non-skid finish shall be used for underground installations.

G. Box extensions and adjacent boxes within 48” of each other are not allowed for the purpose of creating more wire capacity.

H. Junction boxes 6" x 6" or larger size shall be without stamped knock-outs.

I. Wireways shall not be used in lieu of junction boxes.

2.13 GENERAL

A. All steel fittings and conduit bodies shall be galvanized.

B. No cast metal or split-gland type fittings permitted.

C. Mogul-type condulets larger than 2 inch (50 mm) not permitted except as approved or detailed.

D. All condulet covers must be fastened to the condulet body with screws and be of the same manufacture.

E. Wireways, gutters and c-condulets shall not be used in lieu of pull boxes and condulets.

F. All boxes shall be of sufficient size to provide free space for all conductors enclosed in the box and shall comply with NEC requirements.

PART 3 EXECUTION

3.1 CONDUIT SIZING, ARRANGEMENT, AND SUPPORT

A. EMT is permitted to be used in sizes 4" (50 mm) and smaller for power and telecommunication systems. See CONDUIT INSTALLATION SCHEDULE below for other limitations for EMT and other types of conduit.

B. Size power conductor raceways for conductor type installed. Conduit size shall be 1/2 inch (13 mm) minimum except **all homerun conduits shall be ¾”,** or as specified elsewhere. **Caution: Per the NEC, the allowable conductor ampacity is reduced when more than three current-carrying conductors are installed in a raceway. CONTRACTOR must take the NEC ampacity adjustment factors into account when sizing the raceway and wiring system.**

C. Size conduit for all other wiring, including but not limited to data, control, security, fire alarm, telecommunications, signal, video, etc. shall be sized per number of conductors pulled and their cross-section. 40% fill shall be maximum for all new conduit fills.

D. Arrange conduit to maintain headroom and present a neat appearance.

E. Route exposed conduit and conduit above accessible ceilings parallel and perpendicular to walls and adjacent piping.

F. Maintain minimum 6 inch (150 mm) clearance between conduit and piping. Maintain 12 inch (300 mm) clearance between conduit and heat sources such as flues, steam pipes, and heating appliances.

G. Arrange conduit supports to prevent distortion of alignment by wire pulling operations. Fasten conduit using galvanized pipe straps, conduit racks (lay-in adjustable hangers), clevis hangers, or bolted split stamped galvanized hangers.

H. Group conduit in parallel runs where practical and use conduit rack (lay-in adjustable hangers) constructed of steel channel with conduit straps or clamps. Provide space for 25 percent additional conduit.

I. Do not fasten conduit with wire or perforated pipe straps. Before conductors are pulled, remove all wire used for temporary conduit support during construction.

J. Support and fasten metal conduit at a maximum of 8 feet (2.4 m) on center.

K. Supports shall be independent of the installations of other trades, e.g. ceiling support wires, HVAC pipes, other conduits, etc., unless so approved or detailed.

L. Changes in direction shall be made with symmetrical bends, cast steel boxes, stamped metal boxes or cast steel conduit bodies.

M. For indoor conduits, no continuous conduit run shall exceed 100 feet (30 meters) without a junction box.

N. All conduits installed in exposed areas shall be installed with a box offset before entering box.

3.2 CONDUIT INSTALLATION

A. Cut conduit square; de-burr cut ends.

B. Conduit shall not be fastened to the corrugated metal roof deck.

C. Bring conduit to the shoulder of fittings and couplings and fasten securely.

D. Use conduit hubs for fastening conduit to cast boxes. Use sealing locknuts or conduit hubs for fastening conduit to sheet metal boxes in damp or wet locations.

E. All conduit terminations (except for terminations into conduit bodies) shall use conduit hubs, or connectors with one locknut, or shall use double locknuts (one each side of box wall) and insulated bushing. Provide bushings for the ends of all conduit not terminated in box walls. Refer to Section 16451 – Grounding and Bonding for Electrical Systems for grounding bushing requirements.

F. Install no more than the equivalent of three 90 degree bends between boxes.

G. Use hydraulic one-shot conduit bender or factory elbows for bends in conduit larger than 2 inch (50 mm) size unless sweep elbows are required.

H. Conduit shall be bent according to manufacturer’s recommendations. Torches or open flame shall not be used to aid in bend of PVC conduit.

I. Use suitable conduit caps or other approved seals to protect installed conduit against entrance of dirt and moisture.

J. Provide 1/8 inch (3 mm) nylon pull string in empty conduit, except sleeves and nipples.

K. Install expansion-deflection joints where conduit crosses building expansion joints. Note: expansion-deflection joints are not required where conduit crosses building control joints if the control joint does not act as an expansion joint. Install expansion fitting in PVC conduit runs as recommended by the manufacturer.

L. Avoid moisture traps where possible. Where moisture traps are unavoidable, provide junction boxes with drain fittings at conduit low points.

M. Where conduit passes between areas of differing temperatures such as into or out of cool rooms, freezers, unheated and heated spaces, buildings, etc., provide Listed conduit seals to prevent the passage of moisture and water vapor through the conduit.

N. Route conduit through roof openings for piping and ductwork where possible.

O. Conduit is not permitted in any slab topping of two inches (50 mm) or less.

P. Ground and bond conduit under provisions of Section 16451.

Q. Maximum Size Conduit in Slabs Above Grade: 3/4 inch (19 mm). Do not route conduits to cross each other in slabs above grade.

R. PVC conduit shall transition to galvanized rigid metal conduit before it enters a concrete pole base, foundation, wall (where exposed) or up through a concrete floor.

S. Identify conduit under provisions of Section 16195.

T. All conduit installed underground (exterior to building) shall be buried a minimum of 24” below finished grade, whether or not the conduit is concrete encased.

U. PVC conduit shall be cleaned with solvent, and dried before application of glue. The temperature rating of glue/cement shall match weather condition. Apply full even coat of cement/glue to entire area that will be inserted into fitting. The entire installation shall meet manufacturer’s recommendations.

3.3 CONDUIT INSTALLATION SCHEDULE

A. Conduit other than that specified below for specific applications shall not be used.

B. Underground Installations Within Five Feet (1.5 m) of Foundation Wall: Rigid steel conduit.

C. Underground Installations More than Five Feet (1.5 m) From Foundation Wall: Rigid steel conduit. HPDE with approval for use as electrical raceway. Plastic-coated rigid steel conduit. Schedule 40 PVC conduit.

D. Under Slab on Grade Installations: Schedule 40 PVC conduit.

E. Exposed Outdoor Locations: Rigid steel conduit.

F. Concealed in Concrete and Block Walls: Rigid steel conduit. Electrical metallic tubing. Schedule 40 PVC conduit. Electrical Nonmetallic Tubing (ENT).

G. Within Concrete Slab: Rigid steel conduit. Schedule 40 PVC conduit. Electrical Nonmetallic Tubing (ENT).

H. Concealed Dry Interior Locations: Rigid steel conduit. Intermediate metal conduit. Electrical metallic tubing.

I. Exposed Dry Interior Locations: Rigid steel conduit. Intermediate metal conduit. Electrical metallic tubing.

J. Motor and equipment connections: Flexible PVC coated metal conduit (all locations). Minimum length shall be one foot (300 mm); maximum length shall be three feet (900 mm). Conduit must be installed perpendicular to direction of equipment vibration to allow conduit to freely flex.

K. Light fixtures: Direct box or conduit connection for surface mounted and recessed fixtures. Flexible metal conduit from a J-box for recessed lay-in light fixtures. Conduit size shall be 3/8" (10 mm) minimum diameter and six foot (1.8 M) maximum length. Conduit length shall allow movement of fixture for maintenance purposes.

L. Medium Voltage Applications (Interior Locations): Rigid steel conduit.

3.4 SURFACE METAL RACEWAY AND MULTI-OUTLET ASSEMBLY INSTALLATION

A. Use flat-head screws to fasten channel to surfaces every twenty-four (24) inches. Mount plumb and level.

B. Use suitable insulating bushings and inserts at connections to outlets and corner fittings.

C. Maintain grounding continuity between raceway components to provide a continuous grounding path under provisions of Section 16451.

D. Fastener Option: Use clips and straps suitable for the purpose.

3.5 NONMETALLIC SURFACE RACEWAY INSTALLATION

A. Use flat headed screws with appropriate anchors to fasten channel to surfaces secured every twenty-four (24) inches. Mount plumb and level. All surface mounted devices shall be fastened to the wall utilizing flat head screws along with appropriate anchors. No device shall be adhered to the wall surface using two-faced tape or any means other than as described above.

B. Use suitable insulating bushings and inserts at connections to outlets and corner fittings.

C. In areas where the walls cannot be fished, the station cable serving these outlets shall be covered with raceways. No exposed wire shall be permitted within offices, laboratories, and conference rooms or like facilities.

D. The non-metallic raceway shall have a screw applied base. Both the base and cover shall be manufactured of rigid PVC materials.

E. The raceway shall originate from a surface mounted box mounted adjacent to and at the same height as existing electrical boxes in the room, be attached to the wall and terminate above the ceiling.

F. All fittings including, but not limited to, extension boxes, elbows, tees, fixture bodies shall match the color of the raceway.

G. The raceway and all systems devices shall be UL listed and exhibit nonflammable self extinguishing characteristics, tested to specifications of UL94V-0.

H. The raceway and all systems devices shall adhere to the EIA/TIA Category 5e bend radius standard.

3.6 AUXILIARY GUTTERS (WIREWAYS) INSTALLATION

A. Bolt auxiliary gutter to wall using two-piece hangers or steel channels fastened to the wall or in self-supporting structure.

B. Gasket each joint in oil-tight gutter.

C. Mount rain-tight gutter in horizontal position only.

D. Maintain grounding continuity between raceway components to provide a continuous grounding path under provisions of Section 16451.

3.7 COORDINATION OF BOX LOCATIONS

A. Provide electrical boxes as shown on Drawings, and as required for splices, taps, wire pulling, equipment connections, and code compliance.

B. Electrical box locations shown on Contract Drawings are approximate unless dimensioned. Verify location of floor boxes and outlets in offices and work areas prior to rough-in.

C. No outlet, junction, or pull boxes shall be located where it will be obstructed by other equipment, piping, lockers, benches, counters, etc.

D. Boxes shall not be fastened to the metal roof deck.

E. It shall be the CONTRACTOR'S responsibility to study drawings pertaining to other trades, to discuss location of outlets with workmen installing other piping and equipment and to fit all electrical outlets to job conditions.

F. In case of any question or argument over the location of an outlet, the CONTRACTOR shall refer the matter to the Owner’s Representative and install outlet as instructed by the Owner’s Representative.

G. The proper location of each outlet is considered a part of this contract and no additional compensation will be paid to the CONTRACTOR for moving outlets which were improperly located.

H. Locate and install boxes to allow access to them. Where installation is inaccessible, coordinate locations and provide 18 inch (450 mm) by 24 inch (600 mm) access doors.

I. Locate and install to maintain headroom and to present a neat appearance.

J. Install boxes to preserve fire resistance rating of partitions and other elements, using approved materials and methods.

3.8 OUTLET BOX INSTALLATION

A. Do not install boxes back-to-back in walls. Provide minimum 6 inch (150 mm) separation, except provide minimum 24 inch (600 mm) separation in acoustic-rated walls.

B. Power:

1. Recessed (1/4” maximum) outlet boxes in masonry, concrete or tile construction shall be minimum 4 inch square, with device rings. Device covers shall be square-cut except rounded corner plaster rings are allowed in drywall applications. Angle cut plaster rings are not permitted. Coordinate masonry cutting to achieve neat openings for boxes.

C. Low Voltage:

1. Recessed (1/4” maximum) outlet boxes in masonry, concrete or tile construction shall be minimum 4 11/16 inch square, 2-1/8” deep. Device covers shall be square-cut except rounded corner plaster rings are allowed in drywall applications. Angle cut plaster rings are not permitted. Coordinate masonry cutting to achieve neat openings for boxes.

D. Provide knockout closures for unused openings.

E. Support boxes independently of conduit except for cast boxes that are connected to two rigid metal conduits, both supported within 12 inches (300 mm) of box.

F. Use multiple gang boxes where more than one device are mounted together; do not use sectional boxes. Provide non-metallic barriers to separate wiring of different voltage systems.

G. Install boxes in walls without damaging wall insulation.

H. Coordinate mounting heights and locations of outlets mounted above counters, benches, and backsplashes.

I. Ceiling outlets shall be 4 inch square, minimum 2-1/8 inch (54 mm) deep except that concrete boxes and plates will be approved where applicable. Position outlets to locate luminaires as shown on reflected ceiling plans.

J. In inaccessible ceiling areas, position outlets and junction boxes within 6 inches (150 mm) of recessed luminaire, to be accessible through luminaire ceiling opening.

K. Provide recessed outlet boxes in finished areas; secure boxes to interior wall and partition studs, accurately positioning to allow for surface finish thickness. Use stamped steel stud bridges for flush outlets in hollow stud wall, and adjustable steel channel fasteners for flush ceiling outlet boxes.

L. Align wall-mounted outlet boxes for switches, thermostats, and similar devices.

M. Provide cast ferroalloy or aluminum outlet boxes in exterior and wet locations.

N. Surface wall outlets shall be 4 inch (100 mm) square with raised covers for one and two gang requirements. For three gang or larger requirements, use gang boxes with non-overlapping covers.

3.9 PULL AND JUNCTION BOX INSTALLATION

A. Locate pull boxes and junction boxes above accessible ceilings, in unfinished areas or furnish and install DSF approved access panels in non-accessible ceilings where boxes are installed. All boxes are to be readily-accessible.

B. Support pull and junction boxes independent of conduit.

END OF SECTION

SECTION 16119
HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS

PART 1 GENERAL

1.1 SCOPE

A. The work under this sections includes conduit and equipment supports, straps, clamps, steel channel, etc, and fastening hardware for supporting electrical work.

1.2 SUBMITTALS

A. Product Data: Provide data for support channel.

1.3 QUALITY ASSURANCE

A. Support systems shall be adequate for weight of equipment and conduit, including wiring, which they carry.

PART 2 PRODUCTS

2.1 MATERIAL

A. Support Channel: Steel, Galvanized, Enameled or other corrosion resistant.

B. Hardware: Corrosion resistant.

C. Minimum sized threaded rod for supports shall be 3/8” for trapezes and single conduits 1-1/4” and larger, and ¼” for single conduits 1” and smaller.

D. Conduit clamps, straps, supports, etc., shall be steel or malleable iron. One-hole straps shall be heavy duty type. All straps shall have steel or malleable backing plates when rigid steel conduit is installed on the interior or exterior surface of any exterior building wall.

PART 3 EXECUTION

3.1 INSTALLATION

A. Fasten hanger rods, conduit clamps, outlet, junction and pull boxes to building structure using pre-cast insert system, preset inserts, beam clamps, expansion anchors, or spring steel clips (interior metal stud walls only).

B. Use toggle bolts or hollow wall fasteners in hollow masonry, plaster, or gypsum board partitions and walls; expansion anchors or preset inserts in solid masonry walls; self-drilling anchors or expansion anchors on concrete surfaces; sheet metal screws in sheet metal studs and wood screws in wood construction. If nail-in anchors are used, they must be removable type anchors.

C. **Power-actuated fasteners and plastic wall anchors are not permitted.**

D. File and de-bur cut ends of support channel and spray paint with cold galvanized paint to prevent rusting.

E. Do not fasten supports to piping, ductwork, mechanical equipment, cable tray or conduit. Do not fasten to suspended ceiling grid system.

F. Do not drill structural steel members unless approved by Engineer.

G. Fabricate supports from galvanized structural steel or steel channel, rigidly welded or bolted to present a neat appearance. Use hexagon head bolts with spring lock washers under all nuts.

H. In wet locations, mechanical rooms and electrical rooms install free-standing electrical equipment on 3.5 inch (89 mm) concrete pads.

I. Install surface-mounted cabinets and panelboards with minimum of four anchors. Provide steel channel supports to stand cabinet one inch (25 mm) off wall (7/8” Uni-strut or ¾” painted, fire-retardant plywood is acceptable).

J. Bridge studs top and bottom with channels to support flush-mounted cabinets and panelboards in stud walls.

K. Furnish and install all supports as required to fasten all electrical components required for the project, including free standing supports required for those items remotely mounted from the building structure, catwalks, walkways etc.

END OF SECTION

SECTION 16121
LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLE

PART 1 GENERAL

1.1 SCOPE

A. The work under this section includes furnishing and installing required wiring and cabling systems including pulling, terminating and splicing.

1.2 RELATED WORK

A. Applicable provisions of Division 1 and Division 16 govern work under this Section.

   1. Section 16118 – Raceway and Boxes for Electrical Systems.
   2. Section 16195 – Identification for Electrical Systems.

1.3 REFERENCES

A. NFPA 70 - National Electrical Code.

1.4 SUBMITTALS

A. Submit product data: Provide for each cable assembly type.

B. Submit factory test reports: Indicate procedures and values obtained.

C. Submit shop drawings for modular wiring system including layout of distribution devices, branch circuit conduit and cables, circuiting arrangement, and outlet devices.

D. Submit manufacturer's installation instructions. Indicate application conditions and limitations of use stipulated by product testing agency specified under Regulatory Requirements.

1.5 PROJECT CONDITIONS

A. Verify that field measurements are as shown on Drawings.

B. Conductor sizes are based on copper.

C. Wire and cable routing shown on Drawings is approximate unless dimensioned. Route wire and cable as required to meet project conditions.

D. Where wire and cable routing is not shown, and destination only is indicated, determine exact routing and lengths required.

PART 2 PRODUCTS

2.1 GENERAL

A. All wire shall be new, delivered to the site in unbroken cartons and shall be less than one year old out of manufacturer's stock.

B. All conductors shall be copper. Aluminum conductors size #1/0 and larger may be substituted for copper and used for transformer secondary conductors, switchboard feeders, and panelboard feeders.

C. Aluminum conductors shall not be used for serving individual motors, chillers, VFD’s and motor controllers.

D. The following requirements shall be met when aluminum conductors are used:

1. Aluminum alloy conductors shall be compact stranded conductors of a recognized Aluminum Association 8000 Series aluminum alloy conductor material (AA-8000 series alloy).
2. It is the responsibility of the CONTRACTOR to increase the size of the conduit, wire gutter, or enclosure, if necessary, to accommodate the aluminum conductors and meet allowable code requirements.
3. It is the responsibility of the CONTRACTOR to increase the size of the aluminum conductor to match the ampacity of the copper conductor circuit shown on the Drawings.
4. The CONTRACTOR shall submit a feeder schedule to the Engineer for all conductor substitutions indicating the aluminum conductor wire size and the conduit size. The CONTRACTOR shall not begin the installation until written approval is granted by the Engineer.
5. All aluminum conductors shall terminate on a mechanical screw-type connector or mechanical compression-type connector. Connector shall be dual rated (AL7CU or AL9CU) and Listed by UL for use with aluminum and copper conductors, and sized to accept aluminum conductors of the required ampacity. When using compression-type connectors, the lugs shall be marked with wire size, die index, number and location of crimps and shall be suitably color-coded. Using a suitable stripping tool, remove insulation from the required length of the conductor. Wire brush the conductor and apply a Listed joint compound. Tighten or crimp the connection per the connector manufacturer’s recommendation. Wipe off any excess joint compound.
6. When terminating aluminum conductors to aluminum bus, prepare a mechanical screw-type or compression-type connection. Bolts shall be anodized alloy and conform to current ANSI and ASTM chemical and mechanical property limits. Nuts shall be aluminum alloy and conform to current ANSI standards. Washers shall be flat aluminum alloy, Type A plain, standard wide series conforming to current ANSI standards.

Lubricate and tighten the hardware per manufacturer's recommendations.

7. When terminating aluminum conductors to copper bus, prepare a mechanical screw-type or compression-type connection. Bolts shall be plated or galvanized medium carbon steel; heat treated, quenched and tempered equal to current ASTM standard or SAE grade 5. Nuts shall conform to current ANSI standards. Washers shall be steel, Type A plain, standard wide series conforming to current ANSI standards. Belleville conical spring washers shall be of hardened steel, cadmium plated or silicone bronze. Lubricate and tighten the hardware per manufacturer's recommendations.
8. The final tightening torque shall be recorded for all aluminum conductor mechanical screw-type connections and provided in report form, in the completed O&M manuals.
9. The CONTRACTOR shall perform an infrared survey of all aluminum conductor connections after the installation is complete and in normal service. Infrared surveys shall be performed during periods of maximum possible loading with at least 30% of rated load of the equipment being inspected. All connections with elevated temperatures shall be corrected by the CONTRACTOR. The infrared survey results shall be provided in report form, in the completed O&M manuals.
10. No copper-to-aluminum transitions permitted when splicing onto existing copper feeders.

E. Insulation shall have a 600 volt rating.

F. All conductors shall be stranded.

1. Stranded conductors may only be terminated with UL OR ETL Listed type terminations or methods: e.g. stranded conductors may not be wrapped around a terminal screw but must be terminated with a crimp type device or must be terminated in an approved back wired method.

2.2 BUILDING WIRE

A. Description: Single conductor insulated wire.

B. Insulation:

1. Type THHN/THWN-2, XHHW-2 insulation for feeders and branch circuits with copper conductors.
2. Type THHN/THWN-2, XHHW-2 insulation for feeders with aluminum conductors.

2.3 VARIABLE FREQUENCY DRIVE (VFD) WIRE

A. All power wiring from the VFD output to the motor shall be type XHHW-2 insulation, single conductor wire.

2.4 UNDERGROUND WIRE FOR EXTERIOR WORK

A. Description: Stranded single or multiple conductor insulated wire.

B. Insulation: Type XHHW-2 or USE.

C. This wiring shall be used in all underground applications, except when run in a concrete-encased ductbank.

2.5 WIRING CONNECTORS

A. Split Bolt Connectors: Not acceptable.

B. Solderless Pressure Connectors: High copper alloy terminal. May be used only for cable termination to equipment terminals. Not approved for splicing.

C. Twist Type Wire Connectors: Solderless twist type spring connector (wire-nut) with insulating cover for copper wire splices and taps. Use for conductor sizes 10 AWG and smaller. The manufacturer’s wire fill capacity must be followed.

D. All wire connectors used in underground or exterior pull boxes shall be gel filled twist connectors or a connector designed for damp and wet locations. Gel filled twist type connectors can be used for copper conductor sizes 6 AWG and smaller for site lighting applications. The manufacturer’s wire fill capacity must be followed.

E. Mechanical Connectors: Bolted type tin-plated; high conductivity copper alloy; spacer between conductors; beveled cable entrances.

F. Compression (crimp) Connectors: Long barrel; seamless, tin-plated electrolytic copper tubing; internally beveled barrel ends. Connector shall be clearly marked with the wire size and type and proper number and location of crimps. Connector must be installed with a crimper tool listed for use with the manufacturer and type of compression connector.

G. Insulation Piercing Connectors: Molded insulated body, copper teeth, wrench tightened, UL 486B Listed. May be used only for connection of a tap conductor in run and tap type applications when main conductor is 8 AWG and larger.

PART 3 EXECUTION

3.1 GENERAL WIRING METHODS

A. All wire and cable shall be installed in conduit.

B. Do not use wire smaller than 12 AWG for power and lighting circuits.

C. All conductors shall be sized to prevent excessive voltage drop at rated circuit ampacity. As a minimum use 10 AWG conductor for 20 ampere, 120 volt branch circuit home runs longer than 100 feet (30 m), and for 20 ampere, 277 volt branch circuit home runs longer than 200 feet (61 m).

D. Make conductor lengths for parallel conductors equal.

E. Splice only in junction or outlet boxes.

F. No conductor less than 10 AWG shall be installed in exterior underground conduit.

G. Identify ALL low voltage, 600v and lower, wire per section 16195.

H. Neatly train and lace wiring inside boxes, equipment, and panelboards.

3.2 WIRING INSTALLATION IN RACEWAYS

A. Pull all conductors into a raceway at the same time. Use Listed water or silicone based wire pulling lubricant for pulling 4 AWG and larger wires and for other conditions when necessary. Wax based lubricants are not allowed. Pulling lubricant is not required for low friction type products where the cable manufacturer recommends that cables be pulled without lube.

B. Install wire in raceway after interior of building has been physically protected from the weather and all mechanical work likely to injure conductors has been completed.

C. Completely and thoroughly swab raceway system before installing conductors.

D. Place all conductors of a given circuit (this includes phase wires, neutral (if any), and ground conductor) in the same raceway. If parallel phase and/or neutral wires are used, then place an equal number of phase and neutral conductors in same raceway or cable.

E. VFD Installations: Install VFD input wiring and output wiring in separate conduit systems. Do not mix VFD input power and output power, or control wiring in a common raceway.

3.3 WIRING CONNECTIONS AND TERMINATIONS

A. Splice only in accessible junction boxes.

B. Wire splices and taps shall be made firm, and adequate to carry the full current rating of the respective wire without soldering and without perceptible temperature rise.

C. All splices shall be so made that they have an electrical resistance not in excess of two feet (600 mm) of the conductor.

D. Use solderless twist type spring connectors (wire nuts) with insulating covers for wire splices and taps, 10 AWG and smaller.

E. Use mechanical or compression connectors for wire splices and taps, 8 AWG and larger. Tape uninsulated conductors and connectors with electrical tape to 150 percent of the insulation value of conductor.

F. Thoroughly clean wires before installing lugs and connectors.

G. At all splices and terminations, leave tails long enough to cut splice out and completely re-splice.

3.4 FIELD QUALITY CONTROL

A. Field inspection and testing will be performed under provisions of Section 16015.

B. Additional testing as follows shall be performed if aluminum conductors are used:

1. Equipment terminated with aluminum conductors shall be tested with a thermal imager and recorded.
2. Conductors shall be closely checked for loose or poor connections, and for signs of overheating or corrosion.
3. Test procedures shall meet NETA guidelines.
4. Test results and report shall be provided to the Owner’s Representative.
5. CONTRACTOR shall correct all deficiencies reported in the test report.

3.5 WIRE COLOR

A. General:

1. Solid colored insulation is required for all THHN/THWN-2 wire. For other wire types use colored wire or identify wire with colored tape at all terminals, splices and boxes. Wire shall be colored as indicated below.
2. In existing facilities, use existing color scheme.

3. In new facilities, use black and red for single phase circuits at 120/240 volts, use Phase A black, Phase B red and Phase C blue for circuits at 120/208 volts single or three phase, and use Phase A brown, Phase B orange and Phase C yellow for circuits at 277/480 volts single or three phase. Note: This includes fixture whips except for Listed whips mounted by the fixture manufacturer on the fixture and Listed as a System.
4. All switch legs shall be the same color as their associated circuit. Traveler conductors run between 3 and 4 way switches shall be colored pink or purple.

B. Neutral Conductors: White for 120/208V and 120/240V systems, Gray for 277/480V systems. Where there are two or more neutrals in one conduit, each shall be individually identified with a different stripe.

C. Branch Circuit Conductors: Three or four wire home runs shall have each phase uniquely color coded.

D. Feeder Circuit Conductors: Each phase shall be uniquely color coded.

E. Ground Conductors: Green colored insulation for THHN/THWN-2 wire. For other wire types use green colored wire or identify wire with green tape at both ends and at all access points, such as panelboards, motor starters, disconnects and junction boxes. When isolated grounds are required, CONTRACTOR shall provide green with yellow tracer.

3.6 BRANCH CIRCUITS

A. The use of single-phase, multi-wire branch circuits with a common neutral is not permitted. All single-phase branch circuits shall be furnished and installed with an individual accompanying neutral, sized the same as the phase conductors.

3.7 EMERGENCY CIRCUITS

A. All emergency system wiring (level 1 and level 2) shall be installed in separate raceways after their associated transfer switches. The wiring shall be separate from each other and from all normal system wiring.

END OF SECTION

SECTION 16122
CONTROL-VOLTAGE ELECTRICAL POWER CABLES

PART 1 GENERAL

1.1 SCOPE

A. The work under this section includes furnishing and installing required remote control and signal cabling.

1.2 RELATED WORK

A. Applicable provisions of Division 16 govern work under this Section.

1. Section 16118 – Raceway and Boxes for Electrical Systems.
2. Section 16195 – Identification for Electrical Systems.

1.3 REFERENCES

A. NFPA 70 - National Electrical Code.

1.4 SUBMITTALS

A. Submit product data: Provide for each cable assembly type.

B. Submit manufacturer's installation instructions. Indicate application conditions and limitations of use stipulated by product testing agency specified under Regulatory Requirements.

1.5 PROJECT CONDITIONS

A. Verify that field measurements are as shown on Drawings.

B. Conductor sizes are based on copper.

C. Wire and cable routing shown on Drawings is approximate unless dimensioned. Route wire and cable as required to meet Project Conditions.

D. Where wire and cable routing is not shown, and destination only is indicated, determine exact routing and lengths required.

PART 2 PRODUCTS

2.1 GENERAL

A. All wire shall be new, delivered to the site in unbroken cartons and shall be less than one year old out of manufacturer's stock.

B. All conductors shall be copper.

C. Insulation shall have a 600 volt rating.

D. All conductors must be suitable for the application intended. Conductors #12 and smaller may be solid or stranded with the following requirements or exceptions:

1. All conductors terminated with crimp type devices must be stranded.
2. Stranded conductors may only be terminated with UL OR ETL Listed type terminations or methods: e.g. stranded conductors may not be wrapped around a terminal screw but must be terminated with a crimp type device or must be terminated in an approved back wired method.

2.2 REMOTE CONTROL AND SIGNAL CABLE

A. All other systems cabling shall meet the requirements of NEC Article 725 and the following:

1. Control Cable for Class 1 Remote Control and Signal Circuits: 600 volt insulation, individual conductors twisted together, [shielded], and covered with an overall PVC jacket. Cable shall be Listed, temperature rated, and plenum or non-plenum rated for the application as required in the National Electrical Code.
2. Control Cable for Class 2 or Class 3 Remote Control and Signal Circuits shall be constructed, Listed, temperature rated, and plenum or non-plenum rated for the application as required in the NEC Article 725.

2.3 WIRING CONNECTORS

A. Split Bolt Connectors: Not acceptable.

B. Spring Wire Connectors: Solderless spring type pressure connector with insulating covers for copper wire splices and taps. Use for conductor sizes 10 AWG and smaller.

C. All wire connectors used in underground or exterior pull boxes shall be gel filled twist connectors or a connector designed for damp and wet locations.

PART 3 EXECUTION

3.1 GENERAL WIRING METHODS

A. Low voltage control and signal cables shall be installed in conduit. However, they may be installed without conduit above accessible ceilings if the cable meets NEC requirements for the application, unless specified to be in conduit in other sections of the specifications. See requirements for free-air cabling installation below.

B. Control cables for controlling HVAC and lighting equipment connected to emergency power shall be routed in raceway.

C. Do not use wire smaller than 14 AWG for control wiring greater than 60 volts, or 18 AWG for voltages less than 60 volts, all sizes subject to NEC 725 requirements.

D. Splice only in junction boxes.

E. Identify wire per section 16195.

F. Neatly train and lace wiring inside boxes, and equipment.

3.2 WIRING INSTALLATION IN RACEWAYS

A. Pull all conductors into a raceway at the same time. Use Listed wire pulling lubricant for pulling conditions when necessary.

B. Install wire in raceway after interior of building has been physically protected from the weather and all mechanical work likely to injure conductors has been completed.

C. Completely and thoroughly swab raceway system before installing conductors.

3.3 FREE-AIR CABLE INSTALLATION

A. When permitted in exposed ceiling areas, ‘Free-Air’ wiring runs shall avoid areas of high traffic (i.e. aisle way), shall be run as close as possible to outlining walls and shall be a minimum of ten (10) feet above finished floor.

B. Cabling shall be neatly run at right angles and be kept clear of other trades work.

C. Cabling shall be supported at a maximum of 4-foot intervals utilizing ‘bridal-type’ mounting rings anchored to ceiling concrete, piping supports or structural steel beams. If cable sag at mid-span exceeds 12-inches, another support shall be provided. Mounting rings shall be designed to maintain cables bend to larger than the minimum bed radius (typically 4 x cable diameter).

D. Cabling shall not be attached to or supported by existing cabling, plumbing or steam piping, ductwork, suspended ceiling supports or electrical conduit. Additionally, cabling shall not be laid directly on the ceiling grid.

E. To reduce or eliminate Electro-Magnetic Interference (EMI), the following minimum separation distances for ‘Free-Air’ cabling installations shall be adhered to:

1. Twelve (12) inches from power lines of less than 5kV.
2. Thirty-nine (39) inches from power lines of 5kV or greater.
3. Eighteen (18) inches from lighting fixtures.
4. Thirty-nine (39) inches from transformers and motors.

F. A coil of 2 feet in each cable shall be placed in the ceiling at each ‘free-air’ wired device. These coils shall be secured (wire tied) at the last cable support before the cable reaches the device and shall be coiled from 100% to 200% of the cable recommended minimum bend radius.

G. All cable shall be free of tension at both ends. Nylon strain relief connectors shall be provided at each device and junction box where cables enter. In cases where the cable must bear some stress, Kellum type grips may be used to spread the strain over a longer length of cable.

H. Cable manufacturers minimum bend radius shall be observed in all instances. Care should be taken in the use of cable ties to secure and anchor the station cabling. Ties should not be over tightened as to compress the cable jacket. No sharp burrs should remain where excess length of the cable tie has been cut.

I. All exposed vertical cable extensions to devices located below the finished ceiling shall be in conduit.

J. Provide protection for exposed cables where subject to damage.

K. Use suitable cable fittings and connectors.

3.4 WIRING CONNECTIONS AND TERMINATIONS

A. Splice only in accessible junction boxes.

B. All splices shall be so made that they have an electrical resistance not in excess of two feet (600 mm) of the conductor.

C. Use solderless spring type pressure connectors with insulating covers for wire splices and taps, 10 AWG and smaller.

D. Thoroughly clean wires before installing lugs and connectors.

E. At all splices and terminations, leave tails long enough to cut splice out and completely re-splice.

3.5 FIELD QUALITY CONTROL

A. Field inspection and testing will be performed as per NEC and industry best practices.

END OF SECTION

SECTION 16195
IDENTIFICATION FOR ELECTRICAL SYSTEMS

PART 1 GENERAL

1.1 SCOPE

A. The work under this section includes the products and execution requirements relating to labeling of power, lighting, general wiring, signal, fire alarm, and telecommunications wire and cabling. Further, this section includes labeling of all terminations and related sub-systems, including but not limited to nameplates, stenciling, wire and cable marker labeling of all backbone fiber optic (inter-building, tie & riser) cables, terminating equipment and labeling of inner duct (fiber optic).

1.2 RELATED WORK

A. Applicable provisions of Division 16 shall govern work under this section.

1. Section 16121 – Low-Voltage Electrical Power Conductors and Cables
2. Section 16122 – Control-Voltage Electrical Power Cables

1.3 SUBMITTALS

A. Include schedule for nameplates and stenciling.

B. Prior to installation, the CONTRACTOR shall provide samples of all label types planned for the project. These samples shall include examples of the lettering to be used. Samples shall be mounted on 8 1/2” x 11” sheets annotated, explaining their purposed use.

PART 2 PRODUCTS

2.1 MATERIALS

A. Labels: All labels shall be permanent, and machine generated. NO HANDWRITTEN OR NON-PERMANENT LABELS ARE ALLOWED. Exception: back side of device plates and junction boxes may use handwritten, legible labeling on box covers, unless specifically prohibited by other specification sections.

B. Cable label size shall be appropriate for the conductor or cable size(s), outlet faceplate layout and patch panel design. All labels shall be self-laminating, white/transparent vinyl and be wrapped around the cable or sheath. Labels for power conductors (600V and lower) shall be cloth-type. Flag type labels are not allowed. The labels shall be of adequate size to accommodate the circumference of the cable being labeled and properly self-laminate over the full extent of the printed area of the label.

C. Nameplates: Engraved three-layer laminated plastic, black letters on a white background. Emergency system (level 1 and level 2) shall use white letters on red background.

D. Tape (phase identification only): Scotch #35 tape in appropriate colors for system voltage and phase.

E. Adhesive type labels not permitted except for phase and wire identification. Machine generated adhesive labels shall be permitted for device plates, 4-11/16" and smaller junction boxes, Fire alarm and control devices.

PART 3 EXECUTION

3.1 GENERAL

A. Where mixed voltages are used in one building (e.g. 4160 volt, 480 volt, 208 volt) each switch, switchboard, junction box, equipment, etc., on each system must be labeled for voltage in addition to other requirements listed herein.

B. All branch circuit and power panels must be identified with the same symbol used in circuit directory in main distribution center.

C. Clean all surfaces before attaching labels with the label manufacturer's recommended cleaning agent.

D. Install all labels firmly as recommended by the label manufacturer.

E. Labels shall be installed plumb and neatly on all equipment.

F. Install nameplates parallel to equipment lines.

G. Secure nameplates to equipment fronts using screws, rivets or manufacturer approved adhesive or cement.

H. Embossed tape will not be permitted for any application.

3.2 JUNCTION AND PULLBOX IDENTIFICATION

A. The following junction and pullboxes shall be identified utilizing spray painted covers:

System	**Color(s)**
Secondary Power – 480Y/277V	Brown
Secondary Power – 208Y/120V, 240/120V	White
Emergency Power – 480Y/277V	Brown/Red

Emergency Power – 208Y/120V	White/Red
Fire Alarm	Red
Temperature Control	Green
Door Control and Door Monitoring System	Orange
Sound and Intercom Systems	Blue
Video Surveillance System/MATV	Yellow

B. Provide circuit numbers, and source panel designations for power wiring. Other system shall be identified as shown on details or approved shop drawings. Temperature control shall identify the source.

3.3 COMMUNICATIONS SYSTEM IDENTIFICATION AND LABELING

A. Backboard and Equipment Racks:

1. Backboards and equipment racks shall be labeled by the CONTRACTOR identifying the room number. Additionally, equipment racks shall have an alpha character after the room number unique to that particular communications room. For example, Rack 205A would be the first rack in room 205. Character height shall be 1-inch (minimum).

B. Station Cable and Termination Components:

1. Individual labels shall be placed on all Telecommunications Outlets, Data Patch Panels, Voice Termination Blocks, and cables. This is inclusive of each voice, data, video, or fiber optic outlet, or any configuration thereof, as identified on the drawings.
2. Each component shall be clearly labeled using a code identifying each information outlet location throughout the facility. The project documents identify the numbering at each outlet location. Each media type shall be numbered separately. The format of the identifier shall be as follows:
    a. TR-####X
    b. Where: TR = Telecommunication Room identifier serving that location
    c. #### = a sequential number assigned to that port starting at 001
    d. X = an alpha character identifying cable type. V=Voice, D=Data
3. For example: “1A-001D” represents the first data jack served from the Telecommunications Room on the first floor identified as room 1A for that building. A voice outlet at the same location would be labeled as “1A-001V”.

C. Telecommunication Rooms identifiers shall be unique in each building.

D. Telecommunications Outlets are to be labeled 1) on the cover of the assembly and 2) on each cable terminated at that location.

E. All new outlet faceplates shall incorporate recessed label holders and shall be fitted with clear plastic covers. Where no such label holders are present on existing to remain outlets, the faceplate labels shall be protected with a clear over-laminate.

F. Labels shall be White background with Black lettering. Lettering size shall be as large as practicable (up to 16-point) to fit properly on the outlet label. No lettering shall be smaller than 12-point.

G. Copper Data and Fiber Optic Patch Panels shall be labeled identifying Outlet ID. Modular Jacks and/or Fiber Couplers shall be positioned in sequence of Outlet ID. Fiber Panels shall also be labeled with the fiber number. Fibers shall be sequenced in order per the manufacturer's color code.

H. Each Station Cable shall be labeled within 4-inches of the cable end at the Data Patch Panel, 110 blocks, and Information Outlet.

3.4 COMMUNICATION BACKBONE, RISER AND TIE CABLE LABELING

A. All fiber optic backbone and copper (inter-building, riser and tie) cables shall be identified AT BOTH ENDS with a designation that identifies where the opposite end of the same cable terminates (e.g. Equipment Room or Telecommunications Closet I.D.). In addition, labeling of all fiber optic cables shall include the number of fibers in the cable.

B. Each fiber optic termination panel shall be clearly labeled indicating the destination of the cable(s) and the fiber number of each fiber position. The cable identifiers are to be secured to (1) the side and (2) the front cover of the panel enclosure.

3.5 INNERDUCT LABELING

A. All innerduct containing fiber optic cable installed under this project shall be labeled where exposed. This includes areas where the innerduct is (1) installed alone in risers, tunnels or trays, (2) where they transit manholes and/or pull boxes and (3) in equipment rooms.

B. The innerduct shall be labeled with a durable Yellow Polyethylene tag which reads "CAUTION FIBER OPTIC CABLE" and includes blank spaces for adding fiber count and destination information. The destination of the cable(s) contained in the innerduct and the fiber count shall be marked on the tag. Hand lettering is acceptable on this tag, using an indelible type ink.

C. The tag shall be secured to the innerduct(s) using self-locking ties.

D. Innerduct shall be labeled on each floor in a riser installation, in each manhole and/or handhole or at 25-foot intervals in a tunnel or tray installation.

3.6 COMMUNICATION CONDUIT LABELING

A. All conduits installed between Telecommunication Rooms shall be clearly labeled in accordance with ANSI/TIA/EIA-606. Both ends of the conduits shall be labeled. All labels shall be mechanical, no hand written labels. The label shall indicate the location of the far end of the conduit run and a unique conduit number. (i.e. TR-1A-01 or Room #216 – 01).

3.7 POWER AND CONTROL WIRE IDENTIFICATION

A. Provide wire markers on each conductor in panelboard gutters, pull boxes, outlet and junction boxes, and at load connection. Identify with branch circuit or feeder number for power and lighting circuits, and with control wire number as indicated on schematic and interconnection diagrams or equipment manufacturer's shop drawings for control wiring.

B. All wiring shall be labeled within 2 to 4 inches of terminations. Each end of a wire or cable shall be labeled as soon as it is terminated including wiring used for temporary purposes.

3.8 WIRING DEVICE IDENTIFICATION

A. Wall switches, receptacles, occupancy sensors, wall dimmers, device plates and box covers, poke-through fittings, access floor boxes, photocells and time clocks shall be identified with circuit numbers and source. In exposed areas, identifications should be made inside of device covers, unless directed otherwise. Use machine-generated labels, or neatly hand-written permanent marker.

3.9 NAMEPLATE ENGRAVING

A. Provide nameplates of minimum letter height as scheduled below.

B. Panelboards, Switchboards and Motor Control Centers: 1 inch (25 mm); identify equipment designation. 1/2 inch (13 mm); identify voltage rating, source and room location of the source.

C. Equipment Enclosures: 1 inch (25 mm); identify equipment designation.

D. Circuit Breakers, Switches, and Motor Starters in Panelboards or Switchboards or Motor Control Centers: 1/2 inch (13 mm); identify circuit and load served, including location.

E. Individual Circuit Breakers, Disconnect Switches, Enclosed Switches, and Motor Starters: ½ inch (13 mm); identify source and load served.

F. Transformers: 1 inch (25 mm); identify equipment designation. 1/2 inch (13 mm); identify primary and secondary voltages, primary source, and secondary load and location.

G. Junction boxes: 1 inch (25 mm); identify system source(s) and load(s) served. Junction boxes may be neatly identified using a permanent marker.

3.10 PANELBOARD DIRECTORIES

A. Typed directories for panels must be covered with clear plastic, have a metal frame. Room number on directories shall be Owner's numbers, not Plan numbers unless Owner so specifies.

END OF SECTION

SECTION 16451
GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS

PART 1 GENERAL

1.1 SCOPE

A. The work under this section includes grounding electrodes and conductors, equipment grounding conductors, and bonding.

1.2 REFERENCES

A. NFPA 70 - National Electrical Code.

B. ANSI/IEEE 142 (Latest edition) - Recommended Practice for Grounding of Industrial and Commercial Power Systems.

1.3 PERFORMANCE REQUIREMENTS

A. Grounding System Resistance: 2ohms maximum at building service entrance.

B. Testing of grounding system resistance is to be witnessed by the electrical inspector or Field Representative. Provide test report of grounding system resistance in final O&M manuals.

1.4 SUBMITTALS

A. Product Data: Provide data for grounding electrodes and connections.

B. Test Reports: Indicate overall resistance to ground [and resistance of each electrode].

C. Manufacturer's Instructions: Include instructions for preparation, installation and examination of exothermic connectors.

1.5 PROJECT RECORD DOCUMENTS

A. Accurately record actual locations of grounding electrodes.

1.6 REGULATORY REQUIREMENTS

A. Conform to requirements of NFPA 70.

B. Furnish products listed and classified by Underwriters Laboratories, Inc. or testing firm acceptable to authority having jurisdiction as suitable for purpose specified and shown.

PART 2 PRODUCTS

2.1 ROD ELECTRODE

A. Material: Copper-clad steel.

B. Diameter: 3/4 inch (19 mm) minimum.

C. Length: 10 feet (3.5 m) minimum. Rod shall be driven at least 9' 6" deep.

2.2 MECHANICAL CONNECTORS

A. The mechanical connector bodies shall be manufactured from high strength, high conductivity cast copper alloy material. Bolts, nuts, washers and lockwashers shall be made of Silicon Bronze and supplied as a part of the connector body and shall be of the two bolt type.

B. Split bolt connector types are NOT allowed. Exception: the use of split bolts is acceptable for grounding of wire-basket type cable tray, and for cable shields/straps of medium voltage cable.

C. The connectors shall meet or exceed UL 467 and be clearly marked with the catalog number, conductor size and manufacturer.

2.3 COMPRESSION CONNECTORS

A. The compression connectors shall be manufactured from pure wrought copper. The conductivity of this material shall be no less than 99% by IACS standards.

B. Each connector shall be factory filled with an oxide-inhibiting compound.

C. The connectors shall meet or exceed the performance requirements of IEEE 837, latest revision.

D. The connectors shall be clearly marked with the manufacturer, catalog number, conductor size and the required compression tool settings.

E. The installation of the connectors shall be made with a compression tool and die system, as recommended by the manufacturer of the connectors.

F. Pre-crimping of the ground rod is required for all irreversible compression connections to a ground rod.

2.4 EXOTHERMIC CONNECTIONS

A. As manufactured by Cadweld or similar.

2.5 WIRE

A. Material: Stranded copper (aluminum not permitted).

B. Grounding Electrode Conductor: Size as shown on drawings, specifications or as required by NFPA 70, whichever is larger.

C. Foundation Electrodes: As required by applicable codes.

D. Primary Manhole, Main Switchgear room and Vault Bonding: No. 4/0 minimum.

E. Feeder and Branch Circuit Equipment Ground: Size as shown on drawings, specifications or as required by NFPA 70, whichever is larger. Differentiate between the normal ground and the isolated ground when both are used on the same facility.

2.6 BUS

A. Material: Copper (aluminum not permitted).

B. Size: 1/4" X 2" minimum.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify that final backfill and compaction has been completed before driving rod electrodes.

3.2 GENERAL

A. Install Products in accordance with manufacturer's instructions and per codes and references described in part 1.

B. Mechanical connections shall be accessible for inspection and checking. No insulation shall be installed over mechanical ground connections.

C. Ground connection surfaces shall be cleaned and all connections shall be made so that it is impossible to move them.

D. Attach grounds permanently before permanent building service is energized.

E. All grounding electrode conductors and individual grounding conductors shall be installed in PVC conduit, in exposed locations.

3.3 FIELD QUALITY CONTROL

A. Inspect grounding and bonding system conductors and connections for tightness and proper installation.

END OF SECTION

SECTION 16462
LOW VOLTAGE TRANSFORMERS

PART 1 GENERAL

1.1 SCOPE

A. The work under this section includes dry type general purpose two winding transformers meeting the requirements of NEMA TP-1, and dry type isolation transformers.

1.2 REFERENCES

A. NEMA TP-1

1.3 SUBMITTALS

A. Include outline and support point dimensions of enclosures and accessories, unit weight, voltage, kVA, and impedance ratings and characteristics, loss data, efficiency at 25, 50, 75 and 100 percent rated load, sound level, tap configurations, insulation system type, and rated temperature rise.

1.4 OPERATION AND MAINTENANCE DATA

A. All operations and maintenance data shall comply with the submission and content requirements specified under section GENERAL REQUIREMENTS.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Store and protect equipment in a dry location with uniform temperature. Cover ventilating openings to keep out dust.

B. Handle transformers using only lifting eyes and brackets provided for that purpose. Protect units against entrance of rain, sleet, or snow if handled in inclement weather.

PART 2 PRODUCTS

2.1 DRY TYPE GENERAL PURPOSE TWO WINDING TRANSFORMERS

A. Dry Type General Purpose Transformers: Factory-assembled, air cooled, dry type general purpose two winding transformers per NEMA-TP1; ratings as shown on the Drawings.

B. Transformers shall meet the energy efficiency standards of NEMA TP-1 and the DOE ‘ENERGY STAR’ label.

C. Transformer losses shall conform to NEMA TP-1 requirements.

D. Insulation system shall be rated at 220 degrees C.

E. Winding temperature rise shall be rated at 150 degrees C above a 40 degree C ambient.

F. Case temperature shall not exceed 50 degrees C rise above a 40 degrees C ambient at its warmest point.

G. Winding Taps, Transformers 15 KVA and Larger: Four 2-1/2 percent taps, two above and two below rated voltage, full capacity taps on primary winding.

H. Sound Levels: Maximum sound levels are as follows:

KVA Rating	Sound Level
15-50	45 dB
51-150	50 dB
151-300	55 dB
301-500	60 dB
501-750	65 dB

I. Ground core and coil assembly to enclosure by means of a visible flexible copper grounding strap sized to meet NEMA and UL standards.

J. Coil Conductors: Continuous windings with termination pads brazed or welded.

K. Isolate core and coil from enclosure using vibration absorbing mounts.

L. Enclosure: NEMA Type 3R. Provide lifting eyes or brackets.

M. Nameplate: Include transformer connection data.

N. Mounting: Transformers 75 KVA and less shall be suitable for wall, floor, or trapeze mounting; transformers larger that 75 KVA shall be suitable for floor or trapeze mounting.

2.2 DRY TYPE ISOLATION TRANSFORMERS

A. Dry Type Isolation Transformers: Factory-assembled, air cooled dry type shielded isolation transformers: ratings as shown on the Drawings.

B. Insulation system and average winding temperature rise for rated KVA as follows:

KVA Insulation Rating	Class	Temperature Rise (degree C)
1-10	185	80
15-500	220	80

C. Case temperature shall not exceed 35 degrees C rise above 40 degrees C ambient at its warmest point.

D. Winding Taps, Transformers Less than 15 KVA: Two 5 percent below rated voltage, full capacity taps on primary winding.

E. Winding Taps, Transformers 15 KVA and Larger: Four 2-1/2 percent full capacity taps on primary winding-two above and two below rated voltage.

F. Sound Levels: Maximum sound levels are as follows:

KVA Rating	Sound Level
1-9	40 dB
10-45	45 dB
50-500	50 dB

G. Provide electrostatic winding shield with separate insulated grounding connection.

H. Ground core and coil assembly to enclosure by means of a visible flexible copper grounding strap.

I. Coil Conductors: Continuous windings with termination pads brazed or welded.

J. Isolate core and coil from enclosure using vibration-absorbing mounts.

K. Enclosure: NEMA Type 3R. Provide lifting eyes or brackets.

L. Nameplate: Include transformer connection data.

M. Mounting: Transformers 75 KVA and less shall be suitable for wall, floor, or trapeze mounting: transformers larger than 75 KVA shall be suitable for floor or trapeze mounting.

PART 3 EXECUTION

3.1 INSTALLATION

A. Set transformer plumb and level.

B. Use flexible conduit, 2 ft. (0.6 m) minimum length, for connections to transformer case. Make conduit connections to side panel of enclosure.

C. Mount transformers on vibration isolating pads suitable for isolating the transformer noise from the building structure.

D. Provide sufficient space around transformer for cooling as recommended by the manufacturer.

3.2 FIELD QUALITY CONTROL

A. Check for damage and tight connections prior to energizing transformer.

B. Measure primary and secondary voltages and make appropriate tap adjustments within 2-1/2% of the normal operating load after the building is in full operation.

END OF SECTION

SECTION 16470
PANELBOARDS

PART 1 GENERAL

1.1 SCOPE

A. The work under this section includes main, distribution and branch circuit panelboards.

1.2 SUBMITTALS

A. Include outline and support point dimensions, voltage, main bus ampacity, integrated short circuit ampere rating, and circuit breaker arrangement and sizes.

1.3 OPERATION AND MAINTENANCE DATA

A. All operations and maintenance data shall comply with the submission and content requirements specified under section GENERAL REQUIREMENTS.

1.4 SPARE PARTS

A. Keys: Furnish 2 keys for each panelboard to Owner.

PART 2 PRODUCTS

2.1 MAIN AND DISTRIBUTION PANELBOARDS

A. Panelboards: Circuit breaker type.

B. Enclosure: NEMA Type 3R. Minimum cabinet size: 5-3/4 inches (144 mm) deep; 20 inches (508 mm) wide, with 5" minimum gutter space top and bottom. Constructed of galvanized code gauge steel.

C. Provide cabinet front with hinged door with flush lock. Front cover shall be hinged to allow access to wiring gutters without removal of panel trim. Hinged trim shall be held in place with screw fasteners. Finish in manufacturer's standard gray enamel.

D. Provide metal directory holders with clear plastic covers.

E. Provide panelboards with copper bus (phase buses, bus fingers, etc.), ratings as scheduled on Drawings. Provide ground bars in all panelboards. Neutral and ground bars can be dual rated ALCU9. All spaces shall have bus fully extended and drilled for the future installation of breakers.

F. Minimum System (i.e. individual component) Short Circuit Rating: As shown on the Drawings.

G. Molded Case Circuit Breakers: Provide circuit breakers with integral thermal and instantaneous magnetic trip in each pole. Provide circuit breakers UL listed as Type HACR for air conditioning equipment branch circuits.

H. Circuit breakers shall be bolt-on type with common trip handle for all poles. No handle ties of any sort will be approved.

2.2 BRANCH CIRCUIT PANELBOARDS

A. Lighting and Appliance Branch Circuit Panelboards: Circuit breaker type.

B. Enclosure: Type 3R. Minimum cabinet size: 5-3/4 inches (144 mm) deep; 20 inches (508 mm) wide with 5" minimum gutter space top and bottom. Constructed of galvanized code gauge steel. Panel enclosure (back box) shall be of non-stamped type (without KO's) to avoid concentric break out problem.

C. Provide [flush] [surface] cabinet front with concealed trim clamps, concealed hinge and flush cylinder lock all keyed alike. Front cover shall be hinged to allow access to wiring gutters without removal of panel trim. Hinged trim shall be held in place with screw fasteners. Finish in manufacturer's standard gray enamel.

D. Provide metal directory holders with clear plastic covers.

E. Provide panelboards with copper bus (phase buses, bus fingers, etc.), ratings as scheduled on Drawings. Provide ground bars in all panelboards. Neutral and ground bars can be dual rated ALCU9. All spaces shall have bus fully extended and drilled for the future installation of breakers.

F. Minimum System (i.e. individual component) Short Circuit Rating: As shown on the Drawings.

G. Molded Case Circuit Breakers: Bolt-on type thermal magnetic trip circuit breakers. Provide UL Class A ground fault interrupter circuit breakers where shown on Drawings. Provide circuit breakers UL listed as Type HACR for air conditioning equipment branch circuits.

H. Do not use tandem circuit breakers.

I. Circuit breakers shall be bolt-on type with common trip handle for all poles. No handle ties of any sort will be approved.

J. All of the panelboards provided under this section shall be by the same manufacturer.

PART 3 EXECUTION

3.1 INSTALLATION

A. See section 16119 for support requirements.

B. Install panelboards plumb with wall finishes.

C. Height: 6 ft (2 m) to top.

D. Install a crimp type stud termination to stranded conductor when terminating on circuit breakers without a captive assembly rated for terminating stranded conductors.

E. Provide filler plates for unused spaces in panelboards.

F. See section 16195 for identification requirements. Provide typed circuit directory for each branch circuit panelboard. Revise directory to reflect circuiting changes required to balance phase loads.

G. Stub three (3) empty ¾” conduits to accessible location above ceiling or below floor out of each recessed panelboard. Cap these conduits to prevent material from entering them.

3.2 FIELD QUALITY CONTROL

A. If aluminum conductors size #1/0 and larger (per Section 16121) are to be used as panelboard feeders, it is the responsibility of the CONTRACTOR to provide panelboards with adequate wire bending space to accommodate the aluminum conductors and terminators to meet allowable code requirements. The CONTRACTOR shall circuit the panelboards as shown on the drawings. Measure steady state load currents at each panelboard feeder. Should the difference at any panelboard between phases exceed 10 percent, rearrange circuits in the panelboard to balance the phase loads within 10 percent.

B. Visual and Mechanical Inspection: Inspect for physical damage, proper alignment, anchorage, and grounding. Check proper installation and tightness of connections.

END OF SECTION

SECTION 16481
LOW-VOLTAGE CONTROLLERS

PART 1 GENERAL

1.1 SCOPE

A. The work under this section includes manual motor starters, magnetic motor starters, combination magnetic motor starters and motor control centers.

1.2 RELATED WORK

A. Applicable provisions of Division 16 shall govern work under this Section.

1. Section 16119 – Hangers and Supports for Electrical Systems.

1.3 COORDINATION WITH OTHER TRADES

A. Motors: In general, all electric motors required for this installation will be supplied with equipment, apparatus and/or appliances covered under other sections of the specifications.

B. For the sake of consistency and conformity of manufacturer, design and construction, all motors shall conform to the following description unless otherwise noted or required.

1. Motors 3/4 HP and smaller shall be wound for operation on single phase, 60 Hz. service unless otherwise noted.
2. Motors 1 HP and above shall be wound for operation on 3 phase, 60 Hz service unless otherwise noted.
3. Refer to drawings in each case in order to verify voltage characteristics required.

C. Equipment:

1. All building utility motors such as fans, pumps, overhead doors, etc., together with certain "controlling equipment" for same, except motor starters and related apparatus, will be furnished under other sections of the specifications and delivered to the building site unless specifically noted otherwise. The above mentioned "controlling equipment" pertains to electrical thermostats, electro-pneumatic and pneumatic-electric and detection devices, or any other device not purely electrically operating in nature.
2. The starters for these motors shall be furnished and installed by the Electrical Trade unless noted otherwise.
3. The Electrical Trade shall set and connect all specified starting equipment, install all power conduits and wiring and shall furnish and

make all connections from starting equipment to motors as required to leave the apparatus in running condition.

D. Wiring Connections:

1. Furnish branch circuits for all motors to the starting equipment and then to the motors, complete with all control wiring for automatic and remote control where required or noted. Conduits to motors shall terminate in the conduit fittings on the motors, the final connection being made with flexible, PVC-coated metal conduit.
2. Provide all necessary labor and material to completely connect all electrical motors and controls (where required) in connection with the building utility equipment, including fans, pumps, overhead door operators, etc.
3. All conduits and wiring required for control work from the holding coil circuit of the starter, including the furnishing and installation of control devices such as auxiliary contacts, control relays, time delay relays, pilot lights, selector switches, alternators, etc., shall be provided and installed by other trades unless otherwise indicated.

E. Power Branch Circuits:

1. Wire sizes for branch circuits not specifically called for on drawings or in specifications shall be based on 125 percent of the full load current of the motor unless the voltage drop of motor branch circuits exceeds 1-1/2 percent from the distribution panel to the motor; in which case, voltage drop shall govern wire sizes. A power factor of 80 percent shall be used for motors in such calculations.

1.4 REFERENCES

A. ANSI/NEMA ICS 6 - Enclosures for Industrial Controls and Systems.

B. ANSI/UL 198E - Class R Fuses.

C. NEMA AB 1 - Molded Case Circuit Breakers.

D. NEMA ICS 2 - Industrial Control Devices, Controllers, and Assemblies.

E. NEMA KS 1 - Enclosed Switches.

F. NEMA PB 1 - Panelboards.

G. NEMA PB 1.1 - Instructions for Safe Installation, Operation and Maintenance of Panelboards Rated 600 Volts or Less.

1.5 SUBMITTALS

A. Indicate on shop drawings, front and side views of motor control center enclosures with overall dimensions. Include conduit entrance locations and requirements; nameplate legends; size and number of bus bars per phase, neutral and ground; electrical characteristics including voltage, frame size and trip ratings, withstand ratings, and time-current curves of all equipment and components.

B. Provide product data on motor starters and combination motor starters, relays, pilot devices, and switching and overcurrent protective devices.

1.6 OPERATION AND MAINTENANCE DATA

A. All operations and maintenance data shall comply with the submission and content requirements specified under section GENERAL REQUIREMENTS.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Store in a clean, dry space. Maintain factory wrapping or provide an additional heavy canvas or heavy plastic cover to protect units from dirt, water, construction debris, and traffic.

B. Handle in accordance with manufacturer's written instructions. Lift only with lugs provided for the purpose. Handle carefully to avoid damage to motor control center components, enclosure, and finish.

1.8 SPARE PARTS

A. Keys: Furnish two (2) each to Owner.

B. Provide three (3) spares of each size and type fuse used. Provide enclosure for spare fuses.

C. Fuse Pullers: Furnish one fuse puller to Owner.

PART 2 PRODUCTS

2.1 MANUAL MOTOR STARTERS

A. Manual Motor Starter: NEMA ICS 2; size as required. AC general-purpose Class A manually operated full-voltage controller for induction motors rated in horsepower, with overload protection, red pilot light and toggle operator.

B. Enclosure: As required for environment.

C. Provide manufacturer’s equipment ground kit in all starter enclosures.

2.2 MAGNETIC MOTOR STARTERS

A. Magnetic Motor Starters: NEMA ICS 2; AC general-purpose Class A magnetic controller for induction motors rated in horsepower; size 0 minimum.

B. Full Voltage Starting: Non-reversing type.

C. Reduced Voltage Starting: Solid-state type, trip current rating shall be adjustable. The overload shall be self-powered, provide phase loss and phase unbalance protection, have a permanent tamper guard and be ambient insensitive. The overload shall have a mechanical test function.

D. Size: NEMA ICS 2; size as required, size 1 minimum.

E. Coil Operating Voltage: 120 volts, 60 Hz.

F. Overload Protection: bimetal or melting alloy.

G. Enclosure: NEMA Type: As required for environment.

H. Provide manufacturer’s equipment ground kit in all starter enclosures.

I. Auxiliary Contacts: NEMA ICS 2; two normally open closed contacts in addition to seal-in contact.

J. Selector Switches: NEMA ICS 2; HAND/OFF/AUTO, in front cover.

K. Indicating Lights: NEMA ICS 2; LED Push-to-test type. RUN: red in front cover.

L. Relays: NEMA ICS 2; Provide on-time delay (0-60 sec) relays for motors greater than 10hp.

M. Provide phase loss protection relay with each motor starter, with contacts to de-energize each motor starter.

N. Control Power Transformers: Each magnetic starter shall have a fused primary and a fused 120V secondary control transformer, sized for the load, 100 VA minimum. Additionally, the X2 terminal of the control transformer shall be grounded.

O. Combination Motor Starters: Combine motor starters with molded case circuit breaker and disconnect in common enclosure.

2.3 CONTROLLER OVERCURRENT PROTECTION AND DISCONNECTING MEANS

A. Molded Case Thermal-Magnetic Circuit Breakers: NEMA AB 1; circuit breakers with integral thermal and instantaneous magnetic trip in each pole.

B. Motor Circuit Protector: NEMA AB 1; circuit breakers with integral instantaneous magnetic trip in each pole.

C. Nonfusible Switch Assemblies: NEMA KS 1; quick-make, quick-break, load interrupter enclosed knife switch with externally operable handle. Provide interlock to prevent opening front cover with switch in ON position. Handle lockable in OFF position.

D. Fusible Switch Assemblies: NEMA KS 1; quick-make, quick-break, load interrupter enclosed knife switch with externally operable handle. Provide interlock to prevent opening front cover with switch in ON position. Handle lockable in OFF position.

2.4 MOTOR CONTROL CENTER

A. Motor Control Centers: NEMA ICS 2.

B. Main Overcurrent Protection: Molded case circuit breaker.

C. Motor Starters: As specified elsewhere in this Section and as scheduled on Drawings.

D. Feeder Tap Units: Fusible switches.

E. Voltage Rating: As required.

F. Horizontal Bussing: Copper, with a continuous current rating of 600 amperes. Include copper ground bus entire length of control center.

G. Vertical Bussing: NEMA ICS 2; copper.

H. Include copper neutral bus.

I. Integrated Equipment Short Circuit Rating: As required.

J. Configuration: Units accessible from the front only.

K. Enclosure: NEMA Type: as required for location.

L. Finish: Manufacturer's standard gray enamel.

M. Control Power Transformers: Each magnetic starter shall have a fused primary and a fused 120Vsecondary control transformer, sized for the load, 100 VA minimum. Additionally, the X2 terminal of the control transformer shall be grounded.

2.5 FUSES

A. Fuses 600 Amperes and Less: Dual element, time delay, 600 volt, UL Class RK 5. Interrupting Rating: 200,000 rms amperes.

PART 3 EXECUTION

3.1 INSTALLATION

A. Install motor control equipment in accordance with manufacturer's instructions.

B. Motor Starter Panelboard Installation: In conformance with NEMA PB 1.1.

C. Select and install heater elements in motor starters to match installed motor characteristics.

D. Motor Data: Provide neatly typed label inside each motor starter enclosure door identifying motor served, nameplate horsepower, full load amperes, code letter, service factor, and voltage/phase rating.

END OF SECTION

SECTION 16482
PLC CONTROL PANEL

PART 1 GENERAL

1.1 SCOPE

A. This specification describes the necessary features, components and methods required to construct, supply, and field install industrial grade control panels for the project.

1.2 REFERENCES

A. NFPA 70

1.3 SUBMITTALS

A. Include layout drawings, complete schematic drawings, and material lists.

1.4 OPERATION AND MAINTENANCE DATA

A. All operations and maintenance data shall comply with the submission and content requirements specified under section GENERAL REQUIREMENTS.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Store and protect equipment in a dry location with uniform temperature. Cover ventilating openings to keep out dust.

B. Handle transformers using only lifting eyes and brackets provided for that purpose. Protect units against entrance of rain, sleet, or snow if handled in inclement weather.

PART 2 PRODUCTS

2.1 ENCLOSURE

A. The enclosure is to be as per the manufacturer and part number specified on the drawings.

2.2 COMPONENTS

A. The main PLC controller shall be an Allen Bradley ControlLogix PLC complete with Ethernet interface and I/O cards suitable for instrumentation. Field control panels in the kiosks shall be as specified on the drawings.

B. The PLC control panel shall be equipped with an Allen Bradley Panelview Plus HMI display (minimum 12” display) complete with Allen Bradley FactoryTalk software.

C. A separate SCADA computer shall be furnished complete with Allen Bradley FactoryTalk software with remote access functionality fully implemented. Provide detailed instructions for establishing remote access.

D. FactoryTalk programming shall provide viewing and logging of all data, alarms, and setpoints. Multiple security levels shall be established – some accounts allow “viewing only”, others to allow modification of setpoints.

E. A telephone alarm dialer shall be incorporated into the PLC control panel design.

F. All components shall be as per the drawings and shall carry UL approval.

G. The bill of materials for the kiosk control panels is provided to assist the CONTRACTOR in pricing the panel.

H. The CONTRACTOR must include all additional sundries and materials necessary to complete the panel for its intended use.

I. All materials shall be new and undamaged.

J. Where fuseblocks are specified, fuses shall be included.

K. Spare fuses shall be supplied as follows:

L. 2 or 25% (whichever is greater) of each size for single phase circuits.

PART 3 EXECUTION

3.1 LAYOUT

A. The layout of the panel shall be such that the components are placed in a logical fashion and that there is sufficient clearance to allow replacement or removal at a later date.

B. Approximately 20% spare shall be allowed for future.

C. All components other than operator devices mounted in the door shall be secured to the removable backplate.

D. The terminals of all components shall be front access and all necessary adjustments accessible from the front.

E. Components utilizing higher voltages shall be segregated from those operating only at control voltages.

F. Transformers, power supplies, fuses and other heat producing devices shall be located near the top of the panel.

G. Terminal blocks shall be installed as indicated on the drawings. 20% spare terminals shall be installed.

3.2 WIRING

A. Color coding of wire shall be as specified below:

1.	AC power	black
2.	AC control	red
3.	AC neutral	white
4.	DC power	blue
5.	DC control	blue
6.	Interlocks	yellow
7.	Equipment ground	green

B. Wire shall be type TEW rated at 75 degrees C or better. The minimum wire size for power conductors shall be #14 AWG. The minimum size for conductors within the panel shall be #16 AWG. Internal wiring shall be enclosed in wiring ducts. All signal wiring shall use Belden twisted and shielded cable.

C. All door mounted devices shall be neatly harnessed and wired to terminal blocks on the backplate.

3.3 GROUNDING

A. Panel shall have a ground bus or stud installed to consolidate the various equipment and chassis grounds. The main ground from the incoming supply shall be connected to this bus.

B. The enclosure door(s) shall be bonded to the enclosure. Where necessary to make a positive connection to ground, the panel paint shall be scraped to bare metal.

C. Signal grounds shall be installed as per the drawings.

3.4 MARKING AND LABELLING

A. All marking and labelling shall be neat and easily readable.

B. All panel components shall be identified with lamacoid tags attached to the panel in proximity to the component.

C. Lamacoid tags shall be used to provide additional information regarding the operation of the panel or safety issues. Lamacoid tags shall be white with black lettering.

D. Tags for warning or danger shall be red with white lettering.

E. Tags indicating the presence of interlocks or voltage from other sources shall be yellow with black lettering.

F. All wires shall be marked at each end using plastic sleeve or pre-numbered markers. Adhesive tape markers are not acceptable.

G. All terminal blocks shall be marked using the manufacture's recommended method.

3.5 CONSTRUCTION

A. The CONTRACTOR shall be responsible to ensure that the panel is constructed to perform all functions as indicated on the drawings and contract documents.

B. Any errors or omissions discovered in the drawings shall be immediately communicated to the Owner's Representative for resolution.

C. Any work deemed as an extra shall not be performed without written authorization from the Owner's Representative.

3.6 TESTING

A. The CONTRACTOR shall perform the following tests and checks on the completed panel:

1. Voltage checks to ensure correct levels.
2. Point to point continuity check.
3. Terminal screws and fasteners are tightened to correct.
4. Panel to be burned-in for a period of 24 hours.

3.7 APPROVALS

A. The panel shall be built in compliance with all applicable codes and shall be UL approved.

B. The CONTRACTOR shall be responsible for and shall include in the price, all necessary inspections and shall be responsible for all necessary modifications to obtain approval.

END OF SECTION

B&L Woodwaste Site
Pierce County, Washington

Engineering Design Report (EDR) Addendum 3

Phase 2 Part 1 Remediation Design Report

Groundwater Recovery and Treatment System

Appendix 3G
Permits and Approvals
(Reserved)

FINAL

B&L Woodwaste Site
Pierce County, Washington

Engineering Design Report (EDR) Addendum 3

Phase 2 Part 1 Remediation Design Report

Groundwater Recovery and Treatment System

Appendix 3H
Construction Quality Assurance Plan

FINAL

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Attachment 3H.2 Samples Forms for Technical Documentation

1.0 Introduction

Cleanup actions identified in the 2008 Cleanup Action Plan (2008 CAP) will be implemented at the B&L Woodwaste Site (Site) under a phased program, as described in Consent Decree No. 08-2-10610-7 (Consent Decree) and the Scope of Work attached to the Consent Decree. Phase 2 Part 1 of the CAP implementation includes: groundwater recovery wells, groundwater collection piping system, construction of a treatment building, and construction of a complete treatment system (collectively referenced as the Work). The purpose of this Phase 2 Part 1 Construction Quality Assurance Plan (CQAP) is to ensure that work completed for the Phase 2 Part 1 remedy components is constructed in accordance with the design requirements and that reliable, accurate, and verifiable construction data are recorded.

1.1 DEFINITIONS

Owner	The owner of the Work to be completed by the Contractor. The Owner for this project is the B&L Woodwaste Site Custodial Trust (Trust).
Construction Manager	Person appointed by the Owner to represent the Owner and to oversee and manage implementation of the Work. The Construction Manager may also be referred to as the "Owner's Representative". The Construction Manager shall have sole authority to accept completed portions of the Work and to accept quality control (QC) and quality assurance (QA) reports.
Resident Engineer	Person or persons appointed by the Owner and/or project team to oversee quality control and quality assurance activities at the project site.
Contractor	The Contractor retained by the Owner to complete the Work. The Contractor shall have responsibility for all subcontractors retained by the Contractor to complete the Work.

1.2 CONSTRUCTION QUALITY ASSURANCE PLAN OBJECTIVES

Specific objectives of the CQAP are as follows:

- Define project management organization and authorities.
- Define the roles and responsibilities of project team members.
- Define procedures and methods to check performance and work quality.
- Identify corrective actions if performance standards or design criteria are not met.
- Define documentation procedures and requirements.

1.3 ELEMENTS OF CONSTRUCTION QUALITY ASSURANCE PLAN

The Contractor has the primary responsibility for the quality of all work performed under the Owner's contract covering the Work. The Project Plans and Specifications provide the guidelines for preparing and implementing a QC program for construction and management activities. Oversight of contractor QC procedures and verification of work quality will be performed by the Construction Manager and/or the Resident Engineer. The essential elements of the CQAP are listed below:

- Project organization
- Personnel qualifications
- Responsibilities
- Project control
- Verification
- QA inspections
- Meetings
- Reporting procedures and frequency

2.0 Project Organization

The Phase 2 Part 1 construction management and oversight will be performed by the Floyd|Snider and AMEC Geomatrix, Inc. (AMEC) project team under contract to the Trust, which is the Owner of this Work. The remedy components included in the Work will be constructed by a General Design-Build Contractor (Contractor) under contract to the Trust.

2.1 MANAGEMENT OF CONSTRUCTION QUALITY

Construction quality is the responsibility of the Contractor and the Construction Manager provided by the Floyd|Snider/AMEC project team. Managing construction quality involves both QC and QA. QC is performed by the Contractor and consists of inspections and field or laboratory testing that directly monitor and control quality of materials, installation, and/or workmanship. QA is performed by the Construction Manager and/or Resident Engineer and consists of inspections, verifications, audits, and evaluations to provide assurance that the completed construction elements satisfy design requirements. The Contractor shall be responsible for the performance of any subcontractors retained by the Contractor to complete the Work.

2.2 PROJECT QUALITY ASSURANCE TEAM

The project QA team will consist of the Floyd|Snider/AMEC project management team, which includes the Construction Manager and Resident Engineer. The roles and responsibilities of the team will be established prior to start of construction; specific responsibilities and roles for the QA team are described in the following sections.

2.3 KEY QUALITY ASSURANCE AND QUALITY CONTROL PERSONNEL

2.3.1 Construction Manager and Resident Engineer

The Floyd|Snider/AMEC project team will provide a Construction Manager to supervise and manage the construction activities and a Resident Engineer to provide technical and field support. The Construction Manager and/or Resident Engineer will observe the construction activities, collect samples, conduct QA inspections and audits, and conduct analyses in accordance with the CQAP and addenda. The Construction Manager will have the authority to stop work if the proper procedures are not being followed and/or corrective measures for any noncompliant work are not taken in a reasonable period of time.

The Construction Manager and/or Resident Engineer will document the daily activities, and provide weekly and monthly project status reports to the project participants as required.

The Construction Manager's specific responsibilities include the following:

- Documenting and tracking project scope changes as related to QA functions.
- Reviewing the Contractor's Quality Control Project Plan for consistency with the requirements of the drawings and specifications, and ensuring that performance

standards will be met. The review will examine the appropriateness and the frequency of the tests and inspections.

- Establishing procedures to resolve disputes or misunderstandings during construction.
- Reviewing emergency action and contingency planning.
- In the event that any action during the performance of the construction activities causes or threatens a release that may present an immediate danger to on-site construction workers, the Resident Engineer will initiate actions to be taken in accordance with the Health and Safety Plan. The Resident Engineer will take directions from the Site Health and Safety Coordinator (SHSC).
- Maintaining a log of observations at the Site, including interactions with all parties; samples collected; results of tests; site visits; and questions, concerns, or discussions about conformance with the approved design drawings and specifications.
- Reviewing endpoint activities and procedures for project completion.
- Observing tests used to monitor construction and the frequency of performance of the activities.
- Reviewing sampling activities, frequency of testing, acceptance and rejection criteria, and drawings for implementing corrective measures as addressed in the drawings and specifications.
- Observing the Work in progress to determine if the Work is generally proceeding in accordance with the drawings and specifications, and preparing daily inspection reports.
- Immediately notifying the authorized representative of the Contractor, the Owner, and the Floyd|Snider/AMEC project management team of observed activities presenting imminent and substantial endangerment to the public health or welfare or environment, and following up with an appraisal of the situation to the Floyd|Snider/AMEC project management team.
- Reporting actions that a contractor takes in interpreting contract documents in a way that may materially affect the Work in progress or intent of the drawings and specifications.

The Construction Manager may delegate specific QA duties but retains responsibility for the items listed above.

2.3.2 Contractor Quality Control Officer

The Contractor will designate an employee as the QC Officer for the project. The QC Officer will be an engineer or technician knowledgeable of standard QA/QC procedures for construction activities related to the Work. The QC Officer responsible for portions of the Work conducted below grade will have successfully met health, safety, and medical monitoring requirements specified in the Health and Safety Plan.

The QC Officer’s responsibilities will include:

- implementation of the approved submittals,
- adherence to project specifications, drawings, and field changes approved by the Resident Engineer,
- insuring that sample collection, sample handling, and laboratory testing conform to the applicable professional standards,
- performing the required inspections and testing as outlined in each applicable specification, and
- Maintaining QC documentation, including the “Construction Quality Control Daily Report,” and providing such documentation to the Construction Manager.

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3.0 Quality Assurance Program

Throughout the construction work, inspections by the Construction Manager and/or Resident Engineer will be performed to assure that quality construction practices and safe work procedures are employed. The inspections will also verify compliance with environmental and safety requirements. This section outlines the performance QA program.

3.1 QUALITY ASSURANCE/QUALITY CONTROL ENFORCEMENT

If construction deficiency is noted by the QC Officer or Construction Manager on any portion of the Work, the Contractor shall immediately stop work on that work item. Activities shall not proceed on the affected portion of the Work until the deficiency is corrected to the satisfaction of the QC Officer and the Construction Manager. The specific corrective action will be determined by the Construction Manager and/or Resident Engineer and will be implemented by the Contractor. The Contractor will be responsible for addressing any schedule delays caused by addressing deficient work.

3.2 VERIFICATION

The Contractor shall provide QC documentation to the Construction Manager and/or Resident Engineer. In addition, independent sampling and inspections will be periodically performed by the Construction Manager and/or Resident Engineer to verify performance.

3.3 GENERAL QUALITY ASSURANCE/QUALITY CONTROL PROCEDURES

The following list consists of the general QA/QC procedures to be performed by the Contractor and the Construction Manager during inspection activities.

- Ascertain that applicable or required approvals and permits have been obtained.
- Ensure that Project Documents (approved design drawings, specifications, work plans, and contract) are on-hand, reviewed, and organized for ready reference.
- Verify that project work is performed in accordance with the drawings, specifications, and applicable regulations and standards.
- Review field orders, change orders, and Project Documents for conformance.
- Recognize and report potential problem areas.
- Check that surveying, laboratory services, testing methods, and procedures are arranged, scheduled, and performed in accordance with procedures and/or accepted practice. Verify that all testing equipment used on-site has current calibration documentation.
- Confirm that record drawings are prepared and accurate.
- Check that necessary corrective actions are completed, verified, and recorded.

- Ensure that required forms, records, and other appropriate documents are complete, in order, and properly filed, and that all reports (such as daily, weekly, monthly, special, final, etc.) are completed and distributed.

3.3.1 Material Inspections

The Construction Manager and/or Resident Engineer will inspect and/or measure the products and materials upon delivery to ensure that the products and materials are those specified and to ensure that no damage has occurred during shipping. If damage or incorrect shipping occurs, those products and/or materials will be replaced by the appropriate material and in good condition.

3.3.2 Field Engineering Inspections

Field engineering includes surveying and locating each Work component on the Site by the Contractor and subcontractors. The QA inspection activities by the Construction Manager for field engineering include verification of the correct placement of all project facilities and installations. The dimensions, locations, elevations, and tolerances indicated in the Project Plans and Specifications will be independently confirmed by the Construction Manager and/or Resident Engineer, as will the engineering requirements concerning trenching, material placement and compaction, grading, pipe routing, and other construction activities.

3.4 QUALITY ASSURANCE/QUALITY CONTROL AUDITS

Periodic audits of QA/QC activities may be conducted throughout the construction. Floyd|Snider and AMEC will provide a team to perform the audits. Monthly audits will focus on documentation and compliance with procedures established in this CQAP and the Project Documents. Once completed, the results of the audit will be discussed with the Contractor and the Construction Manager followed by a written report of results.

3.5 PROJECT CLOSEOUT

Project closeout is the process of project completion and includes development and implementation of final punch list items (i.e., items to be completed prior to Contractor demobilization from the Site), and post-construction submittals. Contract closeout is normally accomplished in two phases: substantial completion and final completion. The Contractor shall provide all post-construction submittals, which include, but are not limited to the following:

- Reports of all tests demonstrating satisfactory functions of all operable items; instruction to Owner's personnel for their use; and transfers of all keys, samples, extra materials, and other items as required by the Project Documents.
- Submittal of all maintenance, operating information, record drawings, warranties, manuals, and other information/documents that are required by the Project Documents.
- A schedule for completion of all outstanding work items noted by the Construction Manager.

- Submittal of certifications as required by the Project Documents.
- Delivery of affidavits for the following:
    - Payment of debts and claims
    - Release of liens
    - Consent of surety for final payment
    - Release of waiver of liens
    - Release of claims
    - Other affidavits as may be required by the Project Documents.

Project closeout activities involving the Owner will proceed in parallel with construction closeout activities described herein. Project closeout will include the following:

- Preparation of record drawings to reflect as-constructed conditions for submittal to the Owner.
- Preparation of remedial action report; report will include a brief synopsis of work done and documentation associated with the Work (i.e., daily logs, manifests, and certificates of disposal).
- Consolidation of project records.

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4.0 Meetings, Reviews, and Documentation

4.1 MEETINGS

The Construction Manager will schedule and oversee kickoff and progress meetings.

4.1.1 Kickoff Meeting

Prior to the start of construction, the Construction Manager will hold a kickoff meeting. Participants at the meeting will include the Owner, key personnel from the Floyd|Sninder/AMEC project team, and the Contractor's management and lead field personnel. Representatives from the Washington Department of Ecology may attend the kickoff meeting.

The agenda of the kickoff meeting may include the following:

1. Distribution and discussion of:
    a. the list of major subcontractors and suppliers and
    b. the projected construction schedules.
2. Construction schedule and critical work sequencing.
3. Major equipment deliveries and priorities.
4. Designation of responsible personnel.
5. Procedures and processing of:
    a. field decisions,
    b. proposal requests,
    c. submittals,
    d. Change Orders, and
    e. applications for payment.
6. Adequacy of distribution of Contract Documents.
7. Procedures for maintaining Record Documents.
8. Use of premises (office, work, and storage areas).
9. Construction facilities, controls, and construction aids.
10. Temporary rerouting and termination of utilities, access roads, etc.
11. Health and safety overview.
12. Safety and first aid procedures.
13. Fire department alert procedures.
14. Issuance of the Emergency Telephone List.
15. Emergency contingency planning.

16. Environmental and stormwater management procedures.
17. Security procedures.
18. Housekeeping procedures.
19. Permits.
20. Handling of potentially contaminated materials (soil and water).
21. Discussion of modifications to the Contractor QC program to ensure that site-specific considerations are addressed.
22. Establishment of criteria to assess QA/QC progress of the project.
23. Review of pertinent design documents, plans, and requirements.
24. Conduct a site reconnaissance to verify that the design criteria, plans, and specifications are understood by the Contractor.

4.1.2 Progress Meeting

Weekly progress meetings will be held by the Construction Manager. Required attendees at the meeting will include the Construction Manager and the Contractor's management and lead field personnel. Other personnel may attend, as appropriate. The Project Manager and Owner may attend or participate by telephone.

The agenda at the progress meetings will include the following:

1. Review of the Contractor's progress and schedules and effort to complete the remaining task(s) in a technical and budget-related basis.
2. Review of action items from previous weekly meeting.
3. Identification of potential delays and development of actions to maintain schedules.
4. The project schedule for the following 3 weeks.
5. Scheduling and issues related to the different Contractors performing different components of the Work and Owner supplied equipment.
6. Coordination of work between the Floyd|Snider/AMEC project team and the Contractor.
7. Review and resolution of any QA/QC issues identified in the previous week.
8. Site safety conditions and practices, and conformance with the Site Health and Safety Plan.
9. Administrative and financial issues.
10. Identification and tracking of action items.

4.2 DOCUMENTATION

Project documentation will include maintaining activity and summary information for all relevant components of the project, including but not limited to, activities, quantities, and technical information. Sample project documentation forms are presented in Attachment 3H.1.

4.2.1 Daily Log

The Construction Manager will document detailed site activities in a field book. A summary of activities and relevant information will be documented in a daily log. Copies of daily logs will be sent to the Owner the following morning via e-mail. Log entries should be completed using the following guidelines:

- Every day should be reported and every calendar date should be accounted for; if followed by the words "no work," then the reason for no work should be recorded.
- Note directions given to the Contractor (verbal and written).
- Note weather conditions for each day. Describe unusual weather and its impact on construction.
- Reference phone calls, conversations, and decisions.
- Document site activities, any problems, and their reasons and resolutions.
- Record time and name of Contractor representative to whom field paperwork is delivered, and the contents of the paperwork.
- Note questions of workmanship and whether it was brought to the attention of the Contractor.
- Note material and equipment testing results.
- Record quantities of unit-priced items as agreed with the Contractor.
- Sign and date daily log.

4.2.2 Weekly Log

The weekly log will be completed at the conclusion of each week's activities by the Construction Manager. This report will provide a weekly summary of construction activities, a projection of the following week's construction, delivery problems and/or delays, interface problems, changes, and potential claims. The weekly log will include a summary of the daily logs for that week.

4.2.3 Monthly Status Report

The Construction Manager will prepare a monthly technical and financial status report for submittal to the Owner. The summary of construction activities to be included in the report will be based on review of daily and weekly logs, periodic site visits, and financial summaries.

4.2.4 Meeting Notes

Project meetings will be recorded by the Resident Engineer. An agenda will be prepared and the meeting summary will be documented on the agenda and distributed to all parties. The meeting notes will contain the following information:

- Time
- Location
- Project Number
- Attendees
- Topics discussed, decisions made, or action items list
- Work progress and schedule

4.2.5 Health and Safety Records

Daily Safety Meeting: Daily safety meetings will be organized by the Construction Manager and/or Resident Engineer and attended by all site personnel to review the day's activities and associated health and safety issues and requirements. All attendees shall sign the daily safety meeting form. A copy of the daily safety meeting form will be kept in the project files.

Incident Reports: Any incidents involving personnel or equipment must be reported to the Construction Manager and/or Resident Engineer and documented, with documentation provided to the Construction Manager. The Construction Manager and/or Resident Engineer will be responsible for reporting incidents to the Floyd|Snider/AMEC project team and the Owner.

Emergency Telephone List: An emergency phone list will be prepared at the beginning of the field work. The list will be posted by the telephone in the field offices for the Construction Manager and Contractor. The list will contain phone numbers for medical emergency support, utility companies, and key project personnel.

4.2.6 Photograph Log

The Construction Manager will document construction work with photographs, specifically including key construction milestones, and will maintain project photograph documentation and files. Photographs will be electronically filed and chronologically arranged. Each photograph should be identified by a date and sequence number. Captions for each photograph should include the date of the photograph and an activity description using the terminology common to the Contract and Project Documents. The photograph log will be used to keep a list of project photographs.

5.0 Quality Assurance Procedures

The QA procedures include daily review of the Contractor's QC and construction records, observation of the Contractor's QC tests and inspections, and spot testing for adherence to critical construction criteria, as necessary. Sample forms to be completed to document the technical aspects of the project are included in Attachment 3H.2. Additional forms will be used as needed.

5.1 CONTRACTOR QUALITY CONTROL REQUIREMENTS

The Contractor shall provide and maintain an effective QC program or inspection system that shall assure that all supplies and services required under the Contract conform to Contract requirements, whether constructed or processed by the Contractor or procured from subcontractors or vendors. The Contractor shall perform or have performed the inspections and tests required to substantiate that supplies and services conform to the requirements of the Project Plans and Specifications. Specific requirements for testing, inspection, and samples are included in the detailed specifications and shown on the drawings. In general the Contractor's QC requirements include, but are not limited to the following:

- Ensure quality and suitability of all materials used (concrete, rebar, structural steel, pipe bedding, trench backfill, pipe, valves, conduit, cable, etc.).
- Ensure quality and suitability of all equipment and structures procured by Contractor for the Work (tanks, pumps, instruments, controls, etc.).
- Ensure proper methods for installation of all items, to meet reference specifications and manufacturer's instructions.

The results of all tests and inspections will be recorded and will be available for review by the Construction Manager throughout the construction period.

All materials used and equipment or structures procured by the Contractor shall meet or exceed the criteria indicated on the Project Documents and/or in approved submittals. Any deviation must be pre-approved by the Construction Manager. The Contractor shall be responsible for implementing QC procedures and for maintaining QC and construction records in the on-site workbook or file.

The Contractor shall retain an independent testing laboratory as specified in the Project Documents. The laboratory shall be independent of the manufacturer, Contractor, and any party involved with the manufacture, design, and/or installation of any of the material and/or equipment used in the Work.

5.2 GROUNDWATER COLLECTION SYSTEM

5.2.1 Wells

The Construction Manager and/or Resident Engineer shall verify that the location of wells, depth, casing diameter, screen, and vaults meet the requirements of the plans and specifications.

5.2.2 Trenches

The Construction Manager and/or Resident Engineer shall verify that the depth and location of the trenches meet the requirements of the Project Plans and Specifications. The Construction Manager and/or Resident Engineer will carefully monitor excavation in the landfill area to ensure that the landfill cap materials are not damaged, and repaired if necessary. If the cap liners are damaged during trenching, the Contractor will be required to repair damaged liners to be consistent with existing conditions, as determined by the Construction Manager. The Construction Manager and/or the Resident Engineer will also monitor trenching in other areas to monitor impacts to wetlands areas and compliance with access agreements for off-property work. Any damage or impact will be repaired by the Contractor to the satisfaction of the Construction Manager.

The Construction Manager and/or Resident Engineer shall observe pipe bedding and backfill material to ensure it meets the Project Plans and Specifications, and will verify that appropriate compaction methods are used. Compaction and moisture testing shall be as specified in Section 02200 – Earthwork, and other testing required by the Project Plans and Specifications. Tests shall be performed at the Contractor’s expense and observed by the Construction Manager and/or Resident Engineer.

5.2.3 Buried Piping and Conduit

The Construction Manager and/or Resident Engineer shall inspect pipe material when it arrives on-site to ensure that the material, diameter, and wall thickness meet the requirements of the Project Plans and Specifications.

The Construction Manager and/or Resident Engineer shall observe and inspect the piping, cleanouts, vault material, and installation depth to verify compliance with the design specifications. The Construction Manager and/or Resident Engineer will witness the pressure testing performed by the Contractor to ensure the system is free of leaks.

The Construction Manager and/or Resident Engineer shall also observe and inspect the material, workmanship, and depth of installation of the electrical conduits and junction boxes.

5.3 GROUNDWATER TREATMENT BUILDING

5.3.1 Earthwork

The Construction Manager and/or Resident Engineer shall inspect backfill material and other earthen materials used in the Work to ensure they meet the Project Plans and Specifications and verify that appropriate compaction methods are used. Compaction and moisture testing shall be as specified in Section 02200 – Earthwork, and other testing required by the Project Plans and Specifications. Tests shall be performed at the Contractor's expense and observed by the Construction Manager and/or Resident Engineer.

The Contractor shall provide moisture density curves for each type of soil to be compacted. Earthwork construction shall be performed in accordance with the Project Documents and shall be observed by the Construction Manager and/or Resident Engineer. An independent testing company retained by the Contractor shall perform compaction testing with the frequency identified in the design drawings to verify adherence to the design compaction requirements.

Tests and locations shall be identified by elevation and grid coordinates on a drawing of the construction area. The test locations shall be evenly distributed across each lift being tested. Any area appearing to the Construction Manager and/or Resident Engineer to be of questionable quality shall be tested instead of, or in addition to, the area previously planned for testing.

5.3.2 Concrete

The Construction Manager and/or Resident Engineer shall ensure testing and documentation requirements of Section 03310 – Concrete, and all other requirements of the Project Plans and Specifications are met. The Construction Manager and/or Resident Engineer shall visually inspect forms and rebar before structural concrete is poured to ensure those components meet the requirements of the Project Plans and Specifications.

5.3.3 Pre-engineered Metal Building

The Construction Manager and/or Resident Engineer shall inspect the location and size of the building, the door and window size and placement, and review the building against approved submittal drawings from the Contractor. As per Section 13120 – Pre-engineered Buildings of the Project Plans and Specifications, a representative from the building system manufacturer will carry out inspections of the building erection process during a minimum of three site visits to ensure the building meets the manufacturer's recommended installation procedures.

5.3.4 Piping

The Construction Manager and/or Resident Engineer shall inspect pipe material when it arrives on-site to ensure that the material, diameter, and wall thickness meet the requirements of the Project Plans and Specifications and any approved submittals. The Construction Manager and/or Resident Engineer shall inspect the piping and installation to verify compliance with the design specifications. The Construction Manager and/or Resident Engineer will witness the pressure testing performed by the Contractor to ensure the system is free of leaks.

5.4 ELECTRICAL CONTROLS AND COMMISSIONING

The Contractor shall provide the proposed electrical system specifications, logic, and design drawings to the Construction Manager for approval at least 10 calendar days prior to procurement. Upon completion of all system installations, the Construction Manager and/or Resident Engineer will test all components of the system to verify proper function of all the items in accordance with the design requirements and logic. Any problems identified shall be corrected to the satisfaction of the Construction Manager.

5.6 DOCUMENTATION

The Construction Manager shall document that QA requirements have been addressed and satisfied. Documentation shall consist of daily and weekly logs, photographs, design and specification revisions, test reports, monthly status reports, record drawings, and a construction report. The daily and weekly logs will be completed as described above.

The finished project components and elements will be surveyed by the project surveyor, and record drawings will be prepared. The Construction Manager shall maintain a working set of record drawings where all deviations and changes from the design are noted daily. The working set of record drawings will include dimensions, location, and identification as appropriate to the Work completed.

At the completion of the Work, the Construction Manager shall submit a final construction report. This report will document that the Work was performed in compliance with the Project Documents and note any discrepancies. At a minimum, the final construction report will include laboratory test results, observation and test results, descriptions of significant construction problems and the solutions of these problems, a list of design revisions and the justifications for these changes, and a certification statement signed and sealed by a Professional Engineer registered in the State of Washington.

B&L Woodwaste Site
Pierce County, Washington

Engineering Design Report (EDR) Addendum 3

Phase 2 Part 1 Remediation Design Report

Groundwater Recovery and Treatment System

Attachment 3H.1
Sample Forms for Project Documentation

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Visitor Log, Phase 1 Part 1 Cleanup Action Plan

Weekly Field Activities Summary, Phase 1 Part 1 Cleanup Action Plan

Confined Space Entry Permit

(All copies of permit will remain at job site until job is completed.)

Date ______________

Location/Description
of Confined Space ____ Time ______________
Purpose of Entry ____ Expiration ______________
Expected Hazards ____
Communications ____
Entry Supervisor ____

Special Requirements Before Entry:	Yes	No		Yes	No
Lockout De-Energize - Test and Verify			Escape Harness Required		
Lines Broken - Capped or Blanked			Tripod Emergency Escape Unit		
Purge - Flush and Vent			Lifelines		
Ventilation			Fire Extinguishers		
Secure Area (Post and Flag)			Lighting (Explosion Proof)		
Breathing Apparatus			Protective Clothing		
Resuscitator - Inhalator			Respirator		

Test Interval ____________________

Test(s) to be Taken/Acceptable Entry Conditions		Date										
		Tester										
Do Not Enter If Permissible Entry Levels are Exceeded		Time										
	Permissible Entry Level	Am/Pm	M	M	M	M	M	M	M	M	M	M
% of Oxygen	19.5% to 23.5%											
% of L.F.L.* (gas/vapor/mist)	Less than 10%											
Carbon Monoxide	35 ppm (8 hr.)											
Aromatic Hydrocarbon	1 ppm (8 hr.)											
Hydrogen Sulfide	10 ppm (8 hr.)											
Sulfur Dioxide	2 ppm (8 hr.)											
Ammonia	25 ppm (8 hr.)											

* L.F.L. Lower Flammable Level

Name of Gas Tester(s) ____

Note: Continuous/periodic tests shall be established before beginning the job. Any questions pertaining to test requirements should be directed to ________________________

Testing Instruments Used	Name/Type	Identification No.	Calibration Time	Calibration Reading	Background Measurement

Permit Authorization

I certify that all actions and conditions necessary for safe entry have been performed.

Name (Print)	Signature
Date	Time

Authorized Entrants	Authorized Attendants

Construction Photo Index
Phase 1 Part 1 Cleanup Action Plan

Date	Photo ID	Photographer	Description	Aspect

Daily Quality Control Report
Phase 1 Part 1 Cleanup Action Plan

Project Name: Phase 1 Part 1 Cleanup Action Plan
B&L Woodwaste Site
Project Number: 13488
Date: ______
Project Location: Pierce County, Washington
Field Representative: ______
Weather: ______ **Wind:** ______ **Temp:** ______

PERSONNEL:

Name	Company	Time In	Time Out

DESCRIPTION AND LOCATION OF WORK:

DECONTAMINATION PROCEDURES:

CONTRACTORS QUALITY CONTROL:

Daily Quality Control Report
Phase 1 Part 1 Cleanup Action Plan
(continued)

SAMPLING:

Location	Type	Depth	Analyses

MATERIALS RECEIVED ON-SITE:

DESCRIBE MATERIALS STORAGE (Location, Protection):

DISCUSSIONS WITH CONTRACTOR:

Daily Quality Control Report
Phase 1 Part 1 Cleanup Action Plan
(continued)

SAFETY VIOLATIONS & ACCIDENTS OBSERVED AND ACTION TAKEN:

REMARKS (INCLUDE VISITORS):

WORK PERFORMED:

Description	Quantity Today	Total to Date

Signature of Contractor: ______________________ Date: __________

Signature of Field Representative: ______________________ Date: __________

Environmental Project Health and Safety Field Meeting Form
Phase 1 Part 1 Cleanup Action

Date: ____________________ Time: ____________ Project No.: 13488.__________

Project Name: Phase 1 Part 1 Cleanup Action________________________________

Location: Pierce County, Washington________________________________

Meeting Conducted by: ________________________________

TOPICS DISCUSSED

Physical Hazards:________________________________

Chemical Hazards:________________________________

Personal Protection:________________________________

Decontamination: ________________________________

Special Site Considerations:________________________________

____

____

____

Emergency Information: ________________________________

Hospital Location: ________________________________

Attendees

Name/Company (printed)	Signature

Meeting Conducted by: ________________________________
Signature

Investigation Report for Occupational Accident, Injury, or Illness
Phase 1 Part 1 Cleanup Action

Date of investigation: ______________ Conducted by: ______________________________

Event leading to this investigation: ______________________________

Was anyone injured as a result of this incident? ☐ Yes ☐ No

If so, describe the injury: ______________________________

____

Was a safe work practice violated? ☐ Yes ☐ No

If so, describe: ______________________________

____

Was an unanticipated unsafe condition encountered? ☐ Yes ☐ No

If so, describe: ______________________________

____

What corrective action is needed? ______________________________

Person responsible for corrective action: ______________________________

Date received by responsible person: ______________________________

Completion of corrective action:

My signature below certifies that I have completed the corrective action(s) described above.

______________________________	______________________________
Signature	Date

Will an additional safe work practice be needed? ☐ Yes ☐ No

If so, describe: ______________________________

____

Was the unsafe condition corrected? ☐ Yes ☐ No

If not, what interim actions have been taken? ______________________________

____

Does our inspection checklist need modification? ☐ Yes ☐ No

If so, describe: ______________________________

______________________________	______________________________	______________
Investigator Printed Name	Investigator Signature	(Date)

Training Records Summary
Phase 1 Part 1 Cleanup Action Plan

Name	Organization	Medical Monitoring Expires	40-Hour HAZWOPER Training Date	8-Hour HAZWOPER Refresher Expires	Respirator Fit Test Expires	Asbestos Supervisor Expires	Asbestos Worker Expires	Lead Awareness Expires	8-Hour Lead Abatement Expires	First Aid Expires	CPR Expires	Confined Space Entry Expires

Visitor Log
Phase 1 Part 1 Cleanup Action Plan

Date	Name	Organization	Purpose of Visit	Time	
				In	Out

Weekly Field Activities Summary
Phase 1 Part 1 Cleanup Action

Week No.: **Dates:** **To:**	**Project No.:** 13488
Project Name: B&L Woodwaste Site	**Date:**
Project Location: Pierce County, Washington	**Field Representative:**

Prepared by:

Reviewed by:

B&L Woodwaste Site
Pierce County, Washington

Engineering Design Report (EDR) Addendum 3

Phase 2 Part 1 Remediation Design Report

Groundwater Recovery and Treatment System

Attachment 3H.2
Sample Forms for Technical Documentation

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Perimeter Air Monitoring Log

Solid Waste Disposal Tracking, Phase 1 Part 1 Cleanup Action

Waste Characterization Analytical Results, Phase 1 Part 1 Cleanup Action

Field Site Inspection Checklist

Inspections of our field sites will be conducted periodically and as needed to identify potential hazards. Appropriate corrective action will be taken when hazards are identified. The following checklist will be used to facilitate the inspection. A check mark indicates that an item has been inspected and appears to present no hazard in the best judgment of the person conducting the inspection. An N/A indicates that the item is not applicable at the time of inspection. If an unsafe condition exists, corrective action will be documented on the Corrective Action Form that follows the checklists.

PROJECT NAME: B&L Woodwaste Site; Phase 1 Part 1 Cleanup Action Plan ______________
____

PROJECT NUMBER: 13488.__________ PROJECT MANAGER: Tina Gary_____________

LOCATION: Pierce County, Washington____

INSPECTION CONDUCTED BY: ____

DATE OF INSPECTION: ____

1. TYPE OF FIELD PROJECT

_____ Does field work involve investigating, monitoring, or remediating environmentally released hazardous wastes and thus require compliance with 29 CFR 1910.120 or Cal OSHA 5192 regulations? If yes, complete Sections 2 through 8.

_____ Does field work involve being around construction activity, drilling, or heavy equipment? If yes, complete Section 9.

_____ Does field work involve any excavation or trenching activities? If yes, complete Section 10.

_____ Does field work involve entering a confined space? If yes, complete Section 11.

_____ Does field work involve potential exposure to excessive noise (for example, indoor drilling, air percussion drilling, pile driving, etc.)? If yes, complete Section 12.

List any specific site hazards not covered above.

____

____

____

_____ Is emergency information (location of nearest emergency medical facility and emergency phone numbers) readily available?

_____ Is a first-aid kit available at the field site?

2. SITE HEALTH AND SAFETY PLAN

_____ Is the site Health and Safety Plan (HASP) available on site?

_____ Does the HASP contain chemical information sheets for contaminants of concern at the site?

_____ Were health and safety briefings held before the start of field work?

_____ Were briefings documented as to content and attendance?

3. TRAINING AND MEDICAL MONITORING

_____ Do all employees working on site have documentation confirming 40-hour training and annual refresher updates?

_____ Do all employees working on site have documentation confirming participation in a periodic medical surveillance program?

_____ Have all employees working on site participated in a respiratory protection program and been fit-tested within the past year?

_____ Is at least one person on site currently certified in first aid/CPR?

_____ Have all employees working on site read the HASP, and do they understand site-specific hazards and requirements for site control, personal protective equipment, decontamination procedures, and emergency procedures?

_____ Is all above outlined documentation also available for all subcontractors working on site?

4. SITE CONTROL

_____ Are site control measures being implemented? Explain ________________________

____

_____ Is there a site map available to employees?

_____ Are work zones clearly defined/boundaried?

_____ Are on-site communication systems available?

5. WORK PRACTICES AND PERSONAL PROTECTIVE EQUIPMENT (PPE)

_____ Does the HASP contain appropriate requirements for PPE?

_____ Are the PPE requirements that are outlined in the HASP being followed by all on-site personnel?

_____ Is PPE being properly handled, cleaned, and stored?

_____ Is used PPE being properly decontaminated or disposed of?

_____ Are appropriate work practices being followed by all on-site personnel?

_____ Is drinking water available on site?

6. AIR MONITORING

_____ Is air monitoring being conducted on site?

Purpose: ____

Type: ____

_____ Are the people performing air monitoring properly trained in using the instruments?

_____ Are air monitoring instruments being properly calibrated?

_____ Is information on instrument calibration, background readings, and work site readings being properly recorded in the field notes?

_____ Is air monitoring performed at appropriate times during site work (when new activities are begun, at new locations, at frequent enough intervals, etc.)?

7. DECONTAMINATION

_____ Are appropriate decontamination procedures outlined in the HASP?

_____ Are the decontamination procedures outlined in the HASP being followed?

_____ Are decontamination wastes being handled and disposed of properly?

8. EMERGENCY PROCEDURES

_____ Are emergency procedures outlined in the HASP?

_____ Are on-site personnel familiar with emergency procedures?

_____ Is the route to the nearest medical facility provided in the HASP?

_____ Is there an evacuation meeting place designated and known to on-site personnel?

_____ Are emergency phone numbers readily available?

_____ Is there a first-aid kit and fire extinguisher available on site?

9. PERSONAL PROTECTIVE EQUIPMENT (PPE) FOR DRILLING OR CONSTRUCTION SITES

_____ Are field staff wearing hard hats and work boots?

_____ Is eye protection available and being worn around drilling rigs or other operating equipment?

_____ Is hearing protection available? In use?

_____ Is drinking water available on site?

10. EXCAVATION AND TRENCHING

_____ Does field work require anyone to enter trenches or excavations 5-feet deep or deeper?

_____ If so, has an OSHA permit been obtained, and are requirements of CCR Title 8 Sections 1504, 1539-1547 being met?

_____ Is a copy of the above regulations available at the site? (Note: Use a copy of the regulations to check that field work complies with the regulations.)

_____ Are employees wearing appropriate protective gear such as hard hats, work boots, safety glasses, and earplugs if needed?

11. CONFINED SPACE

_____ Does field work require entering a confined space?

_____ Has a confined space entry plan been developed to address air monitoring, ventilation, and surveillance requirements (CCR Title 8, Article 108)?

_____ Are requirements being met?

12. NOISE

_____ Are noise levels being measured and recorded in field notes?

_____ Are ear protectors available, and are employees properly fitted and instructed in their use?

Inspection Report and Corrective Action Form
Phase 1 Part 1 Cleanup Action

Location	Problem	Corrective Action

Perimeter Air Monitoring Log

PROJECT		**Name: B&L Woodwaste Site**	**Number: 13488.**				
PUMP		**Manufacturer:**	**Model:**				
Date	**Time**	**Location / Comments**	**Air Volume (Liters)**	**Sampling Results**			**Operator Initials**
				PCBs	Lead	Other	

Abbreviation:

PCB	Polychlorinated biphenyl

Solid Waste Disposal Tracking
Phase 1 Part 1 Cleanup Action

Shipment Date	Manifest No.	Estimated Weight (Ton)	Source Area	Material	Date Accumulated	Date Disposed	Certificate of Disposal	Actual Weight (Ton)

FLOYD | SNIDER
AMEC Geomatrix

B&L Woodwaste Site
Pierce County, WA

Waste Characterization Analytical Results
Part 1 Phase 1 Cleanup Action

Sample			Analytical Results (mg/kg)								Comments
Identification	Material	Date									

B&L Woodwaste Site
Pierce County, Washington

Engineering Design Report (EDR) Addendum 3

Phase 2 Part 1 Remediation Design Report

Groundwater Recovery and Treatment System

Appendix 3I

Health and Safety Plan

FINAL

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1.0 Plan Objectives and Applicability

This Health and Safety Plan (HASP) has been written to comply with the standards prescribed by the Occupational Safety and Health Act (OSHA) and the Washington Industrial Safety and Health Act (WISHA).

The purpose of this HASP is to establish protection standards and mandatory safe practices and procedures for personnel involved with the construction, commissioning, and startup of the groundwater recovery and treatment system. This work will be performed at the B&L Woodwaste Site (Site), which incorporates the B&L Property (Property) and several adjacent and nearby properties that have been affected by hazardous constituent releases from the B&L Woodwaste Landfill (Landfill). This HASP assigns responsibilities, establishes standard operating procedures, and provides for contingencies that may occur during field work activities. The plan consists of site descriptions, a summary of work activities, an identification and evaluation of chemical and physical hazards, monitoring procedures, personnel responsibilities, a description of site zones, decontamination and disposal practices, emergency procedures, and administrative requirements.

The provisions and procedures outlined by this HASP apply at a minimum to all contractors, subcontractors, oversight personnel, and all other persons involved with the field work activities described herein. All such persons are required to read this HASP and indicate that they understand its contents by signing the Health and Safety Officer/Site Supervisors' (HSO/SS) copy of this plan. It should be noted that contractors and subcontractors working on this project may develop additional plans addressing the health and safety of their employees and that address their specific work activities.

It should be noted that this HASP is based on information that was available as of the date indicated on the title page. It is possible that additional hazards that are not specifically addressed by this HASP may exist at the Site with the work addressed by this HASP, or may be created as a result of on-site activities. It is the firm belief of Floyd|Snider and AMEC Geomatrix, Inc. (AMEC) that active participation in health and safety procedures and acute awareness of on-site conditions by all workers is crucial to the health and safety of everyone involved. Should project personnel identify a site condition that is not addressed by this HASP and have any questions or concerns about site conditions, they should immediately notify the HSO/SS and an addendum will be provided to this HASP.

The HSO/SS has field responsibility for ensuring that the provisions outlined herein adequately protect worker health and safety and that the procedures outlined by this HASP are properly implemented. In this capacity, the HSO/SS will conduct regular site inspections to ensure that this HASP remains current with potentially changing site conditions. The HSO/SS has the authority to make health and safety decisions that may not be specifically outlined in this HASP, should site conditions warrant such actions. In the event that the HSO/SS leaves the Site while work is in progress, an alternate Site Safety Officer (SSO) will be designated. Personnel responsibilities are further described in Section 4.0.

This HASP has been reviewed by the Construction Manager (CM) and the HSO/SS prior to commencement of work activities. All Floyd|Snider and AMEC personnel shall review the plan and be familiar with on-site health and safety procedures. A copy of the HASP will be on-site at all times and available to all site workers.

2.0 Emergency Contacts and Information

2.1 DIAL 911

In the event of any emergency, DIAL 911 to reach fire, police, and first aid.

2.2 HOSPITAL AND POISON CONTROL

Nearest Hospital Location and Telephone: **(Refer to Figure 3I.1 for directions and map to the hospital.)**	**Tacoma General Hospital** **315 Martin Luther King Jr. Way** **Tacoma, WA 98405-4234** **(253) 403-1000**
Washington Poison Control Center:	**(800) 222-1222**

2.3 PROVIDE INFORMATION TO EMERGENCY PERSONNEL

All Floyd|Snider and AMEC project personnel should be prepared to give the following information:

Information to give to Emergency Personnel	
Site Location: **(Refer to Figure 3I.2 for directions and map to the Site.)**	B&L Woodwaste Site 2206 6th Ave. or 552 Fife Way, Milton/Fife, WA (Unincorporated Pierce County) **Landfill location:** the entrance is located ¼ mile north of intersection between 20th Street East and Fife Way. Enter from Fife Way.
Number that you are calling from:	Look on the phone you are calling from.
Describe accident and/or incident and numbers of personnel needing assistance.	Type of Accident Type(s) of Injuries

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3.0 Background Information

3.1 SITE BACKGROUND

The Site is located at 552-817 Fife Way, Milton/Fife, Washington (Unincorporated Pierce County). Groundwater impacted by arsenic is present beneath the Landfill and adjacent wetlands area. Site background information is discussed in detail in the Engineering Design Report (EDR; Floyd|Snider/AMEC 2009). Groundwater is being remediated in accordance with a Cleanup Action Plan (CAP) issued by the Washington Department of Ecology (Ecology) in 2008. The construction work covered by this HASP as a major component of the remedy specified in the CAP. Floyd|Snider and AMEC will oversee all field work conducted under this HASP on behalf of the B&L Woodwaste Site Custodial Trust (Trust) and Ecology. Construction work will be completed by independent contractors under contract with the Trust. Floyd|Snider and AMEC will jointly provide construction management and field engineering support for the construction project.

3.2 SCOPE OF WORK

This scope of work is Phase 2 Part 1 of the 2008 CAP remedy. The following construction work will be conducted under this HASP:

- Drilling, installation, and development of extraction and monitoring wells completed within groundwater contaminated with arsenic.
- Excavation of shallow utility trenches from the location of a groundwater treatment building to the extraction wells.
- Placement of pipelines, conduit, and wiring within the utility trenches, followed by backfilling of the trenches.
- Construction of a pre-manufactured building to house a groundwater treatment plant (GWTP).
- Installation of a groundwater treatment plant comprised of tanks, chemical feed equipment, pumps, filters, and adsorption vessels.
- Installation of instruments within the GWTP and within existing piezometers and wells within and outside the limits of the Landfill.
- Installation of electrical, potable water, and sanitary sewer utilities for the GWTP building.
- Installation and testing of electrical equipment and instruments, including an automated control and data acquisition system.
- Grading and seeding of disturbed areas to control stormwater runoff and erosion.
- Installation of security fencing around the GWTP building.

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4.0 Primary Responsibilities

4.1 PROJECT COORDINATOR

The Project Coordinator (PC) will approve this HASP and any amendments thereof, and will ultimately be responsible for full implementation of all elements of the HASP.

4.2 CONSTRUCTION MANAGER

The CM will have overall responsibility for the completion of the project, including the implementation and review of this HASP. The CM will review health and safety issues as needed and as consulted, and will have authority to allocate resources and personnel to safely accomplish the field work.

The CM will direct all Floyd|Snider and AMEC personnel involved in field work at the Site. If the project scope changes, the CM will notify the HSO/SS so that the appropriate addendum will be included in the HASP. The CM will ensure that all Floyd|Snider and AMEC personnel on-site have received the required training, are familiar with the HASP, understand safe work practices, and understand the procedures to follow should an accident and/or incident occur on-site.

4.3 HEALTH AND SAFETY OFFICER AND SITE SUPERVISOR

The HSO/SS will advise the CM and project personnel on all potential health and safety issues of the field investigation and remedial activities to be conducted at the Site. The HSO/SS will specify required exposure monitoring to assess site health and safety conditions, modify the site HASP based on field assessment of health and safety accidents and/or incidents, and recommend corrective action if needed. The HSO/SS will report all accidents and/or incidents to the CM. If the HSO/SS observes unsafe working conditions by Floyd|Snider and AMEC personnel or any contractor personnel, the HSO/SS will suspend all work until the hazard has been addressed.

4.4 SITE SAFETY OFFICER

The SSO may be a person dedicated to this task **to** assist the HSO/SS during field work activities. The SSO will ensure that all personnel have appropriate personal protective equipment (PPE) on-site and PPE is properly used. The SSO will assist the HSO/SS in field observation of Floyd|Snider, AMEC, and contractor personnel safety. If a health or safety hazard is observed, the SSO shall suspend all work activity. The SSO will conduct on-site safety meetings daily before work commences. All health and safety equipment (e.g., air monitoring instrument) will be daily calibrated and records kept in the daily field logbook. The SSO may perform exposure monitoring if needed and will ensure that equipment is properly maintained.

4.5 FLOYD|SNIDER AND AMEC PROJECT PERSONNEL

All Floyd|Snider and AMEC project personnel involved in constructon or construction-related activities will take precautions to prevent accidents and/or incidents from occurring to themselves and others in the work areas. Employees will report all accidents and/or incidents or other unsafe working conditions to the HSO/SS or SSO immediately. Employees will inform the HSO/SS or SSO of any physical conditions that could impact their ability to perform field work.

4.6 TRAINING REQUIREMENTS

All Floyd|Snider and AMEC project personnel must comply with applicable regulations specified in the Washington Administrative Code (WAC) Chapter 296-843, Hazardous Waste Operations Training (HAZWOPER), administered by the Washington State Department of Labor and Industries (L&I). Project personnel working independently at the project site will be 40-hour HAZWOPER trained and maintain their training with an annual 8-hour refresher. Personnel with limited tasks and minimal exposure potential will be required to have 24-hour training and a site hazard briefing and be escorted by a trained employee. Personnel with defined tasks that do not include potential contact with disturbed site soils, waste, groundwater, or exposures to visible dust (e.g., surveying or construction in clean areas) are not required to have any level of hazardous waste training beyond a site emergency briefing and hazard orientation by the HSO/SS. Floyd|Snider and AMEC project personnel will fulfill the medical surveillance program and respiratory protection program requirements.

In addition to the 40-hour course and 8-hour refreshers, the HSO/SS will have completed an 8-hour HAZWOPER Supervisor training as required by WAC 296-843-20015. At least one person on-site during field work will have current CPR/First Aid certification. All field personnel have a minimum of 3 days of hazardous materials field experience under the direction of a skilled supervisor. Documentation of all required training will be maintained in a 3-ring binder on-site and kept either in the HSO/SS vehicle or equipment storage bin.

Additional site-specific training that covers on-site hazards, PPE requirements, use and limitations, decontamination procedures, and emergency response information as outlined in this HASP will be given by the HSO/SS before on-site work activities begin. Daily health and safety meetings will be documented on the Daily Tailgate Safety Meeting form included in this HASP as Attachment 3I.A.

4.7 MEDICAL SURVEILLANCE

All Floyd|Snider and AMEC field personnel are required to participate in their respective company's medical surveillance program, which includes annual audiometric and physical examinations for employees involved in HAZWOPER projects. The program requires medical clearance before respirator use or participating in HAZWOPER activities. Medical examinations must be completed before conducting field work activities and on an annual basis.

5.0 Hazard Evaluation and Risk Analysis

In general, there are three broad hazard categories that may be encountered during site work: chemical exposure hazards, fire/explosion hazards, and physical hazards. Sections 5.1 through 5.3 discuss the specific hazards that fall within each of these broad categories.

5.1 CHEMICAL EXPOSURE HAZARDS

The following subsections describe chemical hazards associated with the trenching and placement of underground utilities and pipelines (Section 5.1.1), and for installation of extraction and/or monitoring and extraction wells (Section 5.1.2). Potential routes of exposure are described in the following paragraph. Chemical exposure hazards are not anticipated when measuring groundwater elevations or during above-ground construction because there will be no contact with contaminated materials during these tasks.

Potential routes of exposure include inhalation, dermal contact, ingestion, and eye contact. The primary route of exposure during site work is inhalation of dust from contaminated soil or waste, with a lesser likelihood of ingestion of contaminated soil, waste, and/or groundwater. Short-term inhalation exposure to elevated arsenic is unlikely to cause noticeable effects beyond upper respiratory tract irritation. Long-term exposure, or brief exposure to very high levels, can cause swelling of the face, nausea, vomiting, stomach pain, or diarrhea. Other effects of significant exposures to arsenic include internal bleeding, nerve damage, weakness, or loss of sensation in the hands, feet, arms, or legs, and long-term exposure to small amounts of arsenic (greater than 6 months) has been linked to bladder cancer, lung cancer, cardiovascular disease, and diabetes.

Inhalation of volatile arsenic species (e.g., dimethyl and trimethyl arsine) associated with organics in the Landfill or the wetlands is considered highly unlikely. When new areas of excavation or drilling are opened, the site HSO/SS will be alert for disagreeable garlic/onion odors that would indicate volatile arsenic species. Further details on air monitoring are provided in Section 6.0. Lead and copper are also present in the Landfill but at levels that would not pose an inhalation hazard.

5.1.1 Utility Trench Excavation and Installation of Underground Lines and Utilities

Trench excavation will begin with the removal of soil from the areas designated for trenching. This will include portions of the landfill cap and areas outside the Landfill, including properties to the north and west of the B&L Property. Arsenic concentrations are not anticipated to exceed cleanup levels in soils to be exposed during trench excavation, as the trenches are located in areas with no known soil contamination. During excavation of the trenches in the areas north of the Landfill, there is potential to expose groundwater. If groundwater is exposed, groundwater arsenic concentrations as high as 3,000 ppb may be encountered. Higher groundwater arsenic concentrations may be encountered in the area immediately north of the Northern Stormwater Pond (Drawing C-04 of EDR Addendum 3). Appropriate precautions and PPE should be implemented during trench excavation and placement of pipe, conduits, and wiring to avoid contact or exposure to groundwater.

Wood waste and copper smelting slag (slag), a shiny black granular material, is present in landfilled waste. Although these materials are not known to be present outside the Landfill, they could be encountered during trench excavation in areas outside the landfill cap. The piping and utility trenches to be installed on the upgradient (east) portion of the perimeter road are known to be free of buried waste and slag. If woodwaste or slag is encountered during trench excavation, they should be assumed to contain arsenic concentrations above cleanup levels and precautions should be implemented to minimize the potential for contact and exposure. Based on existing site characterization data, the highest concentration in the woodwaste fill boring samples was 1,150 mg/kg for arsenic, 1,630 mg/kg for copper, and 860 mg/kg for lead. Of these constituents, arsenic represents the greatest hazard for dust inhalation and/or ingestion. The 95 percent upper confidence limit on the arithmetic mean concentration of waste within the Landfill was 860 mg/kg for arsenic, 1,368 mg/kg for lead and 1,927 mg/kg for copper based on the distribution of 9 samples. All site soils outside of the Landfill are expected to have arsenic concentrations below cleanup levels.

5.1.2 Extraction and Monitoring Well Installation

A total of 15 groundwater extraction wells and 8 monitoring wells will be installed for this remediation project. Of these, 5 extraction wells will be placed within the Landfill, requiring drilling through the woodwaste. Groundwater arsenic concentrations of less than 2 to 5,000 ppb are anticipated during well installation, as all wells will be placed within highly contaminated portions of the groundwater plume. The locations of the extraction and monitoring wells are shown on EDR Addendum 3 Drawing C-02. Borings for wells located outside of the Landfill are not anticipated to intersect woodwaste or slag, but will be drilled within the groundwater plume.

The saturated woodwaste and slag that will be encountered during installation of wells within the Landfill will contain arsenic at concentrations significantly above cleanup levels. Safety procedures, PPE requirements, and dust monitoring must be conducted as described in Section 6.0.

5.2 FIRE AND EXPLOSION HAZARDS

Flammable and combustible liquid hazards may occur from fuels and lubricants brought to the property to support heavy equipment and, if necessary, portable generators or compressors. When on-site storage is necessary, such material will be stored in containers approved by the Department of Transportation (DOT) in a location not exposed to strike hazards and provided with secondary containment. A minimum 2-A:20-B fire extinguisher will be located within 25 feet of the storage location, and where refueling occurs. Transferring of flammable liquids (e.g., gasoline) will occur only after making positive metal to metal connection between the containers; a bonding strap may be necessary to achieve this. Storage of ignition and combustible materials will be kept away from storage and fueling operations.

The possibility of a flammable or explosive release of methane during well drilling is considered remote because the Landfill has passed the methanogenic phase of decomposition. Site features, including the cap and limits of woodwaste, are well-established and appear on site drawings. The site HSO/SS will remain vigilant for signs of methane release during all drilling activities.

For well installation and other subsurface activities conducted within or near the limits of woodwaste, appropriate air monitoring will be conducted. Further detail on air monitoring is provided in Section 6.0.

5.3 PHYSICAL HAZARDS

When working in or around any hazardous or potentially hazardous substances or situations, all site personnel should plan all activities before starting any task. Site personnel shall identify health and safety hazards involved with the work planned and consult with the HSO/SS as to how the task can be performed in the safest manner, and if personnel have any reasons for concern or uncertainty.

All field personnel will adhere to general safety rules including wearing appropriate PPE, hard hats, safety vests, and safety glasses. Eating, drinking, and/or use of tobacco or cosmetics will be restricted in all work areas. Personnel will prevent splashing of liquids containing chemicals and minimize dust emissions.

The following table summarizes a variety of physical hazards that may be encountered on the Site during work activities. For convenience, these hazards have been categorized into several general groupings with recommended preventative measures.

Hazard	Cause	Prevention
Head strike	Falling and/or sharp objects, bumping hazards.	Hard hats will be worn by all personnel at all times when overhead hazards exist, such as during drilling activities and around large, heavy equipment.
Foot/ankle twist, crush, slip/trip/fall, and chemical exposure	Sharp objects, dropped objects, uneven and/or slippery surfaces, chemical exposure.	Steel-toed boots must be worn at all times on-site while heavy equipment is present. Pay attention to footing on uneven or wet terrain and do not run. Keep work areas organized and free from unmarked trip hazards.
Hand cuts, splinters, and chemical contact	Hands or fingers pinched or crushed; chemical hazards including dermal exposure to nitric acid, chemical spills, or reagents. Cut or splinters from handling sharp/rough objects and tools.	***Nitrile*** safety gloves will be worn to protect the hands from dust and chemicals. Leather or cotton outer gloves will be used when handling sharp-edged rough materials or equipment. See preventive measures for mechanical hazards below.
Eye damage from flying materials	Sharp objects, poor lighting, exposure due to flying debris or splashes.	Safety glasses will be worn at all times on-site. If a pressure washer is used to decontaminate heavy equipment, a face shield will be worn over safety glasses or goggles.

Hazard	Cause	Prevention
Electrical hazards	Underground utilities, overhead utilities. Electrical cord hazards. Incorrect grounding of the portable generator.	Utility locator service will be used prior to any investigation to locate all underground utilities. Visual inspection of work areas prior to starting work. Whenever possible, avoid working under overhead high voltage lines. The HSO/SS is responsible for documenting a determination of the voltage and minimum approach distance to any potentially energized electrical distribution line. Lines will be confirmed to be de-energized when minimum approach distances cannot be met as referenced in WAC 296-24-960. This should be discussed during the tailgate safety meetings. Make sure that no damage to extension cords occurs. If an extension cord is used, make sure it is the proper size for the load that is being served and rated SJOW or STOW (an “-A” extension is acceptable for either) and inspected prior to use for defects. The plug connection on each end should be of good integrity. Insulation must be intact and extend to the plugs at either end of the cord.

Hazard	Cause	Prevention
Electrical hazards (continued)		Only qualified electricians will work on exposed energized conductors operating at more than 50 volts to ground. All portable power tools will be inspected for defects before use and must either be a double-insulated design or grounded with a ground-fault circuit interrupter (GFCI). Maintain and operate portable generators in accordance with the manufacturer's use and safety instructions and the following: • Always plug electrical appliances and tools directly into the generator, using the appliance manufacturer's supplied cords. Use heavy-duty extension cords that contain a grounding conductor (3-wire flexible cord and 3-pronged cord connectors). • Use GFCIs on all generators. • Visually inspect the equipment before use; remove defective equipment from service and mark or tag it as unsafe for use.
Mechanical hazards	Heavy equipment such as drill rigs, service trucks, mowing equipment, saws, drills, etc.	Ensure the use of competent operators, backup alarms, regular maintenance, daily mechanical checks, and proper guards. Subcontractors will supply their own HASP. All project personnel will wear high-visibility vests around equipment, making eye contact with operator and obtaining a clear OK before approaching or working within swing radius of heavy equipment, staying clear of swing radius. Obey on-site speed limits.
Noise damage to hearing	Machinery creating more than 85 decibels TWA, less than 115 decibels continuous noise, or peak at less than 140 decibels.	Wear earplugs or protective ear covers when a conversational level of speech is difficult to hear at a distance of 3 feet; when in doubt, a sound level meter may be used on-site to document noise exposure.
Falling into excavations	Elevated and/or slippery or uneven surfaces, including wetland pits, surface water, and mud. Trips caused by poor "house keeping" practices.	Guardrails or fall protection devices are required on elevated surfaces greater than 4 feet to the level below, if approached by persons not immediately involved in the excavation (note that flagging would not be adequate).

Hazard	Cause	Prevention
Strains from improper lifting	Injury due to improper lifting techniques, overreaching/ overextending, lifting overly heavy objects.	Use proper lifting techniques and mechanical devices where appropriate. The proper lifting procedure first involves testing the weight of the load by tipping it. If in doubt, ask for help. Do not attempt to lift a heavy load alone. Take a good stance and plant your feet firmly with legs apart, one foot farther back than the other. Make sure you stand on a level area with no slick spots or loose gravel. Use as much of your hands as possible, not just your fingers. Keep your back straight, almost vertical. Bend at the hips, holding load close to your body. Keep the weight of your body over your feet for good balance. Use large leg muscles to lift. Push up with one foot positioned in the rear as you start to lift. Avoid quick, jerky movements and twisting motions. Turn the forward foot and point it in the direction of the eventual movement. Never try to lift more than that to which you are accustomed.
Inhalation exposures	Dust.	No volatile organic species are anticipated. Airborne dust levels are not expected to exceed action levels. If air monitoring indicates a potential hazard from airborne arsenic dust, a respiratory protection addendum will be developed for this HASP. **Further detail on air monitoring is provided in Section 6.0.**
Heat exposure	High temperatures exacerbated by PPE, dehydration.	Workers will ensure adequate hydration, shade, and breaks when temperatures are elevated. **Further detail on heat stress in provided in Section 5.3.1.**
Accidents due to inadequate lighting	Improper illumination.	Work will proceed during daylight hours only, or under sufficient artificial light.

5.3.1 Heat Stress

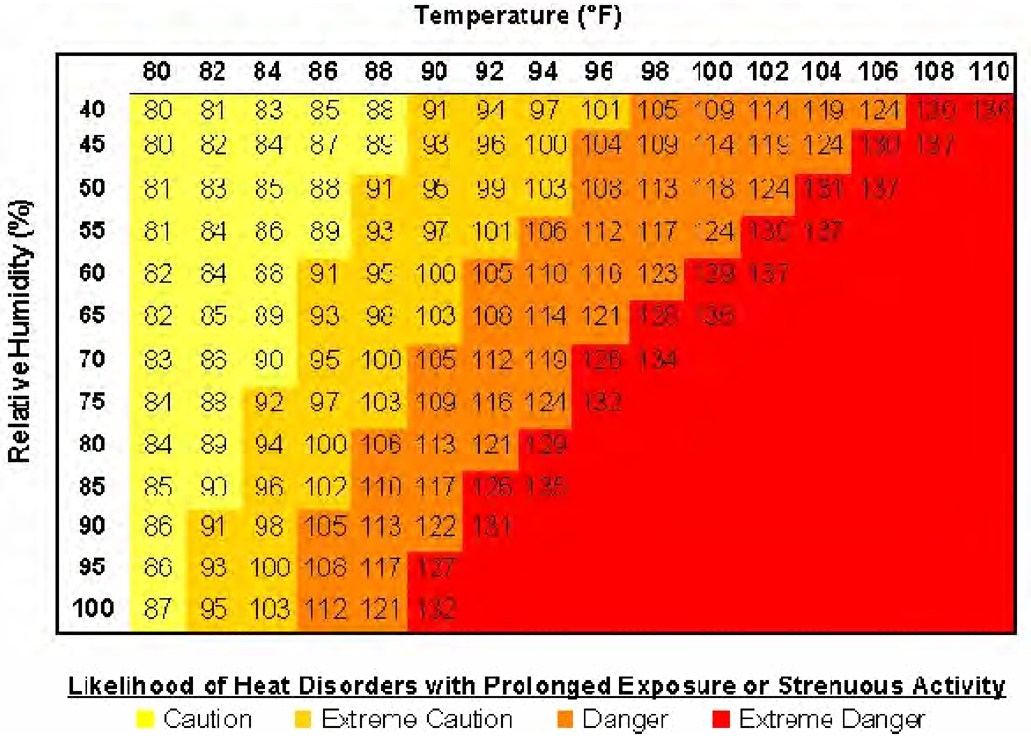
To avoid heat-related illness, current regulations in WAC 296-62-095 through 296-62-09570 will be followed during all outdoor work activities. Floyd|Snider and AMEC will identify and evaluate temperature, humidity and other environmental factors associated with heat-related illness including but not limited to the provision of rest breaks that are adjusted for environmental factors, and encourage frequent consumption of drinking water. Drinking water will be provided and made readily accessible in sufficient quantity to provide at least 1 quart per employee per hour. All Floyd|Snider and AMEC personnel will be informed and trained for responding to signs or symptoms of possible heat-related illness and accessing medical aid.

Employees showing signs or demonstrating symptoms of heat-related illness must be relieved from duty and provided with a sufficient means to reduce body temperature, including rest areas or temperature controlled environments (i.e., air conditioned vehicle). Any employee showing signs or demonstrating symptoms of heat-related illness must be carefully evaluated to determine whether it is appropriate to return to work or if medical attention is necessary. Any incidence of heat-related illness must be immediately reported to the employer directly through the HSO/SS.

The signs, symptoms, and treatment of heat stress include the following:

Condition	Signs/Symptoms	Treatment
Heat Cramps	Painful muscle spasms and heavy sweating.	Increase water intake; rest in shade/cool environment.
Heat Syncope	Brief fainting and blurred vision.	Increase water intak;, rest in shade/cool environment.
Dehydration	Fatigue, reduced movement, headaches.	Increase water intake; rest in shade/cool environment.
Heat Exhaustion	Pale and clammy skin, possible fainting, weakness, fatigue, nausea, dizziness, heaving, sweating, blurred vision, body temperature slightly elevated.	Lie down in cool environment, increase water intake, and loosen clothing. Call 911 for ambulance transport if symptoms continue once in cool environment.
Heat Stroke	Cessation of sweating, skin hot and dry, red face, high body temperature, unconsciousness, collapse, convulsions, confusion or erratic behavior, life threatening condition.	**Medical Emergency!! Call 911** for ambulance transport. Move victim to shade and immerse in water.

If workplace temperatures are forecast to exceed 85 degrees Fahrenheit and physically demanding work will occur that requires impermeable clothing as part of the PPE, the HSO/SS will promptly consult with a certified industrial hygienist (CIH) prior to performing the work, and a radial pulse monitoring method will be implemented to ensure that heat stress is properly monitored and managed among the affected workers. The following heat index chart indicates the relative risk of heat stress:



Temperature (°F)

Relative Humidity (%)	80	82	84	86	88	90	92	94	96	98	100	102	104	106	108	110
40	80	81	83	85	88	91	94	97	101	105	109	114	119	124	130	136
45	80	82	84	87	89	93	96	100	104	109	114	119	124	130	137	
50	81	83	85	88	91	95	99	103	108	113	118	124	131	137		
55	81	84	86	89	93	97	101	106	112	117	124	130	137			
60	82	84	88	91	95	100	105	110	116	123	129	137				
65	82	85	89	93	98	103	108	114	121	128	136					
70	83	86	90	95	100	105	112	119	126	134						
75	84	88	92	97	103	109	116	124	132							
80	84	89	94	100	106	113	121	129								
85	85	90	96	102	110	117	126	135								
90	86	91	98	105	113	122	131									
95	86	93	100	108	117	127										
100	87	95	103	112	121	132										

Likelihood of Heat Disorders with Prolonged Exposure or Strenuous Activity

🟨 Caution 🟨 Extreme Caution 🟧 Danger 🟥 Extreme Danger

5.3.2 Sunburn Hazards

Skin exposure to ultraviolet radiation can result in sunburn. Site personnel will use long-sleeved shirts, hats, and sunscreen as needed to protect against sunburn.

5.3.3 Cold Stress

The construction work will be conducted in summer and winter months. Due to warm summers and mild winters, it is unlikely that cold stress will be a health and safety concern for the work covered by this HASP. Additionally, most of the work to be performed during the winter will be completed within the GWTP building.

However, should work be conducted in the colder months of the year and/or near a body of water, exposure to moderate levels of cold can cause the body's internal temperature to drop to a dangerously low level, causing hypothermia. Symptoms of hypothermia include slow, slurred speech, mental confusion, forgetfulness, memory lapses, lack of coordination, and drowsiness.

To prevent hypothermia, site personnel will stay dry and avoid exposure during cold weather work. Site personnel will be encouraged to wear sufficient clothing in layers such that outer clothing is wind- and waterproof and inner layers retain warmth (wool or polypropylene), if applicable. Site personnel will keep hands and feet well protected at all times during cold weather work.

5.3.4 Biohazards

Bees and other insects may be encountered during the field work tasks. Persons with allergies to bees will make the HSO/SS aware of their allergies and will avoid areas where bees are identified. Controls such as repellents, hoods, nettings, masks, or other personal protection may be used. Report any insect bites or stings to the HSO/SS and seek first aid if necessary.

Site personnel will maintain a safe distance from any urban wildlife encountered, including raccoons and rodents, to preclude a bite from a sick or injured animal. Personnel will be gloved and will use tools to lift covers from catch basins and monitoring wells.

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6.0 Site and Air Monitoring

The following sections describe site monitoring techniques and equipment that are to be used during site field activities. The HSO/SS or a designated alternate is responsible for site control and air monitoring activities.

6.1 SITE MONITORING

The HSO/SS will visually inspect the work site at least daily to identify any new potential hazards. If new potential hazards are identified, immediate measures will be taken to eliminate or reduce the risks associated with these hazards.

6.2 AIR MONITORING

Air monitoring using a photoionization detector (PID) will not be performed, as site contaminants are not volatile. While work is being conducted within or near the Landfill, and if indications of organic vapors are noted, an H_2S/LEL meter will be used to screen new excavation areas and borings. Significant exposure to dust containing arsenic is unlikely for all work other than drilling for installation of extraction wells within the Landfill area. Significant exposure to dust containing arsenic is also unlikely during drilling and well installation because the soil borings will generate a relatively small amount of cuttings. Based on the arsenic levels found within the Landfill (a very conservative assumption), dust generated from drilling is unlikely to contain a hazardous level of arsenic. However, an action level for sustained levels of dust exposure in the breathing zone of site workers has been established to guard against any risk of arsenic exposure above the permissible exposure limit (PEL).

Off-site receptors are unlikely to be exposed to any arsenic contained in fugitive dust generated during soil boring within the Landfill because ground disturbance should be limited and cuttings are expected to be damp. Excavation for trenches and grading in areas outside the Landfill, in contrast, could generate significant fugitive dust. However, this is unlikely to create an arsenic exposure hazard because site investigations have found that arsenic contaminated soils are not present in the work areas outside the Landfill. Therefore, a perimeter dust exposure level has been established to control exposures to fugitive dust from soil excavations. The applicable ambient air quality standard for total suspended particulate per WAC 173-400-100(1) is 150 micrograms per cubic meter ($\mu g/m^3$), averaged over 24 hours. Site work will not occur for more than 12 hours per day, thus adhering to this criterion for the duration of excavation and providing a substantial margin to protect offsite receptors from adverse effects due to earthwork. The air monitoring action levels are presented in the table below:

Air Monitoring Action Levels

Dust Reading (mg/m^{3}above background)	Action
Levels in Work Area	
No visible dust > 5 minutes in work area	Continue periodic observation for dust.
Visible dust > 5 minutes in work area	Implement dust monitoring using instrumentation (below).
Levels in Breathing Zone of Site Workers (PELs: 10 mg/m^3 dust, 0.01 mg/m^3 arsenic over 8 hours)	
<1.3 mg/m^3 >5 minutes in breathing zone	Continue periodic monitoring (each new area/every 2 hours).
≥ 1.3 mg/m^3 >5 minutes in breathing zone	Initiate or improve dust suppression, or reduce excavation rate. Monitor exposed personnel more frequently.
>2.6 mg/m^3 >5 minutes in breathing zone	Improve dust suppression, consult CIH for possible personal exposure monitoring for arsenic.
Levels at Downwind Perimeter of Site (National Ambient Air Quality Standard [NAAQS]: 150 µg/m^3 over 24 hours)	
<0.15 mg/m^3 at downwind perimeter	Continue periodic monitoring (every 2 hours).
≥ 0.15 mg/m^3 at downwind perimeter	Initiate or improve dust suppression, or reduce excavation rate. Monitor upwind/downwind ambient concentrations more frequently. If downwind levels over duration of work day exceed upwind perimeter by 0.15 mg/m3, stop work and consult CIH for possible high-volume ambient air monitoring.

The HSO/SS will look for the presence of dust in the work area and depending on the results will implement dust suppression controls (water application, work pacing, equipment speed limits) and measure dust levels using a TSI AM510 personal particulate monitor (or equivalent) with no size selective inlet.

The action levels are conservative action levels based on maximum detected arsenic concentrations in site soils. The HSO/SS, through consultation with a CIH, may revise these action levels based on analytical results of air sampling for arsenic, up to a maximum of 10 mg/m^3. The maximum particulate concentration at which work may proceed at the Site without use of respirators is 10 mg/m^3. All air monitoring equipment will be calibrated on a daily basis according to manufacturer specifications.

7.0 Hazard Analysis by Task

The following section identifies potential hazards associated with each task listed in Section 3.2 of this HASP. Tasks have been grouped according to the types of potential hazard associated with them.

Task	Potential Hazard
Forming of building foundation and pouring/working concrete foundation	Exposure to loud noise; overhead hazards; head, foot, ankle, hand, and eye hazards; electrical and mechanical hazards; lifting hazards; dust inhalation hazards; fall hazards; heat exposure hazards; biological hazards; and chemical hazards associated with cement.
Construction of building, including structural steel, shell, and interior structures	Exposure to loud noise; overhead hazards; head, foot, ankle, hand, and eye hazards; electrical and mechanical hazards; lifting hazards; rigging hazards, dust inhalation hazards; fall hazards; heat exposure hazards; and biological hazards.
Placement and installation of tanks and vessels for the GWTP	Exposure to loud noise; overhead hazards; head, foot, ankle, hand, and eye hazards; electrical and mechanical hazards; lifting hazards; rigging hazards, dust inhalation hazards; fall hazards; heat exposure hazards; and biological hazards.
Placement and installation of pumps and feed system.	Exposure to loud noise; head, foot, ankle, hand, and eye hazards; electrical and mechanical hazards; lifting hazards; dust inhalation hazards; fall hazards; heat exposure hazards; and biological hazards.
Piping for GWTP	Exposure to loud noise; head, foot, ankle, hand, and eye hazards; electrical and mechanical hazards; lifting hazards; dust inhalation hazards; fall hazards; heat exposure hazards; and biological hazards.
Excavation of trench and installation of pipe, conduits, and vaults	Exposure to loud noise; head, foot, ankle, hand, and eye hazards; electrical and mechanical hazards; lifting hazards; dust inhalation hazards; fall hazards; heat exposure hazards; and biological hazards.

Task	Potential Hazard
Installation of extraction and monitoring wells	Exposure to loud noise; overhead hazards; head, foot, ankle, hand, and eye hazards; electrical and mechanical hazards; lifting hazards; dust inhalation hazards; potential dermal exposure to arsenic in groundwater, soil, slag, and woodwaste; fall hazards; heat exposure hazards; and biological hazards.
Surface completions for extraction wells.	Exposure to loud noise; head, foot, ankle, hand, and eye hazards; electrical and mechanical hazards; lifting hazards; dust inhalation hazards; fall hazards; heat exposure hazards; and biological hazards.
Pressure and leak testing of lines and vessels	Exposure to loud noise; head, foot, ankle, hand, and eye hazards; electrical and mechanical hazards; lifting hazards; dust inhalation hazards; fall hazards; heat exposure hazards; and biological hazards.
Surveying	Exposure to loud noise; head, foot, ankle, hand, and eye hazards; electrical and mechanical hazards; lifting hazards; dust inhalation hazards; fall hazards; heat exposure hazards; and biological hazards, traffic hazards.
Measurement of groundwater elevations from piezometers	Chemical hazards include potential dermal or eye exposure to arsenic in groundwater. Physical hazards include slip, trip, or fall hazards; heat exposure hazards; and biological hazards.

8.0 Personal Protective Equipment

All work involving subsurface excavation or trenching, drilling, and well installation will proceed in Level D PPE, which shall include hard hat, steel-toed boots, hearing protection, eye protection, gloves, and sturdy cotton outer work clothing (if personnel will not contact soils or dust) or removable cotton outer clothing (if personnel will contact soils or dust). Standard PPE for all other site work will include hard hat, steel-toed boots, and eye protection. Workers should have hearing protection and gloves available for use if conditions warrant, as directed by the HSO/SSO.

All personnel will be properly fitted and trained in the use of PPE. The level of protection will be upgraded by the HSO/SS whenever warranted by conditions present in the work area. The HSO/SS will periodically inspect equipment such as gloves, hard hats, and respirators for defects.

For all work involving potential exposure to groundwater, workers will wear nitrile gloves and Level D PPE. Some areas may require the use of hip-waders to prevent dermal contact with arsenic-contaminated surface water and sediment.

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9.0 Site Control

The Site is located in a relatively isolated area. Pedestrians and other unauthorized personnel will not be allowed in the work area. Access to the work site will be restricted to designated personnel. The purpose of site control is to minimize the public's potential exposure to site hazards, to prevent vandalism in the work area and access by children and other unauthorized persons, and to provide adequate facilities for workers. A daily field log will be maintained by the HSO/SS. The field log will include a list of all on-site personnel and visitors.

Fencing and locked gates will prevent after-hour access to the Landfill. Temporary construction fencing, signage, or other appropriate control measures will be maintained in all work areas to limit access during and after work hours.

Work areas will be accessible by the Interurban Trail, a paved bicycle and pedestrian access trail that is located between the Landfill and the wetlands area north of the Landfill. Temporary fencing will be established to keep the public out of work areas. For work in the Interurban Trail, site controls will be implemented in accordance with the City of Milton street work requirements including, but not limited to, warning signs and traffic cones. If necessary, the Interurban Trail will be temporarily blocked to maintain site control.

Work area controls and decontamination areas will be provided to limit the potential for chemical exposure associated with well drilling and trenching in the wetlands areas, as these are the work locations with potential for exposure to contaminated media. The support zone (SZ) for the Site includes all areas outside the work area and decontamination areas. Decontamination procedures will only be required if either groundwater or waste is encountered during well drilling or trenching. Localized and moving exclusion zones (EZs), contamination reduction zones (CRZs), and SZs will be set up for drilling wherever it is conducted and for trenching in the areas outside the limits of the Landfill (i.e., edge of woodwaste). Due to the nature of trenching and drilling, the EZ,CRZ, and SZ will move with the excavation or drilling location. When the ground surface is broken for a trench, the disturbed area is deemed to be part of the EZ and will remain part of the EZ until the trench is backfilled to grade. When the surface is broken for a well, the borehole area is deemed the EZ and will remain part of the EZ until the well has been installed and grouted. The CRZ and SZ will move with the EZ, maintaining an appropriate buffer around the EZ. Only authorized personnel shall be permitted access to the EZ/CRZ. For work being conducted outside the limits of the Landfill and portions of the work area that do not have known arsenic contamination in soil, the EZ/CRZ around work locations will be demarcated with cones and/or barrier hazard tape as needed to effectively limit unauthorized access.

Because dermal transfer and ingestion are the main exposure routes, no cosmetics application, smoking, and/or eating may occur in the EZ. All hands must be washed before exiting the work areas. Portable restrooms with hand sanitizers will be provided on the Site.

All site work will occur in teams and the primary means of communication on-site and with off-site contacts will be via cell phones. An agreed-upon system of alerting via air horns and/or vehicle horns may be used around heavy equipment to signal an emergency if shouting is ineffective.

10.0 Decontamination

Decontamination procedures will be strictly followed to prevent off-site spread of arsenic contaminated soil or water during work associated with drilling wells and trenching in the wetlands areas. Decontamination effectiveness will be assessed by visual inspection by the HSO/SS. Decontamination water, drummed soil, and PPE will be collected and containerized on-site, labeled until hazardous waste characterization is completed, and disposed of in accordance with applicable regulations.

10.1 PERSONNEL/HAND EQUIPMENT DECONTAMINATION PROCEDURES

The CRZ will be equipped with a decontamination station including plastic sheeting, paper towels, trash bags, small broom, wash tub, rinse tub, Alconox detergent, long-handle brush and bucket, and water sprayer. The following decontamination procedures will be followed:

1. Brush off residual soils at exit from EZ; drop equipment on plastic sheeting.
2. Wash and rinse outer gloves; remove them (may be reused on same project).
3. Wipe down equipment with soapy water-moistened paper towels, followed by clean water-moistened paper towels; place trash in bag.
4. Remove inner gloves and place in trash bag.

10.2 DECONTAMINATION PROCEDURES FOR HEAVY EQUIPMENT

Heavy equipment will be swept off at a CRZ when leaving an EZ and proceeding through the SZ. In addition, heavy equipment will be swept off and/or pressure-washed or hand washed with a minimum amount of soapy water to achieve visible cleanliness prior to leaving the Site.

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11.0 Emergency Response and Contingency Plan

This section defines the emergency action plan for the Site. It will be rehearsed with all site personnel and reviewed with visitors upon their initial site visit, and whenever the plan is modified or the HSO/SS believes that site personnel are unclear about the appropriate emergency actions.

A muster point of refuge will be identified by the HSO/SS and communicated to the field team each day. This point will be clear of adjacent hazards and preferably up- or cross-wind for the entire day. In an emergency, all site personnel and visitors will evacuate to the muster point for roll call versus the daily site log. It is important that each person on-site understand their role in an emergency, and that they remain calm and efficiently act to ensure everyone's safety.

After each emergency is resolved, the entire project team will meet and debrief on the incident—the purpose is not to fix blame, but to improve the planning and response to future emergencies. The debriefing will review the sequence of events, what was done well, and what can be improved. The debriefing will be documented in a written format and communicated to the CM. Modifications to the emergency plan will be approved by the CM.

Reasonably foreseeable emergency situations include medical emergencies, accidental release of hazardous materials (such as gasoline or diesel) or hazardous waste, and general emergencies such as vehicle accident, fire, thunderstorm, and earthquake. Expected actions for each potential incident are outlined below.

11.1 MEDICAL EMERGENCIES

In the event of a medical emergency, the following procedures should be used:

1. Stop any imminent hazard if you can safely do so.
2. Remove ill, injured, or exposed person(s) from immediate danger if moving them will clearly not cause them harm and no hazards exist to the rescuers.
3. Evacuate other on-site personnel to a safe place in an upwind or cross-wind direction until it is safe for work to resume.

   If serious injury or life-threatening condition exists, call **911** for paramedics, the fire department, and the police.

   Clearly describe the location, injury, and conditions to the dispatcher. Designate a person to go to the site entrance and direct emergency equipment to the injured person(s). Provide the responders with a copy of this HASP to alert them to chemicals of potential concern.
4. Trained personnel may provide first aid/cardiopulmonary resuscitation if it is necessary and safe to do so. Remove contaminated clothing and PPE only if this can be done without endangering the injured person.
5. Call the CM and PC.

6. Immediately implement steps to prevent recurrence of the accident.

A map showing the location of the nearest hospital with a full service emergency room is attached to this HASP (refer to Section 2.2 for number and address).

11.2 ACCIDENTAL RELEASE OF HAZARDOUS MATERIALS OR WASTES

1. Evacuate all on-site personnel to a safe place in an upwind direction until the HSO/SS determines that it is safe for work to resume.
2. Instruct a designated person to contact the CM or PC and confirm a response.
3. Contain the spill, if it is possible and can be done safely.
4. If the release is not stopped, contact 911 to alert the fire department.
5. Contact the Washington State Emergency Response Commission at 1-800-258-5990 to report the release.
6. Initiate cleanup.
7. The CM and PC will coordinate follow-up written reporting to the Washington State Department of Ecology in the event of a reportable release of hazardous materials or wastes.

11.3 GENERAL EMERGENCIES

In the case of fire, explosion, earthquake, or imminent hazards, work shall be halted and all on-site personnel will be immediately evacuated to a safe place. The local police/fire department shall be notified by calling 911 if the emergency poses a continuing hazard.

In the event of a thunderstorm, outdoor work will be discontinued until the threat of lightning has abated. During the incipient phase of a fire, the available fire extinguisher(s) may be used by persons trained in putting out fires, if it is safe for them to do so. Contact the fire department as soon as feasible.

11.4 EMERGENCY COMMUNICATIONS

In the case of an emergency, an air horn will be used as needed to signal the emergency. One long (5-second) blast will be given as the emergency/stop work signal. If the air horn is not working, a vehicle horn and/or overhead waving of arms will be used to signal the emergency. In any emergency, all personnel will evacuate to the designated refuge area and await further instruction.

11.5 EMERGENCY EQUIPMENT

The following minimum emergency equipment will be readily available on-site and functional at all times:

- First Aid Kit—contents approved by the HSO/SS, including two blood borne pathogen barriers.

- Sorbent material sufficient to contain the volume of the largest single container of hazardous materials (e.g., gas and diesel) brought on-site.
- Portable fire extinguisher (2-A:10 B/C min).
- Two spare sets of PPE suitable for entering the EZ.
- A copy of the current HASP.

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12.0 Administrative

12.1 MEDICAL SURVEILLANCE

Personnel involved with field activities must be covered under their employer's medical surveillance program that includes annual physical examinations and certification to wear respiratory protective equipment. These medical monitoring programs must be in compliance with all applicable worker health and safety regulations.

12.2 RECORD KEEPING

The HSO/SS, or a designated alternate, will be responsible for keeping daily logs of workers and visitors present at the work site, attendance lists of personnel present at site health and safety meetings, accident reports, and signatures of all personnel who have read this HASP.

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13.0 Approvals

Project Coordinator

Date

Construction Manager

Date

Project Health & Safety Officer

Date

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14.0 Signature Page

I have read this Heath and Safety Plan and understand its contents. I agree to abide by its provisions and will immediately notify the HSO/SS if site conditions or hazards not specifically designated herein are encountered.

Name (Print)	**Signature**	**Date**	**Company/Affiliation**

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B&L Woodwaste Site
Pierce County, Washington

Engineering Design Report (EDR)
Addendum 3

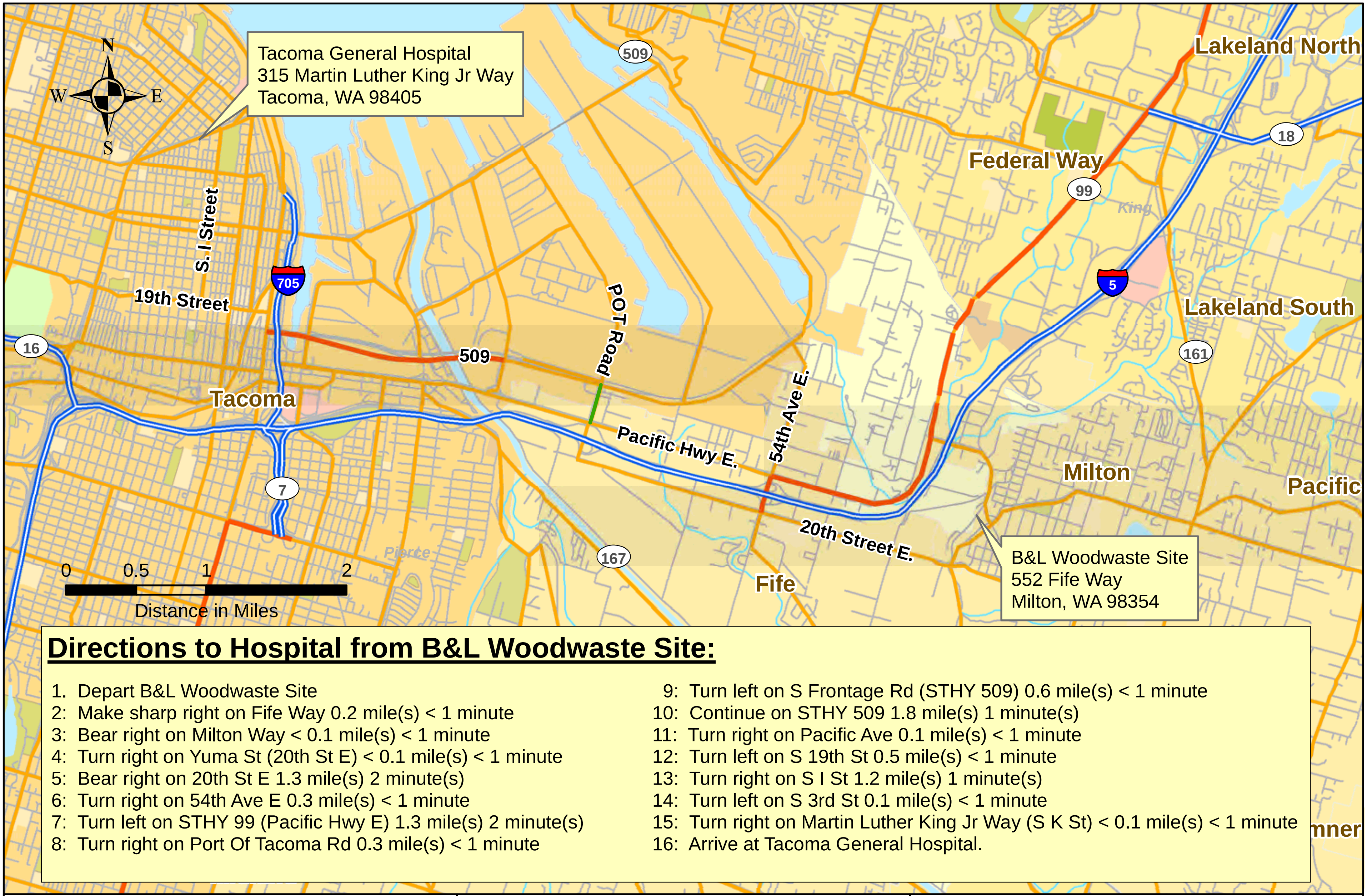
Phase 2 Part 1 Remediation Design Report

Groundwater Recovery and Treatment System

Appendix 3I
Health and Safety Plan

Figures

FINAL



Tacoma General Hospital
315 Martin Luther King Jr Way
Tacoma, WA 98405

B&L Woodwaste Site
552 Fife Way
Milton, WA 98354

Directions to Hospital from B&L Woodwaste Site:

1. Depart B&L Woodwaste Site
2: Make sharp right on Fife Way 0.2 mile(s) < 1 minute
3: Bear right on Milton Way < 0.1 mile(s) < 1 minute
4: Turn right on Yuma St (20th St E) < 0.1 mile(s) < 1 minute
5: Bear right on 20th St E 1.3 mile(s) 2 minute(s)
6: Turn right on 54th Ave E 0.3 mile(s) < 1 minute
7: Turn left on STHY 99 (Pacific Hwy E) 1.3 mile(s) 2 minute(s)
8: Turn right on Port Of Tacoma Rd 0.3 mile(s) < 1 minute
9: Turn left on S Frontage Rd (STHY 509) 0.6 mile(s) < 1 minute
10: Continue on STHY 509 1.8 mile(s) 1 minute(s)
11: Turn right on Pacific Ave 0.1 mile(s) < 1 minute
12: Turn left on S 19th St 0.5 mile(s) < 1 minute
13: Turn right on S I St 1.2 mile(s) 1 minute(s)
14: Turn left on S 3rd St 0.1 mile(s) < 1 minute
15: Turn right on Martin Luther King Jr Way (S K St) < 0.1 mile(s) < 1 minute
16: Arrive at Tacoma General Hospital.

FLOYD | SNIDER strategy ▪ science ▪ engineering AMEC Geomatrix	**B&L Woodwaste Site** **Pierce County, Washington**	Figure 3I.1 Route to Hospital Map

File: F:\projects\B&L RIM\GIS\MXD\Figure 3I.1 (Streetmap USA Route to Hospital Map).mxd
4/19/2011 11:02 AM

Directions to B&L Woodwaste Site:

- Landfill entrance is located 1/4 mile north of the intersection between 20th Street East and Fife Way.
- For work in the Landfill area and southern part of the wetlands, the entrance is located 1/4 mile north of the intersection between 20th Street East and Fife Way. Enter from Fife Way and drive around the east side of the Landfill to Puget Power Road and the wetlands.
- For work in the northern part of the wetlands, enter the wetlands from Fife Way on the unimproved 12th Street East roadway, located 1/2 mile north of the Landfill entrance, at the intersection of Fife Way with Porter Way.

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AMEC Geomatrix

B&L Woodwaste Site
Pierce County, Washington

Figure 3I.2
Directions to B&L
Woodwaste Site

File: F:\projects\B&L RIM\GIS\MXD\Figure 3I.2 (Directions to Site with Aerial).mxd
4/19/2011

B&L Woodwaste Site
Pierce County, Washington

Engineering Design Report (EDR) Addendum 3

Phase 2 Part 1 Remediation Design Report

Groundwater Recovery and Treatment System

Attachment 3I.1
Daily Tailgate Safety Meeting Form

FINAL

B&L Woodwaste Site Health and Safety Plan
ATTACHMENT 3I.1
Daily Tailgate Safety Meeting

Date: ______________________________ Time: ____________________________

Project Name: B&L Woodwaste Site Remedial Investigation

Location: B&L Woodwaste Site, 2206 6th Ave or 552 Fife Way in Milton, Washington

Meeting Conducted by: ____

Topics Discussed:

Physical Hazards: ____

Chemical Hazards: ____

Personal Protection: Modified Level D PPE (hard hat, safety glasses, hearing protection, steel-toed shoes, nitrile gloves).

Decontamination: ____

Special Site Considerations: No smoking is allowed within the limits of the landfill. All employees must wash hands before leaving the work areas for breaks and/or lunch. All contractors should have spill kits (i.e., sorbent pads) of their own in all vehicles and/or heavy machinery in case of an emergency.

____

____

On-site Emergency Contact:, HSO/SS Emergency Dispatch 911

Hospital: Tacoma General Hospital, 315 Martin Luther King Jr. Way,
Tacoma, Washington 98405

Tailgate Safety Meeting Attendees

Name/Company (printed)	Signature

Conducted by: ____________________ ____________________ ____________
Name Signature Date

B&L Woodwaste Site
Pierce County, Washington

Engineering Design Report (EDR) Addendum 3

Phase 2 Part 1 Remediation Design Report

Groundwater Recovery and Treatment System

Appendix 3J
Performance Monitoring Plan

FINAL

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1.0 Introduction

This Phase 2 Part 1 Performance Monitoring Plan (PMP) has been prepared to document plans for performance monitoring of the groundwater recovery and treatment system. Performance monitoring for this system will be performed following construction and will include commissioning and startup testing of the treatment system as well as assessing the performance of the groundwater recovery system in achieving the design objectives. This remedial measure is a key component for full implementation of the 2008 Cleanup Action Plan (CAP) for the B&L Woodwaste Site (Site). The 2008 CAP is being implemented pursuant to Consent Decree No. 08-210610-7 (Consent Decree) and in accordance with the Scope of Work appended to the Consent Decree. The implementation approach for the 2008 CAP is described in the Groundwater Remediation Work Plan (GRWP; Floyd|Snider/AMEC 2009). Additional details regarding the 2008 CAP remedy are presented in the Engineering Design Report (Floyd|Snider/AMEC 2009a).

The goals of this PMP are to establish performance standards and performance tests to evaluate the performance of the Phase 2 Part 1 remedy components, which include the landfill recovery wells, outside area recovery wells, groundwater conveyance system, and the groundwater treatment plant (GWTP). In addition, this PMP identifies the monitoring wells that will be used to monitor hydraulic containment of the landfill remedy (i.e., the barrier wall and groundwater recovery system) described in the 2008 CAP. The monitoring well and piezometer network described in this PMP will be used to collect hydrogeologic elevation data to monitor the effectiveness of the groundwater remedy and to support operation of the groundwater recovery system. Sampling from monitoring wells will be used for compliance monitoring, as described in the Compliance Monitoring Plan (Appendix A to the GRWP).

As work proceeds for implementation of the remaining 2008 CAP remedy components, future performance monitoring will be conducted to address construction of the additional components. A Phase 2 Part 2 performance monitoring plan will be included with the design for the ditch sediment remediation as EDR Addendum 4. After performance monitoring for the full remedy specified in the 2008 CAP has been completed, a comprehensive, long-term compliance monitoring plan will be prepared and implemented to address groundwater quality and hydraulic monitoring associated with the Site. The long-term compliance monitoring program will be documented in the Operation, Monitoring, Inspection, and Maintenance Plan (OMI&MP) to be prepared after completing Phase 2 construction.

1.1 PHASE 2 PART 1 PERFORMANCE MONITORING OBJECTIVES

This PMP establishes specific metrics by which the performance of Phase 2 Part 1 elements will be assessed. Because the hydraulic containment system will be completed by implementation of the work described in Addendum 3, hydraulic control performance will be assessed. The barrier wall and interceptor trench systems, which were constructed in Phase 1, Part 1, are key components of the containment remedy specified in the 2008 CAP for the Landfill CAA. When combined with the groundwater recovery and groundwater treatment systems that are being implemented under Phase 2, Part 1, the hydraulic containment system will fully address the landfill hydraulic control remedy specified in the 2008 CAP. The groundwater recovery system in the areas outside the Landfill will fully address the requirements for arsenic removal from the groundwater plume that was specified in the 2008 CAP. The landfill groundwater recovery system and barrier wall will provide complete hydraulic control by establishing and maintaining an inward, cross-barrier wall hydraulic gradient. The groundwater recovery system in the plume outside the Landfill will recover groundwater exceeding 500 µg/L, supporting rapid reduction of contaminant mass in the groundwater plume.

The general objectives of the Phase 2 Part 1 PMP are twofold: (1) to confirm that the wells and equipment installed function in accordance with the design and (2) to confirm that the groundwater recovery system can achieve the hydraulic control and groundwater recovery objectives specified in the 2008 CAP. These general objectives will be addressed in two separate performance tests.

Specific objectives to confirm performance of the constructed components are as follows:

- Confirm that wells and equipment meet design specifications.
- Confirm that equipment operates within manufacturer specifications.
- Confirm that instruments and controls function as designed and achieve design objectives.

Specific objectives to confirm attainment of remediation objectives are as follows:

- Confirm the landfill groundwater recovery wells can establish and maintain a minimum inward gradient of 0.5 feet (ft) across the barrier wall.
- Confirm the groundwater recovery wells located outside the Landfill are capable of establishing and maintaining a capture zone that encompasses the area estimated to exceed 500 µg/L.

1.2 PERFORMANCE MONITORING STANDARDS AND TESTING

The standards and testing described in this PMP will be used to demonstrate attainment of the objectives outlined above. System commissioning will be conducted initially to assess the functionality of the installed facilities and equipment. After confirming that individual components of the groundwater recovery and treatment systems properly function and that the treatment process achieves the design specifications, the capability of the hydraulic control and outside area groundwater recovery systems to achieve the remediation objectives will be assessed. Specific performance standards for commissioning the system components are discussed as appropriate for each system component in the following section. The standards for achieving remediation objectives are as described above: a minimum inward, cross-barrier wall hydraulic gradient of 0.5 ft and capture of groundwater with arsenic concentrations exceeding 500 µg/L.

2.0 System Commissioning

The groundwater recovery and treatment systems will be commissioned prior to accepting the constructed systems from the Contractor. Commissioning will consist of a series of tests conducted on equipment to determine the acceptability of the mechanical and electrical components. The commissioning will confirm each piece of equipment operates in accordance with manufacturer specifications and achieves the design specifications. Commissioning will initially be completed for the groundwater treatment plant using clean, potable water to avoid contaminating the equipment and to facilitate modifications and or repairs needed to achieve proper operation. After the treatment plant has been commissioned, the wells will be commissioned and tested by activating well pumps, producing contaminated groundwater that will be containerized until performance monitoring of the treatment plant is completed and the contaminated groundwater can be treated and discharged. Well commissioning will assess well and well pump performance and produce groundwater to test the effectiveness of the treatment process.

Prior to system commissioning, the contractor will prepare a full and complete Start-Up Plan for approval by the Floyd|Snider/AMEC Project Team and then perform functional testing program for each subsystem and system, consistent with Specification 01650. The Start-Up Plan will describe in detail the activities planned for system commissioning. The following sections identify the goals and requirements for system commissioning that must be achieved by the contractor's Start-Up Plan.

2.1 GROUNDWATER TREATMENT SYSTEM COMMISSIONING

Commissioning of the groundwater treatment system will confirm that each treatment system component is capable of meeting the design criteria and that they can be operated within the manufacturer's specifications for that equipment. The following steps will be taken to complete groundwater treatment system commissioning, and are described further in the following subsections:

1. Testing Preparation
2. Functional Testing
3. Facility Clean Water Startup Testing

These activities will be conducted in accordance with Section 01650 of the specifications (EDR Addendum 3, Appendix 3F).

2.1.1 Testing Preparation

Testing preparation will be conducted to ready the building and equipment for system commissioning. Once system installation is complete, the contractor will provide all equipment, personnel, and other items needed to complete the commissioning in a timely manner. For major pieces of process equipment, manufacturer's representatives will service the equipment as appropriate to ensure the equipment is properly installed and ready for service. The contractor will also prepare for testing by attending planning meetings and readying the equipment by calibrating, cleaning, and maintaining the components and systems as specified by the equipment manufacturer. Equipment and facilities will be inspected and cleaned prior to introduction of water to the treatment system. The building systems (e.g., lighting, HVAC) will also be checked during this phase of commissioning. Additional details for Testing Preparation are described in Specification 01650 (EDR Addendum 3, Appendix 3F). This phase of commissioning will be complete when the Contractor receives a Ready-to-Test determination from the Owner's Representative.

2.1.2 Functional Testing

Functional testing will be performed to verify that the equipment provided is capable of operation as designed by the manufacturer. Functional testing will include introduction of clean water to the treatment system components. A functional test will be conducted on each individual component or unit to demonstrate that all operational features and controls properly function. This testing will include checking valve operation, checking electrical power to the equipment, pump rotation, mixer rotation, controller functionality, instrument operation, level sensors, etc. prior to introducing clean water to the system. As noted in Specification 01650 (EDR Addendum 3, Appendix 3F), clean water will be introduced to the treatment system to complete functional testing. Functional testing will also verify that instruments and sensors are calibrated and properly placed to ready the system for performance testing and that metering pumps are calibrated. Chemicals will not be introduced to any process equipment during functional testing. Clean water used for functional testing will be left in the system to support clean water startup testing.

2.1.3 Clean Water Startup Testing

The clean water startup testing involves the operation of the entire treatment system using clean, potable water. The purpose of the clean water startup test is to evaluate the mechanical and electrical components of the groundwater treatment system to test system operation at full-scale flows. Potable water is used to avoid contaminating the equipment, minimize the impact of any leakage, and simplify draining and repairs needed to achieve proper operation. Clean water testing will also remove incidental materials that may be present in the new equipment.

The Contractor will commence the clean water startup test only after verifying that the components and equipment have completed functional testing. Chemical feed systems will be operated using clean water. The system will be set up so that the discharge is directed to the head tank, so that clean water is recirculated through the treatment process during the test. The Contractor will follow the Start-Up Plan to verify that each of the components within the system properly works and that installed hydraulic profile is appropriate for gravity flow through the system. Each component that handles a liquid will be tested using potable water, including equipment that would not convey water under normal operating conditions (such as chemical metering pumps and the filter press). It is anticipated that several runs will be conducted, with repairs and/or modifications conducted between runs to address any issues that are identified. Once the system obtains the approval of the Owner's Representative that the system is functioning in accordance with the design and manufacturer specifications, the groundwater treatment system commissioning will be determined complete and the system will be ready for performance testing using site groundwater. The clean water used for testing will sampled for pH, total suspended solids (TSS), oil and grease, and total organic carbon (TOC). If the water quality is acceptable to the Washington State Department of Ecology (Ecology), it will be discharged to the North Pond via the discharge line. If the water quality is above acceptable criteria, it will be placed in temporary storage tanks for subsequent treatment and either discharge or off-site disposal.

2.2 GROUNDWATER RECOVERY WELL COMMISSIONING

Commissioning of the groundwater recovery wells will confirm that the each well is capable of sustained production at the design pumping rate and that the pumps and controls operate within the manufacturer's specifications. As commissioning of the wells will produce contaminated groundwater, well commissioning will not be performed prior to completing treatment system commissioning and readying the system to accept contaminated groundwater. Groundwater recovered during well testing will be discharged to the groundwater treatment system for treatment.

The following tests will be completed to commission the groundwater recovery wells:

- Pump Testing
- Specific Capacity Testing
- Groundwater Conveyance System Integrity Testing

These tests are described in the following subsections. Water produced from the commissioning will be either contained in tanks until it can be treated by the groundwater treatment system or discharged directly to the treatment system for treatment performance testing.

2.2.1 Pump Testing

Pump Testing will be completed to confirm that the pumps are properly installed, that they operate in conformance with manufacturer specifications, and that they can be controlled using the variable speed controllers or back pressure regulators, as appropriate to each well. The nominal capacity of the pumps to be placed in the recovery wells is 5 gallons per minute (gpm). Each well will be operated continuously at a flow rate of 5 gpm for a minimum of 15 minutes to ensure that the pumps can operate within their design capacity. The pumping rate will be measured using the inline flow meter in the well vault. Wellheads will be carefully observed to identify and correct any leakage from the fittings.

After verifying that the pumps are capable of operating at their rated capacity, testing will be performed to confirm that flow controls are functional. Based on groundwater flow modeling, the landfill recovery wells are expected to produce on average 0.5 to 4 gpm to maintain an inward cross-wall hydraulic gradient of 0.5 ft. The outside recovery wells are expected to produce approximately 1 to 2 gpm to capture groundwater exceeding 500 µg/L. Because the pumps planned for use in the recovery wells will be capable of producing higher flow rates, pump control testing will be conducted to ensure that lower flow rates can be reliably achieved with the installed controls.

The landfill recovery wells are intended to operate under automatic flow control. The variable speed well pump controllers for the landfill recovery wells will be calibrated and tested to ensure individual well pumping rates can be controlled between 0.5 and 5 gpm. The controllers will be calibrated at a minimum of four points between 0.25 and 5 gpm by measuring and recording the flow rate at the wellhead for a given controller output. This will result in a calibration curve relating the controller output signal and the well flow rate in gpm. A calibration curve will be prepared for each landfill recovery well. The control capability for each landfill recovery well will be tested by measuring at least three flow rates produced by a setpoint entered to the pump controller for each well. Flow control capability will be accepted if the measured flow rate remains within 20 percent of the target flow rate for 15 minutes with readings taken from the wellhead flow meter every 5 minutes. Flow readings, discharge pressure, and target flow rate will be recorded for each well.

Automatic control of the recovery wells located outside the Landfill will be limited to on/off control. The backpressure regulators installed at each wellhead will be used to manually control well flows. Testing will be conducted to assess flow control from 0.5 to 2 gpm. A minimum of three settings will be tested for each well. The backpressure regulator will be adjusted to achieve each target flow rate; flow control capability will be accepted if the target flow rate is maintained with 20 percent for a period of 15 minutes with readings taken every 5 minutes. The flow rate will be measured using the inline flow meter in the well vault. The target flow rate, discharge pressure, and flow readings will be recorded for each well.

2.2.2 Specific Capacity Testing

Specific capacity testing will be conducted to ensure that the wells are capable of providing the flow rate predicted from groundwater modeling used for design. The measured specific capacity will also be used as the baseline capacity to assess future well performance. The predicted pumping rates for each recovery under normal operations (i.e., during pumping from landfill wells to achieve a 0.5 ft cross-wall gradient and pumping from outside wells for capture of 500 µg/L groundwater) and under operations to dewater landfill waste are summarized on Table 3J.1. Dewatering of landfill waste would be in the future, after completing groundwater recovery in the outside areas. Therefore, no pumping would be conducted from the outside area wells if groundwater levels are being lowered below the depth of waste.

The specific capacity of a well is the rate of water discharge per unit of drawdown measured in the well and is usually expressed in gpm per foot of drawdown (gpm/ft). Testing for the landfill recovery wells will be conducted to assess pumping for normal and waste dewatering conditions; testing for the outside area wells will be done only for normal operations. Based on the data of Table 3J.1, the landfill recovery wells may have to produce up to about 4 gpm under normal operations; Recovery Well R-2, which is located near a gap in the aquitard underlying the Landfill, may have to produce over 15 gpm to support waste dewatering. The wells located outside the Landfill are projected to recover up to about 2 gpm to achieve remediation objectives.

Landfill recovery wells will be tested using the well pumps specified for installation, which have a nominal capacity of 5 gpm. Specific capacity testing for all landfill recovery wells will be conducted by pumping the wells at a rate of 5 gpm for a period of 2 hours. The drawdown in the well will be measured after 2 hours of pumping to calculate the specific capacity. The flow rate will be periodically measured using the inline flow meter in the well vault. Water levels will be monitored in the pumping well using a manual water-level indicator or a recording pressure transducer to ensure that drawdown is acceptable for the selected pumping rate. The wells will be considered acceptable for normal operations if the drawdown remains at least 0.5 ft above the top of the well pump at the end of the specific capacity test.

Multiple tests must be performed to assess the capacity of Recovery Wells R-2 and R-5, which are projected to require production of more than 5 gpm to support waste dewatering. For these two wells, additional specific capacity testing will be conducted at two additional flow rates; one test will be done at the maximum actual pumping rate achievable with the pump under installed conditions (expected to be approximately 6 gpm) for 2 hours and at a flow rate of 3 gpm for 2 hours. Drawdown will be measured at the end of the test period at each flow rate and the specific capacity calculated. If the wells cannot maintain the test flow rate, the test will be repeated at a lower, sustainable flow rate. Results from the three specific capacity tests for each well will be used to extrapolate specific capacity to either the maximum projected pumping rates listed in Table 3J.1 or to the maximum sustainable pumping rate to assess the capacity of the well for supporting pumping to achieve waste dewatering. Flow and drawdown measurements taken during specific capacity testing will be recorded.

Specific capacity testing will also be performed for each of the outside area recovery wells. The outside recovery well pumps will be operated at 3 gpm for a period of 2 hours. Water levels will then be measured to determine drawdown and calculate specific capacity. The outside area wells will be accepted for normal operation if the groundwater level remains at least 0.5 ft above the well pump at the end of the specific capacity test. The specific capacity will be calculated by dividing the well yield expressed in gpm by the amount of drawdown measured in feet (the difference in groundwater level before pumping and after the test is completed. Flow and drawdown measurements taken during specific capacity testing will be recorded.

2.2.3 Groundwater Conveyance System Integrity

During installation the groundwater conveyance system will be pressure tested to ensure that there are no cracks, breaks, or leaks in the piping or valves. Pressure testing is sufficient to ensure that the piping and valves were adequately installed and no additional testing will be performed during commissioning.

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3.0 Performance Testing

This section describes testing to assess the performance of the groundwater recovery and groundwater treatment systems. The purpose of this testing is to confirm that the treatment system can achieve water quality criteria specified in the discharge permit and to demonstrate that the groundwater recovery can achieve remediation objectives. Performance testing will be performed after the groundwater recovery wells and the groundwater treatment plant have been commissioned. Performance testing will consist of the following:

- A test of the treatment effectiveness of the groundwater treatment system.
- A performance test to evaluate the ability of the landfill groundwater recovery well network to achieve a minimum, inward, cross-barrier wall hydraulic gradient of 0.5 ft.
- A performance test to evaluate the ability of the outside area groundwater recovery network to capture groundwater exceeding 500 µg/L of arsenic.

Details for performance testing are described below.

3.1 GROUNDWATER TREATMENT SYSTEM PERFORMANCE TESTING

A full-scale test of the GWTP performance will be completed following commissioning and clean water testing of the system. To the extent feasible, this testing will be coordinated with commissioning of the well commissioning tests described in Section 2.2. The groundwater treatment system is designed to remove arsenic from groundwater so that the final effluent is below the cleanup level for arsenic of 5 µg/L. Additionally, it is necessary for the GWTP to meet the discharge water quality criteria specified in the pending National Pollutant Discharge Elimination System (NPDES) permit. This will be done by treating contaminated groundwater recovered from the Landfill; this groundwater has the highest levels of arsenic and represents the groundwater that must be treated over the long term.

The GWTP has two general treatment steps. The primary treatment step includes chemical oxidation, co-precipitation, and settling; the primary treatment step reduces arsenic concentrations through a co-precipitation reaction with ferrous iron that is also present in site groundwater. Primary treatment was found to substantially reduce contaminant concentrations, but did not achieve the required discharge criteria. The secondary treatment step includes pH adjustment, filtration, and activated alumina adsorption. This polishing treatment was found to further reduce arsenic and achieve the discharge criteria. Pilot testing conducted at the Site demonstrated that this two-stage process can achieve the discharge criteria for arsenic. The treatment process will be tested at the design flow rate to determine if the full-scale system can achieve discharge standards and that the unit operations incorporated into the GWTP achieve manufacturer performance criteria.

Performance testing of the GWTP will be generally based on the “dirty water” test described in Specification 01650 and the approved Start-Up Plan provided by the Contractor. Water will be pumped from the landfill recovery wells to the groundwater treatment system at a total flow rate of 40 gpm. During performance testing, treated water will be placed in temporary storage tanks to confirm water discharged to the North Pond will meet discharge criteria. Water collected in the temporary tanks will be discharged to the North Pond if it meets discharge criteria. If it exceeds criteria, the stored water will be treated in the GWTP to achieve criteria.

Performance testing will include the following steps:

1. Treatment chemicals will be procured, feed solutions will be prepared, and feed systems will be set up using process chemicals.
2. Groundwater recovery wells to be used for performance testing will be sampled to determine arsenic and iron levels so that chemical dosing rates can be determined.
3. Groundwater recovery from landfill wells will be initialed at a reduced flow rate to begin to flush clean water out of GWTP vessels and to startup mixing and chemical feed systems.
4. When feed systems, mixers, and other process equipment are properly operating, the groundwater recovery rate will be increased to achieve a flow rate of approximately 40 gpm.
5. The GWTP will be operated at a flow rate of 40 gpm to achieve the following conditions:
    - Produce groundwater representative of groundwater quality to be treated by the facility. The produced groundwater quality will be compared to the groundwater quality basis presented in the 2010 Design Basis Memorandum (refer to Appendix 3A of this Addendum).
    - The system must have operated continuously for a minimum of 6 hours.
    - The GWTP will have reached steady-state conditions over a 30-minute period, as defined by the following:
        - pH in the co-precipitation tank will be stable (± 10%).
        - The clarifier will be stable and yielding a reasonably clear effluent (based on visual observation).
        - pH in the pH adjustment tank will be stable (± 1.5 standard pH units).
    - Results from field sampling and testing for arsenic, iron, pH, and temperature indicate that the GWTP is operating consistent with observations during the 2010 pilot testing.
6. After the above conditions are achieved, samples will be collected from the head tank discharge, precipitation tank outlet, clarifier outlet, filter outlet, and final effluent. Each sample will be analyzed in an off-site laboratory for pH, total arsenic, total iron, manganese, TSS, TOC, and other constituents specified in the NPDES discharge permit. One duplicate sample will be collected for quality assurance. Samples will be analyzed by a Washington State accredited laboratory.

Field testing will be used as appropriate during performance testing to assess treatment chemistry and assess the performance of unit operations and results of any changes in operating conditions. The treatment effectiveness of the GWTP and the unit operations comprising the GWTP will be evaluated using the analytical results from the laboratory samples noted above. The overall treatment effectiveness will be evaluated by comparing the final effluent quality to the water quality criteria specified in the discharge permit. Removal efficiencies will be calculated for each unit operation and for the GWTP from the influent and effluent sample results.

After the sampling described above is completed, the GWTP will be shut down. Samples will be collected from the storage tank to determine if the stored water meets discharge criteria. If the stored water is below discharge criteria, it will be pumped to the North Pond for discharge under the permit. If the water is above discharge criteria, it will be pumped to the GWTP for treatment and discharge.

The test will be considered successful if the treated effluent meets the permitted discharge criteria. If the treated water does not meet the discharge criteria, the project team will review the system design and installation, and work with Ecology to identify and implement corrective action, which will include repeating the dirty water testing described above.

3.2 GROUNDWATER RECOVERY SYSTEM PERFORMANCE MONITORING

Groundwater recovery from the two recovery well networks can commence after the wells have been commissioned, after successful performance testing of the GWTP, and after emptying of the temporary storage tanks used to support GWTP performance testing. Initial recovery operations will support performance testing of the groundwater recovery system. Performance testing for the landfill recovery well network will be focused on establishing and maintaining a minimum inward-directed cross-wall hydraulic gradient of 0.5 ft along the perimeter of the Landfill. Performance testing for the outside area recovery well network will be focused on capture of groundwater exceeding 500 µg/L.

The existing piezometer network located along the barrier wall (Figure 3J.1) will be used for performance monitoring of the landfill recovery well network. Existing and newly installed monitoring wells (Figure 3J.1) will be used for performance monitoring of the outside area recovery well network.

The following subsections describe the testing that will be conducted for performance monitoring of the groundwater recovery system.

3.2.1 Landfill Recovery Well Network

The following steps will be taken to test the capability of the recovery system to achieve a minimum cross-wall gradient of 0.5 ft. For this performance test, the outside area recovery well network will be shut down so that pumping outside the barrier wall does not influence the observed groundwater levels outside the barrier wall. This will simulate conditions during long-term pumping operations after remediation has been completed outside the Landfill. The transducers in the piezometers will be used to monitor groundwater levels along the barrier wall. The Landfill Recovery Wells R-1 through R-11 will initially be continuously pumped at higher than predicted rates to rapidly reduce the groundwater elevation beneath the Landfill and to establish the cross-wall gradient standard. After establishing a minimum cross-wall gradient of

0.5 ft, the recovery system will be placed in automatic control to assess the capability to maintain the cross-wall gradient standard. Performance of the landfill groundwater recovery network will be considered acceptable if the cross-wall gradient standard can be maintained continuously for a minimum of 4 days.

3.2.2 Outside Area Recovery Well Network

The performance of the recovery wells located outside the Landfill (Recovery Wells R-12 through R-21) will be tested to determine if groundwater exceeding 500 µg/L arsenic is captured. This will be accomplished by operating the extraction wells and monitoring groundwater levels in nearby monitoring wells. The recovery and monitoring well locations are shown in Figure 3J.1. Performance testing of the outside area recovery wells will be done after the landfill recovery well network has been established and is maintaining the cross-wall gradient standard so that interactions between the two recovery well networks can be monitored.

The outside area recovery well network includes three general areas: the Eastern Boundary Mini-Plume area (Recovery Wells R-12 and R-13), the Agricultural Field Mini-Plume area (Recovery Wells R-14 and R-15), and the Wetlands Plume area (Recovery Wells R-16 through R-21). Baseline water quality samples will be collected from the two new monitoring wells located in the Eastern Boundary Mini-Plume (MW-35 and MW-36), the two new monitoring wells in the Agricultural Field Mini-Plume (MW-33 and MW-34), and the four new monitoring wells located in the Wetlands Plume area (MW-32, PD-140, PD-141, and PD-142). The monitoring wells are located near or outside of the projected extent of the groundwater plume exceeding 500 µg/L arsenic; the baseline water quality data will provide additional groundwater characterization data and support future assessment of effects of the recovery system on groundwater quality Recording transducers will then be placed in the eight new monitoring wells and in the existing wells included in the recovery system monitoring program (I.e., Wells D-6A, MW-13, MW-14, MW-15, and MW-17); the transducers will be calibrated to ensure they accurately record groundwater elevation. The transducers will be set to record groundwater elevation every 15 minutes.

Pumping will be initiated in the 10 outside area recovery wells after sampling has been completed and the transducers are in place. Pumping flow rates will be set at the predicted optimal flow rates for normal operation (refer to Table 3J.1). The transducers will record groundwater elevations in the monitoring wells to allow any effect of the pumping wells to be identified. The transducer data will be checked after the recovery wells have been operational for 3 days. If the groundwater level data show an influence of the nearby pumping wells, it will be concluded that the recovery wells are achieving the performance objective of capturing groundwater exceeding 500 µg/L. If the transducer data do not show that the monitoring well has been influenced by the recovery wells, pumping rates in the nearby recovery wells will be increased and a second 3-day test period will be initiated for those recovery wells. The process will be repeated until pumping rates have been established that demonstrate capture of groundwater at the nine monitoring wells.

3.3 PERFORMANCE MONITORING REPORTING

Performance monitoring results will be reported in a Phase 2 Part 1 Performance Monitoring Report following the completion of Phase 2 Part 1 performance monitoring. This report will provide an assessment of the performance of the groundwater recovery and treatment systems relative to the standards described in this PMP.

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4.0. Performance Monitoring Schedule

Performance monitoring will be conducted after construction of the groundwater recovery and treatment systems is substantially complete. Commissioning and performance testing for the GWTP must be completed prior to commissioning of the groundwater recovery system so that contaminated groundwater produced during commissioning and performance testing of the recovery well networks can be treated for discharge. Commissioning and performance testing of the GWTP is projected to take 2 to 3 weeks; analytical results from the laboratory typically require 2 weeks turnaround from sampling; thus, performance testing results for the GWTP are expected to be available 4 to 5 weeks after substantial completion of construction. Commissioning and performance monitoring for the groundwater recovery system is expected to take 2 to 3 weeks, but could take more time if testing must be repeated to achieve performance standards. The Draft Phase 2 Part 1 Performance Monitoring Report will be completed within 90 days of the completion of all performance monitoring tests. The draft report is therefore expected to be completed by about April 2012 and included with the Phase 2 Completion Report. The actual schedule for production of the Phase 2 Completion Report and the Performance Monitoring Report will depend on the actual construction schedule and completion date.

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5.0 References

Floyd|Snider/AMEC Geomatrix (Floyd|Snider/AMEC). 2009. *Groundwater Remediation Work Plan (GRWP)*. January.

_____. 2009a. *B&L Woodwaste Site Engineering Design Report (EDR).* July.

B&L Woodwaste Site
Pierce County, Washington

Engineering Design Report (EDR) Addendum 3

Phase 2 Part 1 Remediation Design Report

Groundwater Recovery and Treatment System

Appendix 3J
Performance Monitoring Plan

Table

FINAL

Table 3J.1
Predicted Groundwater Recovery Rates[1]

Landfill Recovery Wells	Normal Operations[2]	Waste Dewatering[3]
R-1	2	4.7
R-2	4	15.6
R-3	0	2.8
R-4	2	2.4
R-5	0	7.9
R-6	0	4.7
R-7	2.5	0
R-8	2.5	0
R-9	3	0
R-10	3	0
R-11	0.3	0.3
R-12	2.1	0
R-13	1.6	0
R-14	1.6	0
R-15	1.6	0
R-16	1	0
R-17	1	0
R-18	1	0
R-19	1	0
R-20	1	0
R-21	1	0
TOTAL	**32.2**	**38.4**

Notes:

1 Predicted pumping rates have not been demonstrated under field conditions and may require adjustment based on the specific capacity of recovery wells.

2 Normal operations are based on a crosswall gradient of 0.5 ft and capture of groundwater exceeding 500 µg/L outside the Landfill.

3 Waste dewatering is based on pumping only from the Landfill and drawdown of groundwater to 1 ft below the lowest known depth of woodwaste within the Landfill.

B&L Woodwaste Site
Pierce County, Washington

Engineering Design Report (EDR) Addendum 3

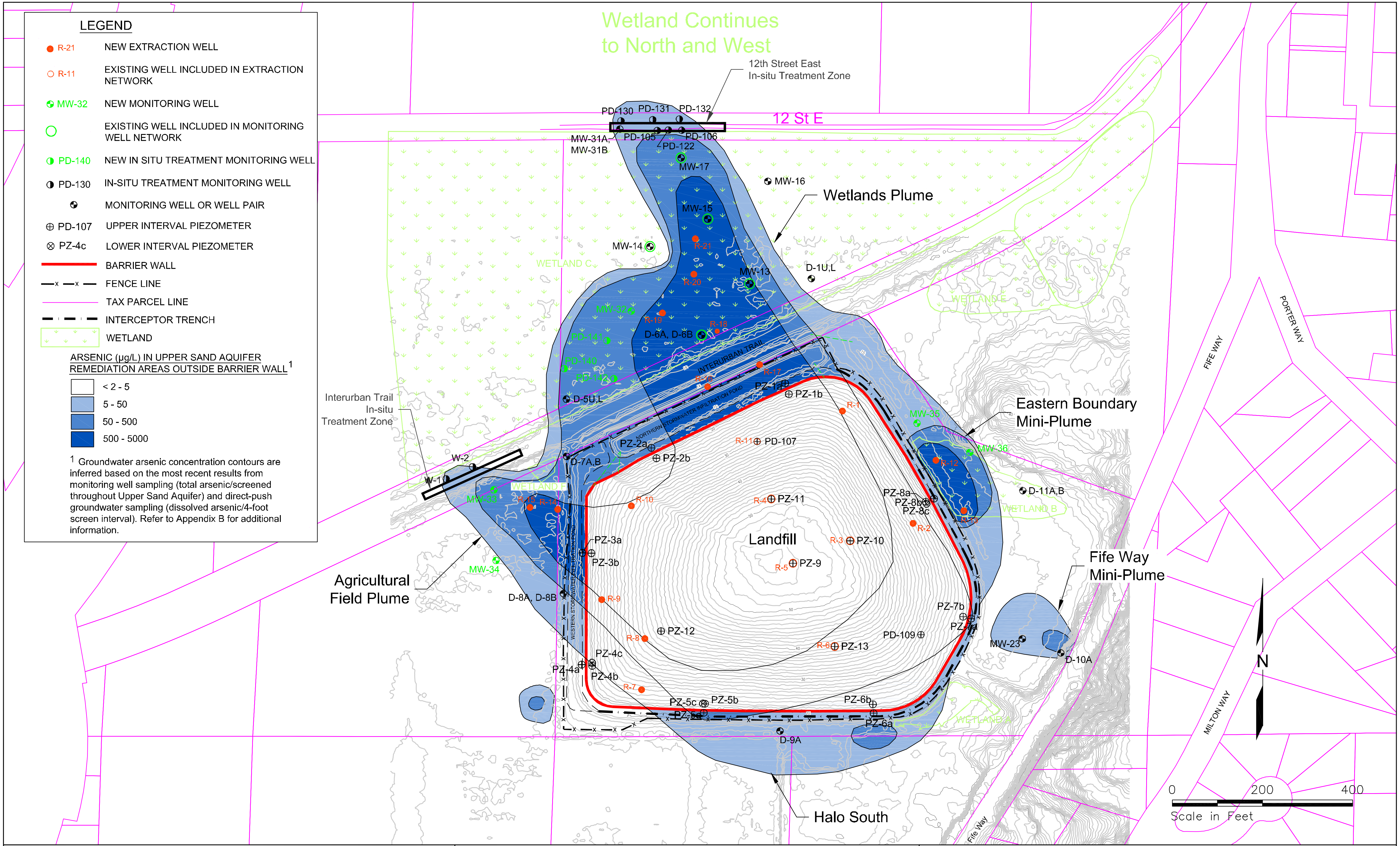
Phase 2 Part 1 Remediation Design Report

Groundwater Recovery and Treatment System

Appendix 3J
Performance Monitoring Plan

Figure

FINAL



FLOYD | SNIDER
strategy ▪ science ▪ engineering
AMEC Geomatrix

EDR Addendum 3
B&L Woodwaste Site
Pierce County, Washington

Figure 3J.1
Groundwater Recovery and Monitoring Wells

DWG NAME: G:\project\Clients\Floyd and Snider\BandL\BandL089.dwg
DATE: 5/19/2011 9:20 AM

B&L Woodwaste Site
Pierce County, Washington

Engineering Design Report (EDR) Addendum 3

Phase 2 Part 1 Remediation Design Report

Groundwater Recovery and Treatment System

Appendix 3K
Geotechnical Engineering Report

FINAL

May 3, 2011
Project No. SE10160010.4102

B&L Custodial Trust
606 Columbia Street NW, Suite 212
Olympia, Washington 98501

Attention: Dan Silver

Subject: Geotechnical Engineering Report
Groundwater Treatment Building
B&L Woodwaste Landfill Site
Pierce County, Washington

Dear Mr. Silver:

AMEC Earth & Environmental, Inc. (AMEC), is pleased to submit this report describing our geotechnical engineering evaluation. The purpose of our evaluation was to derive design conclusions and recommendations concerning site preparation, excavations, foundations, floors, drainage, and structural fill.

We received your written authorization for our evaluation on July 8, 2010. This report has been prepared for the exclusive use of B&L Custodial Trust and their consultants for specific application to this project, in accordance with generally accepted geotechnical engineering practice.

We appreciate the opportunity to be of service on this project. If you have any questions regarding this report or any aspects of the project, please feel free to contact our office.

Sincerely,

AMEC Earth & Environmental, Inc.

Carlo Evangelisti, P.E.
Senior Engineer

cc: Brett Beaulieu, Floyd/ Snider

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GEOTECHNICAL ENGINEERING REPORT

B&L Woodwaste Equipment Building

B&L Woodwaste Landfill Site

Pierce County, Washington

Prepared for:

B&L Custodial Trust
606 Columbia Street NW, Suite 212
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GEOTECHNICAL ENGINEERING REPORT
B&L Woodwaste Equipment Building
B&L Woodwaste Landfill Site
Pierce County, Washington

1.0 SUMMARY

The following summary of project geotechnical considerations is presented for introductory purposes and, as such, should be used only in conjunction with the full text of this report.

- Project Description: Development plans call for a new groundwater treatment building as part of site storm water improvements. After raising grade by about 4 feet, the new building will be a lightly loaded, steel-framed building with slab-on-grade floors. Several moderately sized tanks and associated treatment equipment, pumps, and piping are to be housed within the structure.
- Exploratory Methods: We explored subsurface conditions by means of one boring advanced at the approximate central portion of the proposed building footprint to a depth of 26.5 feet below existing grades. We also reviewed the logs of nearby subsurface explorations previously conducted by AMEC Geomatrix for the design of the slurry wall encircling the existing landfill footprint.
- Soil Conditions: Based on our recent boring and review of previous subsurface explorations, soils underlying the proposed building site generally consist of 2 to 3 feet of medium dense granular fill grading to silty, fine to medium sand with variable gravel content that extends to a depth of 7 feet, underlain by fine to medium sand extending to a depth of 10.5 feet. Below the granular deposits, soft silt was disclosed which extended to a depth of 21 feet. A 2-foot thick layer of peat was encountered below the silt horizon, which was in turn underlain by dense fine to medium sand to the full depth explored
- Groundwater Conditions: Perched groundwater was encountered at a depth of approximately 5 feet below ground surface at the time of drilling. Groundwater measurements from a nearby monitoring well indicated groundwater levels fluctuate from approximately 3 to 5 feet below ground surface, with the shallower levels occurring in the wetter winter months.
- Settlement Considerations: Our analysis indicates that the soft to medium stiff silt and peat would be prone to excessive settlement when subjected to the anticipated load of 4 feet of additional fill, plus building loads. We estimate that, if unmitigated, settlements could be as much as 11 inches beneath the proposed structure. In addition, the site is at risk for earthquake-induced liquefaction settlement.

- Options Analysis: Several options for mitigation of settlement were considered. These included preloading, deep foundations, ground improvement, and lightweight fill. The analysis considered total and differential settlement, impact on construction schedule, and cost.
- Recommended Option: On the basis of the options analysis, ground improvement using aggregate piers is recommended. After ground treatment, the building may be constructed using conventional shallow spread footings and slab-on-grade floors using an allowable bearing pressure of 2,000 pounds per square foot (psf), with differential settlements of 1 inch or less.

2.0 SITE AND PROJECT SUMMARY

The project site is located at 552 Fife Way (with an alternate address of 2206 6th Avenue) within unincorporated Pierce County, approximately 1/4 mile east of Interstate 5 (I-5) and 5 miles east of Tacoma. Portions of the site extend into the city limits of Milton and Fife, Washington (see Figure 1). The B&L Property tax parcel comprises approximately 18.5 acres with the property situated in a residential and agricultural area in northern Pierce County. Farmland borders the western and southwestern edges of the B&L Property, and the Autumn Village Apartment complex adjoins the southeastern corner. Fife Way defines the southeastern boundary. Puget Power Access Road, which was recently converted to a bicycle trail and is now known as the Interurban Trail (it also is referenced as Barth Road on some local maps) delineates the north side. The enclosed *Site and Exploration Plan* (Figure 2) illustrates these site boundaries and adjacent existing features.

Project plans call for installation of groundwater pumping wells and construction of a building near the southeast corner of the project site adjacent to Fife Way and immediately north of the site entrance. The water generated by the wells will be treated by a new groundwater treatment facility housed within the proposed building. Site improvements call for placement of approximately 4 feet of fill to create a level building pad and truck turn-around area to accommodate delivery truck traffic associated with the treatment facility. According to layout drawings, the new building will be approximately 35 feet by 65 feet in overall dimension. The overall fill pad dimensions are roughly 75 feet by 125 feet in dimension. An at-grade concrete slab loading bay is proposed for the north side of the building.

The proposed structure is to be a single-story building of steel frame construction with metal siding, a concrete slab-on-grade floor, and will likely have interior concrete masonry unit (CMU) partition walls. The building is to be used to house groundwater treatment equipment, several tanks varying in size from 1,200 to 3,000 gallons, and other related mechanical systems. The floor loads may include light forklift traffic. In addition to perimeter foundations supporting the walls, there will be isolated interior foundations to support equipment and tanks on metal stands. We anticipate that the building walls will impose relatively low foundation loads, whereas the interior equipment pads will impose moderate loads. Underground utilities will also connect to the building. The enclosed *Site and Exploration Plan* (Figure 2) illustrates the proposed facilities.

3.0 EXPLORATORY METHODS

AMEC explored surface and subsurface conditions at the project site on February 17, 2011. Previous studies were completed in 2008. Our recent exploration and testing program comprised the following elements:

- A visual surface reconnaissance of the site;
- One hollow-stem auger boring (designated B-1) with Standard Penetration Tests, advanced at a strategic location at the site;
- A review of the *Engineering Design Report* by AMEC Geomatrix, which included descriptive logs of the following explorations: boring MW-23, and cone penetrometer tests C-21 and C-22; (advanced in April 2002 and September 2008, respectively), and;
- A review of published geologic and seismologic maps and literature.

Table 1 summarizes the approximate locations, surface elevations, and termination depths of our recent subsurface exploration and the previous explorations reviewed, while Figure 2 depicts their approximate relative locations. Appendix A of this report describes our field exploration procedures and exploration logs.

Table 1 Approximate Locations, Elevations, and Depths of Explorations

Exploration	Location	Surface Elevation (feet)	Termination Depth (feet)
B-1	Central portion of proposed treatment building footprint	19.00	26.5
MW-23*	North edge of proposed treatment building fill pad	18.99	20.0
C-21*	Northwest edge of proposed fill pad	19.99	32.3
C-22*	Southwest edge of proposed fill pad, within	19.85	26.4

* Explorations from previous studies
Elevation datum: NAVD 88

The specific number, location, and depths of our recent exploration was selected by AMEC and field-adjusted by AMEC in relation to the existing and proposed site features, under the constraints of surface access, underground utility conflicts, and budget considerations.

It should be noted that the explorations performed and used for this evaluation reveal subsurface conditions only at discrete locations across the project site and that actual conditions in other locations could vary. Furthermore, the nature and extent of these variations would not become evident until additional explorations are performed or until construction activities have begun. If significant variations are observed at that time, we may need to modify our conclusions and recommendations contained in this report to reflect the actual site conditions.

4.0 SITE CONDITIONS

The following sections of text present our observations, measurements, findings, and interpretations regarding utility, surface, soil, groundwater, and seismic conditions at the project site.

4.1 DEVELOPMENT CONDITIONS

The pentagon-shaped Landfill occupies approximately 13 acres of the 18.5-acre B&L Property. The Landfill is located approximately 150 feet west of Fife Way and lies within a fenced area secured by a locked gate. Access to the property is gained through a locked gate off of Fife Way at the southeast portion of the site with a fill embankment sloping down to the west from Fife Way constructed to access the landfill site. The proposed building location lies immediately north of the driveway, located between the landfill and Fife Way. The area had previously been utilized as a construction staging area with miscellaneous construction materials stored around the perimeter. Based on the site plans supplied to us and surface markings provided by utility locating specialists, no underground utility lines traversed the proposed fill pad footprint. Overhead power lines cross the southern portion of the pad.

4.2 SURFACE CONDITIONS

The proposed building site lies within a flat, low-lying area at an approximate elevation of 19 feet. The south and east sides of the site are adjacent to moderately sloping roadway embankments, supporting thick to moderate vegetation cover consisting of berry vines, field grasses, and small trees. The fill pad area is currently surfaced with 1-inch minus crushed rock, placed during previous site work.

4.3 SOIL CONDITIONS

According to published geologic maps, soil conditions in the site vicinity are characterized by recent alluvial soils characterized by fine-grained sediments typical of flood plain deposits, intermixed with peat and other organics. Our on-site explorations revealed somewhat variable near-surface soil conditions but confirmed the mapped stratigraphy. In general, boring B-1 encountered approximately 4 inches of 1-inch minus gravel surfacing mantling medium dense, silty, sandy gravel, interpreted as uncontrolled fill to a depth of approximately 2 feet. The fill soils in turn mantled medium dense silty gravelly sand that was found to extend to approximately 7 feet below the existing ground surface, then grading to loose, fine to medium sand with trace gravel to a depth of 10.5 feet. Soft sandy silt was encountered below the sand horizon extending to a depth of approximately 21 feet. Immediately below the soft silt was a 2-foot thick peat layer which mantled dense, fine to medium sand with thin interbedded stringers of peat. The dense sand extended to the full depth explored. Review of nearby explorations disclosed similar soil conditions as described above, with interbedded layers of silty fine sand and peat within the silt layer encountered within boring B-1. The enclosed exploration logs provide a detailed description of the soil strata encountered in our subsurface explorations.

4.4 GROUNDWATER CONDITIONS

Groundwater was encountered within boring B-1 at an approximate depth of 5 feet below existing ground surface. Based on soil conditions and previous studies, the shallow groundwater encountered during our recent study is interpreted to represent the Upper Sandy Aquifer identified in the AMEC Geomatrix's *Engineering Design Report*, dated July, 2009. Previous groundwater monitoring performed within MW-23 in 2008 and 2009 disclosed depths to groundwater varying from 3 to 5 feet. Groundwater modeling indicates this aquifer is in direct communication with surface water and responds to changes in levels of Hylebos Creek and nearby agricultural drainage ditches. Because our recent exploration was performed during a period of wet weather, the groundwater conditions present at that time may closely represent the yearly high levels; lower levels occur during the summer and early fall months, whereas higher levels occur during extended periods of wet weather in the winter and early spring months. Throughout the year, groundwater levels would likely fluctuate in response to changing precipitation patterns, off-site construction activities, and site utilization.

5.0 SEISMIC CONDITIONS

Based on our analysis of subsurface exploration logs and our review of published geologic maps, we interpret the on-site soil conditions to correspond to Seismic Site Class D as defined by Table 1613.1.1 of the 2006 IBC. The soils beneath the site consist of medium dense silty sands, loose sands, soft to medium stiff silt, soft peat and dense silty sand. Our analysis indicates that the loose sands may liquefy during a strong earthquake.

The following maximum considered spectral accelerations should be used to determine the design response spectrum, per Figure 1613:

Spectral Acceleration for short periods (S_s):	116% of gravity (1.164g)
Spectral Acceleration for a 1-second period (S_1):	39% of gravity (0.390g)

A value of 1.035 should be used for site coefficient F_a and 1.619 for site coefficient F_v. Peak ground acceleration should be taken as 29 percent of gravity (0.292g).

6.0 LIQUEFACTION ANALYSIS

Liquefaction is a sudden increase in porewater pressure and a sudden loss of soil shear strength caused by shear strains, and could result from an earthquake. Research has shown that saturated, loose sands with a fines (silt and clay) content less than about 25 percent are most susceptible to liquefaction. Although other soil types are generally considered to have a low susceptibility, liquefaction may still occur during a strong earthquake. Our on-site subsurface explorations revealed saturated, loose sand layers or lenses at depths of 7 feet or more. To evaluate the possibility that these on-site native sands could liquefy during a seismic event, we performed a liquefaction analysis based on these site conditions.

For purposes of evaluating liquefaction potential, we used the software program Shake2000 using a model that represents a strong earthquake with a return period of 475 years. According to published seismic maps, these return periods roughly correspond with the following magnitudes and peak ground surface accelerations:

Return Period	Magnitude	Peak Acceleration
475 years	7.5	0.292 g

Using these parameters, we applied an analysis method developed by Seed and others (1983) to determine the factor of safety against liquefaction. Our analyses indicated that the loose sands, below about 7 feet have a safety factor against liquefaction less than 1.0 for the 475-year earthquake; A safety factor less than 1.0 indicates a high potential for liquefaction, whereas a safety factor greater than 1.5 is generally considered to indicate a low potential; safety factors between 1.0 and 1.5 roughly correspond to a moderate potential. Consequently, the subsurface soils appear to have a moderate to high potential for liquefaction during a 475-year earthquake. Using the methodology of Tokimatsu and Seed (1987), we would estimate liquefaction-induced surface settlements due to volume change on the order of 5.5 inches or more for a 475-year earthquake. After calculating the safety factors, we qualitatively evaluated the risk of on-site surface damage resulting from liquefaction of the loose to medium dense saturated native sands. Surface damage could include subsidence, fissuring, or heaving of the ground surface, thereby causing settling, cracking, or tilting of building and other structure. Generally, surface damage decreases as the thickness of non-liquefiable overburden soil increases, due to energy attenuation within the overburden soil. The planned placement of 4 feet of fill would therefore mitigate the risk of ground rupture associated with liquefaction-induced settlement.

7.0 CONCLUSIONS AND RECOMMENDATIONS

The proposed structure is to be a single-story building of steel frame construction with metal siding, a concrete slab-on-grade floor, and will likely have interior concrete masonry unit (CMU) partition walls. The floor loads may include light forklift traffic. In addition to perimeter foundations supporting the walls, there will be isolated interior foundations to support equipment and tanks on metal stands. We anticipate that the building walls will impose relatively low foundation loads, whereas the interior equipment pads will impose moderate loads. Underground utilities will also connect to the building.

While the proposed structure itself is relatively light, the proposed 4 feet of fill that is to be placed over the site to raise grade will impart a relatively heavy load. Our settlement analysis indicates that the soft to medium stiff silt and peat would be prone to excessive settlement when subjected to the anticipated fill loads. We estimate that, if unmitigated, settlements could be as much as 11 inches. Additionally, our liquefaction analysis indicates that during a strong seismic event that there is a high potential for liquefaction resulting in possible settlements of up to about 0.5 feet. To mitigate these settlements, we evaluated several options. These included preloading, deep foundations, ground improvement using aggregate piers,, or a “net-zero load” compensating foundation approach using lightweight fill. Each of these options are discussed below, and a summary of advantages and disadvantages is provided in Table 1.:

- Conventional shallow foundation without ground improvement: With this approach, after placement of the 4 feet of fill to raise grade, the building would be constructed with conventional foundations. A recommended bearing pressure would be 1,000 psf. However, the foundation and floor would be at risk for high total and differential settlements. This option would be lowest in initial cost, but the owner would need to be willing to accept that settlement will occur. This settlement condition could be partially mitigated with geogrid reinforcement placed between the fill and existing subgrade and by using flexible connection to all utilities/piping to the tanks and coming in and out of the building.
- Mat Foundations without ground Improvements: Using a structurally strengthened mat foundation to support the structure and tanks, the differential settlement of the building itself could be partly mitigated; while the building floor may remain intact without cracking, the overall building may undergo tilting. The building would be settling relative to the surrounding site, so that flexible connections for piping in and out of the building would still be required.
- Preloading: With this option, the site would initially receive an 8-foot surcharge (total fill pad will be about 12 feet high). The fill would need to remain in place for about 3 to 6 months in order to precompress the site and mitigate long term settlement. This option was not considered further due to project schedule constraints.
- Deep Foundation: With this approach, the load of the building would be transferred to the underlying dense soils encountered at about 20 to 25 feet below grade. A variety of deep foundation types could be used, including driven pipe piles, drilled Augercast concrete piles, helical piles or other. The disadvantage of these methods is that the deep foundation would need to be installed soon after placement of the 4 feet of fill for the building pad. As a result, the deep foundation elements would be subjected to downdrag loads. For example, we considered a 14-inch diameter Augercast pile, which would have an axial capacity of about 35 tons. The downdrag force imposed by the settling fill would be about 15 tons, resulting in a net allowable load per pile of about 20 tons. Another disadvantage of this method is that the

pile-supported building would not settle, while the surrounding fill pad would continue to settle, resulting in high differential settlements between the building and the piping.

- Compacted Aggregate Piers: Piers of crushed aggregate are constructed by augering and vertical impact ramming energy to compact layers of aggregate composing the pier, resulting in increased strength and stiffness of the subgrade soils. Based on conversations with the specialty contractor, a grid spacing of 8 feet on center would be adequate for this site. The aggregate piers will result in significant reduction in post-construction settlement, and will also mitigate the risk of future liquefaction-induced settlement. After ground improvement using the aggregate piers, the building can be constructed using conventional foundations, with post-construction settlements of less than 1 inch.
- Lightweight Fill: The new loading on the site can be minimized by using a lightweight fill material such as scoria, a lightweight vesicular volcanic rock, to replace a portion of the upper near surface soils and construct the fill pad. To achieve a “net-zero” loading requires removal of 3 feet of existing soil, followed by 3 feet of backfill plus 4 feet to raise grade. This approach mitigates settlement and allows building construction with conventional foundations. This approach does not address the liquefaction settlement.
- Recommended Option: Based on our review, the compacted aggregate pier is the recommended approach. This method mitigates the differential settlement and allows for construction of the building using conventional foundations and floors. The lightweight fill may also be considered beneficial for pad construction, to mitigate settlement outside of the area treated by aggregate piers.

A summary of each approach with comparison of relative settlements, construction timing, and costs is presented in Table 1.

Table 2 Foundation Options

Option	Overall Settlement	Differential Settlement across Building	Differential Settlement Between Building And Surrounding Site	Liquefaction Settlement	Added Construction Time	Cost	Comments
Fill 4 feet, Strip footings at 1,000 psf, slab on grade	calculated 11 inches	estimated 2 to 4 inches	estimated 4 to 6 inches	calculated 5.5 inches	None	Low	
Fill, mat Foundation	calculated 11 inches	estimated 1 to 2 inches	estimated 4 to 6 inches	calculated 5.5 inches	None	low to med	
Fill, Install pile foundation	1/2 to 1 inch	1/4 to 1/2 inch	estimated 8 to 11 inches	none	1 to 2 weeks	High	Any pile foundation will need to carry the downdrag load of 4 feet of fill which continues to settle; for a 14-inch Augercast pile, the allowable capacity of 35 tons per pile is reduced by 15 tons of downdrag load to a net capacity per pile of 20 tons. Cost of piles installed is roughly $25 to 30/foot.
Ground Improvement, aggregate piers, strip footings and slab on grade	calculated 5-6 inches prior to building construction	less than 1 inch	minimal	none	1 to 2 weeks; plus 3 to 4 weeks for initial pad settlement	low to med	Estimated cost to install on 8 foot grid is $75,000
Lightweight fill/ compensating foundation	minimal	minimal	minimal	calculated 5.5 inches	None	med	Use a durable Scoria - red vesicular basalt rock (50 pcf). Need a 3 foot overexcavation. Estimated volume of 75x125x7 feet deep = 3000 cubic yards. Cost estimate =$120,000 including fill to raise site grade 4 feet.

7.1 SUMMARY OF CONCLUSIONS AND RECOMMENDATIONS

Based on the analysis of options, it is assumed that the most feasible approaches will involve ground improvement with compacted aggregate piers, with possible use of lightweight fill for all or a portion of the fill pad. We offer the following general geotechnical conclusions and recommendations concerning this project.

- Feasibility: Based on our field explorations, research, and analyses, the proposed equipment building appears feasible from a geotechnical standpoint, contingent on the recommendations presented herein.
- Foundations: In our opinion, spread footings placed on a minimum of 4 feet of structural fill should be designed for an allowable bearing pressure of 2,000 psf. If a more rigid mat foundation is required to support the structure and tanks, mat foundations should be designed for a vertical modulus of subgrade reaction (k) of 350 pci.
- Floor Slabs: Slab-on-grade floors can be utilized, bearing on properly compacted structural fill. To reduce moisture migration through the slab, a vapor barrier should be placed between the subgrade and the floor slab.
- Settlement Considerations: Our analysis indicates that the soft to medium stiff silt and peat would be prone to excessive settlement when subjected to the anticipated building and fill loads. We estimate that, if unmitigated, settlements could be as much as 11 inches beneath the proposed structure.
- Liquefaction Considerations: Because our explorations revealed liquefaction-prone soils below the site, we interpret the risk of liquefaction to be moderate to high with settlements approaching 5.5 inches in the event of a strong earthquake.
- Recommended Mitigation Option: In our opinion, compacted aggregate piers offer the most advantages for the relative cost. Aggregate piers provide improvement of the compressible native soils beneath the site to mitigate settlement and also mitigates the potential for liquefaction.
- Seismic Considerations: Based on our literature review and subsurface interpretations, we recommend that the project structural engineer use the following seismic parameters for design of the building, as appropriate.

Design Parameter	**Value**
Soil Profile Type	D
PGA	0.292g
S_s	1.164g
S_1	0.390g
F_a	1.035
F_v	1.619

- On-Site Soil Reuse: The near-surface on-site fill soils are generally granular gravelly sands that would be suitable for re-use as backfill with proper moisture conditioning. However, the underlying native soils are highly moisture sensitive and thus would be difficult to reuse at their current moisture content. In conjunction with aggregate piers, a free-draining granular fill is recommended at the base of the fill pad, to allow drainage from the aggregate piers after site filling.
- Site Preparation: Due to the expected settlements of the soft silts and peats and potential for liquefaction, aggregate piers should be utilized for subgrade improvement prior to placing structural fill used to raise site grades.
- Subgrade Protection: Because the on-site soils are moisture-sensitive and would be readily disturbed when wet, the contractor should install appropriate temporary drainage systems at the construction site, and should minimize traffic over exposed subgrades. Ideally, earthwork would be scheduled for the summer and fall months, when drier weather will minimize disturbance to the native subgrade soils.

The following text sections of this report present our specific geotechnical conclusions and recommendations concerning site preparation, foundations, floors, backfilled walls, asphalt pavement, and structural fill. ASTM specification codes cited herein refer to the current American Society for Testing and Materials manual. WSDOT specification codes cited herein refer to current WSDOT publication M41-10, Standard Specifications for Road, Bridge, and Municipal Construction.

7.2 SITE PREPARATION

Preparation of the project site will likely involve temporary drainage, clearing, stripping, cutting, filling, excavations, erosion control, dewatering, and subgrade compaction. The paragraphs below discuss our geotechnical comments and recommendations concerning site preparation.

Temporary Drainage: We recommend intercepting and diverting any potential sources of surface or near-surface water within the construction zones before stripping begins. Because the selection of an appropriate drainage system will depend on the water quantity, season, weather conditions, construction sequence, and contractor's methods, final decisions regarding drainage systems are best made in the field at the time of construction. Nonetheless, we anticipate that curbs, berms, or ditches placed around the work areas will adequately intercept surface water runoff.

Clearing and Stripping: After surface and near-surface water sources have been controlled, the construction areas should be cleared and stripped of all vegetation, topsoil, debris, asphalt, and concrete. During our field investigation, it was observed that the majority of the site had been rough-graded and therefore, minimal clearing and stripping is anticipated. Furthermore, it should be realized that if the stripping operation proceeds during wet weather, a generally greater stripping depth might be necessary to remove disturbed moisture-sensitive soils; therefore, stripping is best performed during a period of dry weather.

Erosion Control Measures: Because stripped surfaces and soil stockpiles are typically a source of runoff sediments, they should be given particular attention. If earthwork occurs during wet weather, we recommend that all stripped surfaces be covered with straw to reduce runoff erosion. Similarly, soil stockpiles and cut slopes should be covered with plastic sheeting for erosion protection. We also recommend that a staked silt fence be installed around the area to be disturbed. The base of the silt fence should be buried so that sediment cannot pass beneath it, and the silt fence should be inspected and maintained during the time that the site soils are exposed, on a periodic basis, and after any major rainstorm event. It may be prudent to maintain a berm and swale around the downslope side of stripped areas and stockpiles in order to capture runoff water and thereby reduce the downslope sediment transport. In addition, the stripped areas should be revegetated as soon as possible, also reducing the potential for erosion.

Site Excavations: We anticipate that excavations may be required to accommodate the proposed underground utilities. Based on our explorations, we anticipate that these excavations will encounter sandy gravel / gravelly sand (fill) and native silty sand and sand. These soils can be readily excavated with conventional earthworking equipment. Although our explorations did not reveal rubble within the fill soils or boulders within the native soils, such obstacles could be present at random locations within these deposits.

Dewatering: Our exploration encountered groundwater at depths of about 5 feet below grade at the time of drilling. Consequently, site excavations might extend below the groundwater level, depending on the actual excavation depth and time of year. If groundwater is encountered, we anticipate that an internal system of ditches, sumpholes, and pumps will be adequate to temporarily dewater the excavation.

Temporary Cut Slopes: Configuration and maintenance of safe working conditions, including temporary excavation stability, is the responsibility of the contractor. All applicable local, state, and federal safety codes should be followed. Temporary excavation should either be shored or sloped in accordance with OSHA specifications. However, appropriate inclinations will ultimately depend on the actual soil conditions exposed during earthwork. For planning purposes, the soil type classification and maximum inclination based on OSHA standards is provided below.

Soil Type	**OSHA Soil Type**	**Maximum Inclination**
Existing Fill, Native Silty Sand, Sand, and Silt	C	1½ H:1V

Subgrade Compaction: Any localized zones of loose granular soils observed within a subgrade should be compacted to a density commensurate with the surrounding soils. In contrast, any organic, soft, or pumping soils observed within a subgrade should be overexcavated and replaced with a suitable structural fill material.

Site Filling: We anticipate that grading plans will call for filling as high as about 4 feet to achieve design subgrades for the new building. Our conclusions regarding the reuse of on-site soils and our comments regarding wet-weather filling are presented subsequently. Regardless of soil type, all fill should be placed and compacted according to our recommendations presented in the *Structural Fill* section of this report. Specifically, all building pad fill soil should be compacted to a uniform density of at least 95 percent (based on ASTM:D-1557). For gravel fill (such as lightweight scoria), it is not feasible to measure compaction, and such materials should be compacted under the observation of the geotechnical engineer, to achieve and firm and non-yielding surface condition.

On-Site Soils: Because only minor cuts for utilities are planned for the project, we expect that only small quantities of on-site soils will be generated during earthwork activities. Nonetheless, we offer the following evaluation of these on-site soils in relation to potential use as structural fill.

- *Surficial Existing Fill*: The near surface fill soils are generally granular gravelly sands that would be suitable for re-use as backfill with proper moisture conditioning.
- *Upper Silty Sands and Sands*: The silty sands underlying the surficial fill soils do not appear suitable for reuse as structural fill at their present moisture contents. These soils will be difficult or impossible to reuse during wet weather, due to their moderately high silt contents. These soils may become suitable for reuse during a period of dry weather if they can be aerated to reduce their moisture content.

Wet-Weather Considerations: As discussed above, most or all of the on-site soils would be difficult to reuse as structural fill during wet weather. Consequently, the project specifications should include provisions for using imported, clean, granular fill in case site filling must proceed during wet weather.

For general structural fill purposes, we recommend using a well-graded sand and gravel, such as "Ballast" or "Gravel Borrow" per WSDOT: 9-03.9(1) and 9-03.14, respectively.

Permanent Slopes: All permanent cut slopes and fill slopes should be adequately inclined to minimize long-term raveling, sloughing, and erosion. We generally recommend that no slopes be steeper than 2H:1V, but fill slopes in crushed angular gravel can be inclined as steep as 1.5H:1V.

Slope Protection: We recommend that a permanent berm, swale, or curb be constructed along the top edge of all permanent slopes to intercept surface flow. Also, a hardy vegetative groundcover should be established as soon as feasible, to further protect the slopes from runoff water erosion. Alternatively, permanent slopes could be armored with quarry spalls or a geosynthetic erosion mat.

7.3 AGGREGATE PIERS

Current development plans call for constructing the structure on a fill pad of about 4 feet in height. We estimate that total settlement on the order of 11 inches in the underlying soft to stiff silt and peat as a result of placing fill across the building site. The use of aggregate piers such as Geopiers (Geopier^{TM} Foundation Systems) or VibroPiers (Hayward Baker), or similar proprietary soil improvement system, may be more cost effective for support of the fill supporting the structure. In addition to mitigating potential settlement, aggregate piers will also mitigate the potential for liquefaction induced settlement in the event of a strong earthquake.

Aggregate Piers: Aggregate piers are gravel-filled columns installed in pre-drilled holes or impact piers using a proprietary ramming technique. The details of pier diameter, depth, and spacing are determined by the aggregate pier supplier or contractor. With aggregate pier support, the structure footings can be designed as conventional spread footings bearing on the structural fill which is in turn supported on the piers. The structural fill will be is placed on top of the piers and beneath the building footings after the piers are complete. Aggregate piers may be installed in groups beneath footings and slabs with pier diameters approximately 30 to 36 inches in diameter to depths of about 25 feet. After placing the 4 feet of structural fill on the aggregate pier improved subgrade, settlements are anticipated to be on the order of 5 to 6 inches and are expected to occur in as little as 1 to 2 weeks. After this primary settlement has occurred, construction of the structure can proceed. Estimated differential settlement of the structural fill supported placed on aggregate pier improved subgrade is estimated to be less than 1-inch.

Aggregate Piers Construction Considerations: Prior to placing fill of the aggregate pier improved area, all vegetation and topsoil should be removed. The area to receive fill should be covered with at least 12 inches of sand or 1.5-inch minus gravel. Slopes on the sides of the fill pad should be no steeper than 1H:1V and no flatter than 2H:1V. The fill soils composing the preload should be compacted in 8- to 12-inch thick lifts to at least 95 percent maximum dry density below finished floor elevation.

Moisture content of the fill soils should be within 2 percent of optimum. Density tests of the fill soils should be performed at a minimum rate of 1 test per 4,000 square feet per lift.

Settlement Monitoring: Because all settlement estimates inherently involve numerous uncertainties, actual settlements should be monitored in the field throughout a period of time after the fill is placed to ensure that primary settlement has occurred prior to construction of the structure. We recommend that vertical survey measurements be taken at settlement plates installed in a quincunx pattern (one at each corner and one at the center) across the building footprint. A settlement plate detail is provided in Figure 3. Measurements should be made on a weekly basis, with an accuracy of 0.01 foot, and all data should be promptly submitted to AMEC for review.

7.4 LIGHTWEIGHT FILL

As an alternative to using aggregate piers, light weight fill could be used to support the structure. Using a "zero-net" replacement approach, lightweight fill consisting of scoria could be used to construct the fill pad supporting the structure. Although lightweight fill will significantly reduce potential settlement, it will *not* mitigate the potential for liquefaction induced settlement in the event of a strong earthquake.

Lightweight Fill: Lightweight fill consisting of scoria, a highly vesicular lightweight volcanic rock can be used to construct the fill pad. In order to achieve a zero net weight on the existing subgrade, the existing soils underlying the proposed fill pad will need to be overexcavated to a depth of approximately 3 feet below existing grade and replaced with compacted lightweight fill (scoria). The additional 4 feet of fill used to raise the site grade should also consist of scoria. Total settlements using the approach are expected to be less than 1-inch with total differential settlements less than one-half the total settlement.

7.5 SPREAD FOOTINGS

In our opinion, conventional spread footings will provide adequate support for the proposed equipment building on properly compacted structural fill or lightweight fill. We offer the following comments and recommendations for purposes of footing design and construction.

Footing Depths and Widths: For frost and erosion protection, the bottoms of all exterior footings should bear at least 18 inches below adjacent outside grades, whereas the bottoms of interior footings need bear only 12 inches below the surrounding slab surface level.

Bearing Subgrades: The soils underlying the proposed building footprint are expected to consist of a minimum of 4 feet of structural fill or lightweight fill and will be well-suited for supporting spread footings. Before footing concrete is placed, any localized zones of loose fill soils exposed across the footing subgrades should be compacted to a firm, unyielding condition.

Subgrade Verification: All footing subgrades should consist of firm, unyielding, suitable structural fill materials placed over properly prepared native soils as described above. Footings should never be cast atop loose, soft, or frozen soil, slough, debris, existing uncontrolled fill, or surfaces covered by standing water. We recommend that the condition of all subgrades be verified by an AMEC representative before any fill or concrete is placed.

Bearing Capacities: Based on the bearing subgrade conditions described above, we recommend that all footings be designed for the following allowable soil bearing capacities, which incorporate static and seismic safety factors of at least 2.0 and 1.5, respectively.

Design Parameter	**Allowable Value**
Static Bearing Capacity	2,000 psf
Seismic Bearing Capacity	2,500 psf

Footing Settlements: We estimate that total post-construction settlements of properly designed footings bearing on properly prepared structural fill or lightweight fill as described above will not exceed 1-inch. Differential settlements could approach one-half of the actual total settlement between adjacent foundation elements. These settlements would be reduced if the actual design bearing pressures are lower than our recommended maximum pressures.

Footing and Stemwall Backfill: To provide erosion protection and lateral load resistance, we recommend that all footing excavations be backfilled on both sides of the footings and stemwalls after the concrete has cured. Either structural fill or lightweight fill can be used for this purpose. Regardless of soil type, all footing backfill soil should be compacted to a density of at least 90 percent (based on ASTM:D-1557).

Lateral Resistance: Footings and stemwalls that have been properly backfilled as described above will resist lateral movements by means of passive earth pressure and base friction. We recommend using the following design values, which incorporate static and seismic safety factors of at least 1.5 and 1.1, respectively. Base friction can be combined with the respective passive pressure to resist static and seismic loads.

Design Parameter	**Allowable Value**
Static Passive Pressure	300 pcf
Seismic Passive Pressure	400 pcf
Base Friction Coefficient	0.4

7.6 MAT FOUNDATIONS

In our opinion, a mat foundation will provide adequate support for the proposed building supported by a minimum of 4 feet of structural fill or lightweight fill. We offer the following comments and recommendations for purposes of mat foundation design and construction.

Foundation Depths: For frost and erosion protection, the bottom edge of all mat foundations should penetrate to a depth of at least 18 inches below adjacent outside grade.

Bearing Subgrades: In our opinion, the proposed structural fill or lightweight fill soils that will support the proposed building footprint will adequately support a mat foundation. Based on our previous subgrade preparation recommendations, we assume that the proposed building foundations will bear on pads of imported structural fill soils compacted to at least 95 percent (based on ASTM:D-1557).

Base Course: To provide a level surface for the mat, and to prevent the upward wicking of groundwater under the mat, we recommend that a base course be placed over the exposed subgrade. This base course should be at least 4 inches thick and should consist of clean crushed rock such as “Crushed Surfacing Base Course” per WSDOT Standard Specification 9-03.9(3).

Subgrade Verification: The mat foundation should bear on firm, unyielding, compacted structural fill or lightweight fill. Foundations should never be cast atop loose, soft, or frozen soil, slough, debris, existing uncontrolled fill, or surfaces covered by standing water. We recommend that the condition of all subgrades be verified by an AMEC representative before any fill or concrete is placed.

Bearing Capacities: A mat foundation that bears on properly prepared subgrade soils can be designed for the following allowable soil bearing capacities, which incorporate static and seismic safety factors of at least 2.0 and 1.5, respectively.

Design Parameter	Allowable Value
Static Bearing Capacity	2,000 psf
Seismic Bearing Capacity	2,500 psf

Vapor Barrier: To minimize moisture infiltration into the new building, we recommend that the floor slab portion of the mat foundation be directly underlain by a layer of plastic sheeting (such as Crosstuff, Moistop, or Visqueen) to prevent the upward migration of ground moisture vapors.

Foundation Backfill: To provide erosion protection and lateral load resistance, we recommend that the foundation excavation be backfilled around the exterior sides of the mat after the concrete has cured. Either imported structural fill or non-organic on-site soils can be used for this purpose, contingent on a suitable moisture content at the time of placement. All backfill soil should be compacted to a density of at least 90 percent (based on ASTM:D-1557).

Estimated Settlements: We estimate that the total settlement of a properly designed mat foundation bearing on a properly prepared subgrade will not exceed 1 inch. Differential settlements across the width of the mat foundation could approach one-half of the total settlement.

Vertical Deflections: Mat foundations can deflect downward when vertical loads are applied, due to elastic compression of the subgrade. In our opinion, a subgrade reaction modulus (k) of 350 pounds per cubic inch can be used to estimate such deflections.

Lateral Resistance: Mat foundations can resist lateral loads by means of passive earth pressure acting on the sidewalls and by friction acting along the base. We recommend using the following design values, which incorporate static and seismic safety factors of at least 1.5 and 1.1, respectively. Base friction can be combined with the respective passive pressure to resist static and seismic loads.

Design Parameter	**Allowable Value**
Static Passive Pressure	300 pcf
Seismic Passive Pressure	400 pcf
Base Friction Coefficient	0.4

7.7 SLAB-ON-GRADE FLOORS

In our opinion, soil-supported slab-on-grade floors can be used in the proposed building if the subgrades are properly prepared. Alternatively, a structurally supported (post-tensioned) slab-on-grade floor can be used, without the need for rigorous subgrade preparation. We offer the following comments and recommendations concerning these two types of slab-on-grade floors.

Subgrade Conditions and Verification: All soil-supported slab-on-grade floors should bear on firm, unyielding structural fill soils or lightweight fill. We recommend that the condition of all subgrades and overlying layers be verified by an AMEC representative before any fill or concrete is placed.

Floor Subbase: Structural fill subbases do not appear to be needed under soil-supported slab-on-grade floors at the site if supported by a minimum of 4 feet of structural fill or lightweight fill.

Capillary Break: To retard the upward wicking of groundwater beneath the floor slab, we recommend that a capillary break be placed over the subgrade. Ideally, this capillary break would consist of a 4 inch-thick layer of pea gravel or other clean, uniform, well-rounded gravel, such as “Gravel Backfill for Drains” per WSDOT Standard Specification 9-03.12(4). Alternatively, angular gravel or crushed rock can be used if it is sufficiently clean and uniform to prevent capillary wicking.

Vapor Barrier: We recommend that a layer of durable plastic sheeting (such as Crosstuff, Moistop, or Visqueen) be placed directly between the capillary break and the floor slab to prevent ground moisture vapors from migrating upward through the slab. During subsequent casting of the concrete slab, the contractor should exercise care to avoid puncturing this vapor barrier. However, vapor barriers can be considered optional for use under floors that will not be covered with moisture-sensitive materials.

Curing Course: A “curing course” is a thin layer (typically 2 inches thick) of clean sand that is sometimes placed over the vapor barrier to facilitate uniform curing of the overlying concrete slab. Recent studies, however, have indicated that this course is not necessary when moderately strong concrete is used for the slab, and some structural engineers believe it can be detrimental to a slab’s long-term performance. Consequently, we recommend that the project structural engineer be allowed to decide whether a curing course should be used.

Vertical Deflections: Soil-supported slab-on-grade floors can deflect downward when vertical loads are applied, due to elastic compression of the subgrade. In our opinion, a subgrade reaction modulus of 350 pounds per cubic inch can be used to estimate such deflections.

7.8 DRAINAGE SYSTEMS

In our opinion, the proposed building should be provided with permanent drainage systems to minimize the risk of future moisture problems. We offer the following recommendations and comments for drainage design and construction purposes.

Perimeter Drains: Due to the gravelly, free-draining nature of the proposed structural fill or lightweight fill used to support the structure, we infer that perimeter drains will *not* be needed for the building. However, the final decision regarding the need for perimeter drains should be made at the time of construction, after the foundation excavations have been completed.

Subfloor Drains: Based on the groundwater conditions observed in our site explorations, we do not infer a need for subfloor drains.

Runoff Water: Roof-runoff and surface-runoff water should *not* be allowed to flow into the drainage systems. Instead, these sources should flow into separate tightline pipes and be routed away from the building to an appropriate location. Also, final site grades should slope downward away from the building so that runoff water will flow by gravity to suitable collection points, rather than ponding near the building. Ideally, the area surrounding the building would be capped with concrete, asphalt, or low-permeability (silty) soils to minimize or preclude surface-water infiltration.

7.9 UNDERGROUND UTILITIES

We expect that underground utilities, such as waterlines, storm drains, sewer pipes, manholes, and catch basins, will be included in the site development. Our comments and recommendations concerning the installation of these utilities are presented below.

Soil Classifications: Based on our explorations, we interpret the on-site soils to conform with OSHA Soil Type C.

Subgrade Soils: Based on our explorations, we expect that most or all utility excavations will extend into soils that will adequately support utility pipes, catch basins, vaults, and similar structures. If localized zones of soft or organic soils are encountered in utility excavations, we generally recommend that they be overexcavated to a maximum depth of 24 inches and be replaced with a suitable fill material compacted to a uniform density of at least 90 percent (based on ASTM:D-1557).

Soil Corrosivity: Our scope of work did not include corrosivity testing of the on-site soils. However, based on our classifications of these soils and on our previous corrosivity testing of similar soil types, we do not infer that the on-site soils have a high likelihood of being corrosive to utilities.

Bedding Soils: Utility pipes should be bedded with an appropriate material that extends at least 6 inches outward from the pipe in all directions. For level or gently sloping pipes, we recommend using a clean, uniform, well-rounded material such as pea gravel or "Gravel Backfill for Pipe Bedding" per WSDOT: 9-03.12(3). For moderately or steeply sloping pipes, on the other hand, we recommend using a clean, uniform, angular material such as "Crushed Surfacing Top course" per WSDOT: 9-03.9(3), in order to minimize groundwater flow rates through the bedding.

Backfill Soils: The on-site, non-organic, granular soils can be used as utility excavation backfill if they are placed at a moisture content near optimum. During the wet season or during rainy periods, however, all backfill material used for utility trenches and other excavations would probably need to consist of well-graded granular soils such as "Gravel Borrow" per WSDOT: 9-03.14. Controlled-density fill (CDF) could be used as a more convenient, but also more expensive, alternative to backfill soil in any weather conditions.

Backfill Compaction: We generally recommend that utility backfill soils be compacted to a density commensurate with surrounding fill or native soils, as well as with the requirements of any overlying structures. For backfill placed under future concrete floors or drive slabs, all soil should be compacted to a uniform density of at least 90 percent (based on ASTM:D-1557). For backfill placed under future asphaltic pavements, the upper 2 feet should be compacted to at least 95 percent. CDF backfill does not require compaction but should have a compressive strength commensurate with the application.

7.10 STRUCTURAL FILL

The term "structural fill" refers to any materials used for building pads, roadway embankments, and detention pond berms, as well as materials placed under foundations, retaining walls, slab-on-grade floors, sidewalks, pavements, and other such features. Our comments, conclusions, and recommendations concerning structural fill are presented in the following paragraphs.

Materials: Typical structural fill materials include clean sand, granulithic gravel, pea gravel, washed rock, crushed rock, quarry spalls, controlled-density fill (CDF), lean-mix concrete (LMC), well-graded mixtures of sand and gravel (commonly called "gravel borrow" or "pit-run"), and miscellaneous mixtures of silt, sand, and gravel. Recycled asphalt, concrete, and glass, which are derived from pulverizing the parent materials, are also potentially useful as structural fill in certain applications. Generally, soils used for structural fill should not contain any organic matter or debris, nor any individual particles greater than about 6 inches in diameter.

On-Site Soils: Because only minor cuts for utilities are planned for the project, we expect that only small quantities of on-site soils will be generated during earthwork activities. Nonetheless, we offer the following evaluation of these on-site soils in relation to potential use as structural fill.

- *Surficial Existing Fill*: The near surface fill soils are generally granular gravelly sands that would be suitable for re-use as backfill with proper moisture conditioning.
- *Upper Silty Sands and Sands*: The silty sands underlying the surficial fill soils do not appear suitable for reuse as structural fill at their present moisture contents. These soils will be difficult or impossible to reuse during wet weather, due to their moderately high silt contents. These soils may become suitable for reuse during a period of dry weather if they can be aerated to reduce their moisture content.

Fill Placement: Generally, pea gravel, washed rock, quarry spalls, CDF, and LMC do not require special placement and compaction procedures. In contrast, clean sand, granulithic gravel, crushed rock, soil mixtures, and recycled materials should be placed in horizontal lifts not exceeding 8 inches in loose thickness, and each lift should be thoroughly compacted with a mechanical compactor.

Compaction Criteria: Using the Modified Proctor test (ASTM:D-1557as a standard, we recommend that structural fill used for various on-site applications be compacted to the following minimum densities:

Fill Application	Minimum Compaction
Footing subgrade and bearing pad	95 percent
Foundation backfill	90 percent
Slab-on-grade floor subgrade and subbase	95 percent

Subgrade Verification and Compaction Testing: Regardless of material or location, all structural fill should be placed over firm, unyielding subgrades prepared in accordance with the *Site Preparation* section of this report. The condition of all subgrades should be verified by a geotechnical specialist before filling or construction begins. Also, fill soil compaction should be verified by means of in-place density tests performed during fill placement so that adequacy of soil compaction efforts may be evaluated as earthwork progresses.

Soil Moisture Considerations: The suitability of soils used for structural fill depends primarily on their grain-size distribution and moisture content when they are placed. As the "fines" content (that soil fraction passing the U.S. No. 200 Sieve) increases, soils become more sensitive to small changes in moisture content. Soils containing more than about 5 percent fines (by weight) cannot be consistently compacted to a firm, unyielding condition when the moisture content is more than 2 percentage points above or below optimum. For fill placement during wet-weather site work, we recommend using "clean" fill, which refers to soils that have a fines content of 5 percent or less (by weight) based on the soil fraction passing the U.S. No. 4 Sieve.

CDF Strength Considerations: CDF is normally specified in terms of its compressive strength, which typically ranges from 50 to 200 psi. CDF having a strength of 50 psi (7,200 psf) provides adequate support for most structural applications and can be readily excavated with hand shovels. A strength of 100 psi (14,400 psf) provides additional support for special applications but greatly increases the difficulty of hand-excavation. CDF having a strength greater than about 100 psi requires power equipment to excavate and, as such, should not be used where future hand-excavation might be needed.

8.0 RECOMMENDED ADDITIONAL SERVICES

Because the future performance and integrity of the structural elements will depend largely on proper site preparation, drainage, fill placement, and construction procedures, monitoring and testing by experienced geotechnical personnel should be considered an integral part of the construction process. Consequently, we recommend that AMEC be retained to provide the following post-report services:

- Review all construction plans and specifications to verify that our design criteria presented in this report have been properly integrated into the design;
- Prepare a letter summarizing all review comments (if required by Pierce County);
- Attend a pre-construction conference with the design team and contractor to discuss important geotechnically related construction issues;
- Observe all exposed subgrades after completion of stripping and overexcavation to confirm that suitable soil conditions have been reached and to determine appropriate subgrade compaction methods;
- Monitor the placement of all structural fill and test the compaction of structural fill soils to verify their conformance with the construction specifications;
- Probe all completed subgrades for footings and slab-on-grade floors before concrete is poured, in order to verify their bearing capacity;
- Monitor the installation of all aggregate piers to verify that adequate tip depths have been achieved and to document the installation procedures;
- Observe the installation of all perimeter drains, wall drains, and capillary break layers to verify their conformance with the construction plans; and
- Prepare a post-construction letter summarizing all field observations, inspections, and test results (if required by Pierce County).

In addition to the aforementioned services, AMEC can provide inspection and testing of concrete, steel, masonry, and other structural materials. Upon request, we could submit a proposal for providing some or all of these construction monitoring, inspection, and testing services. Such a proposal is best prepared after the project plans and specifications have been approved for construction.

9.0 CLOSURE

The conclusions and recommendations presented in this report are based, in part, on the explorations that we performed for this study; therefore, if variations in the subgrade conditions are observed at a later time, we may need to modify this report to reflect those changes. Also, because the future performance and integrity of the project elements depend largely on proper initial site preparation, drainage, and construction procedures, monitoring and testing by experienced geotechnical personnel should be considered an integral part of the construction process. AMEC is available to provide geotechnical monitoring, soils and concrete testing, steel and masonry inspection, and other services throughout construction.

We appreciate the opportunity to be of service on this project. If you have any questions regarding this report or any aspects of the project, please feel free to contact our office.

Sincerely,

AMEC Earth & Environmental, Inc.

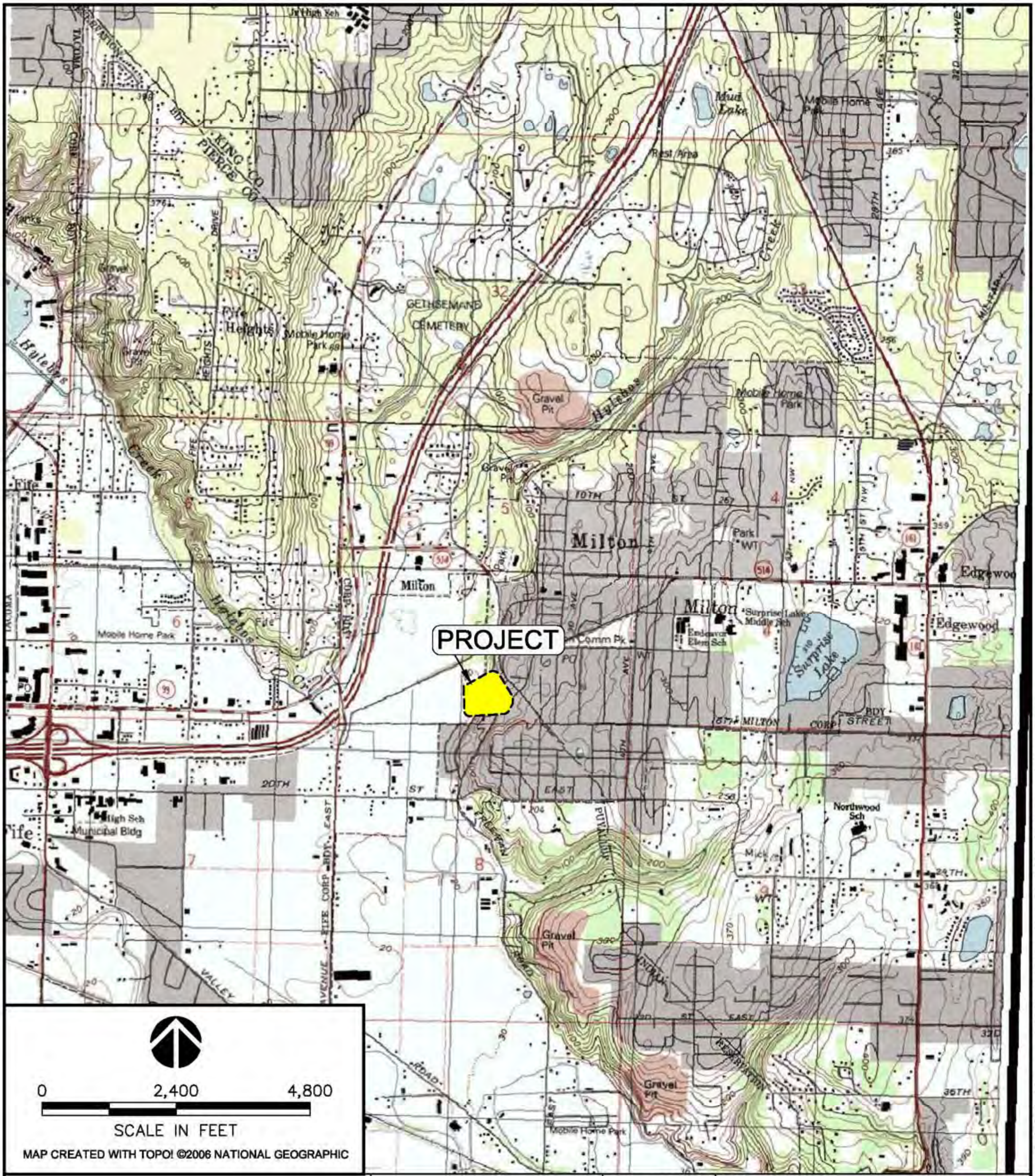
43063

3MAY 11

Carlo Evangelisti, P.E.
Senior Engineer

James S. Dransfield, P.E., Principal
CE/JSD/LS

FIGURES



AMEC Earth & Environmental

11810 North Creek Parkway North
Bothell, WA, U.S.A. 98011-8201

amec

CLIENT LOGO

CLIENT
B&L CUSTODIAL TRUST

PROJECT
B&L WOODWASTE EQUIPMENT BUILDING

DWN BY: JRS
DATUM:
DATE: MARCH 2011

TITLE
SITE VICINITY MAP

CHK'D BY: CE
REV. NO.:
PROJECT NO: SE 10160010

PROJECTION:
SCALE: AS SHOWN
FIGURE No. 1

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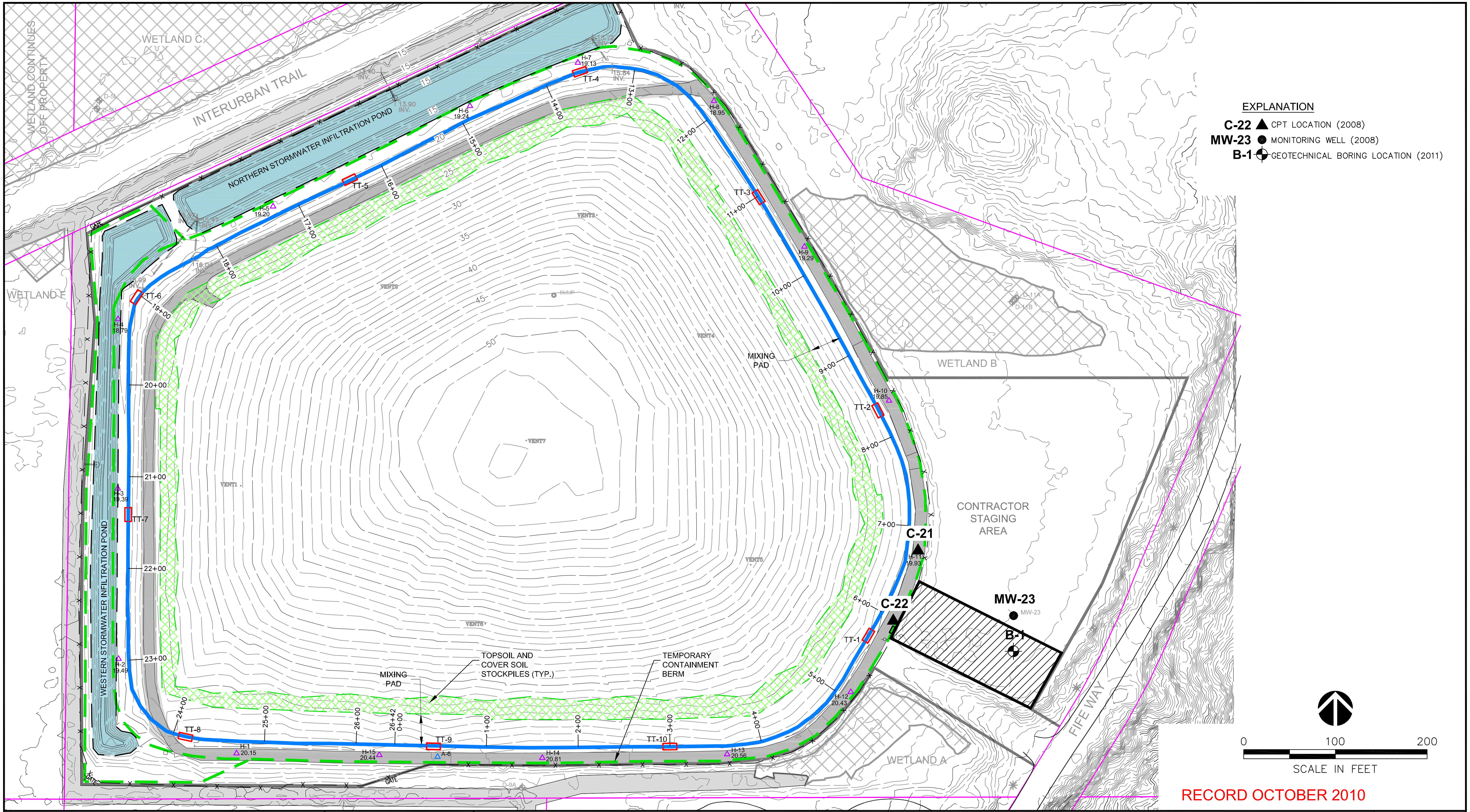

CLIENT LOGO

CLIENT:
B&L CUSTODIAL TRUST

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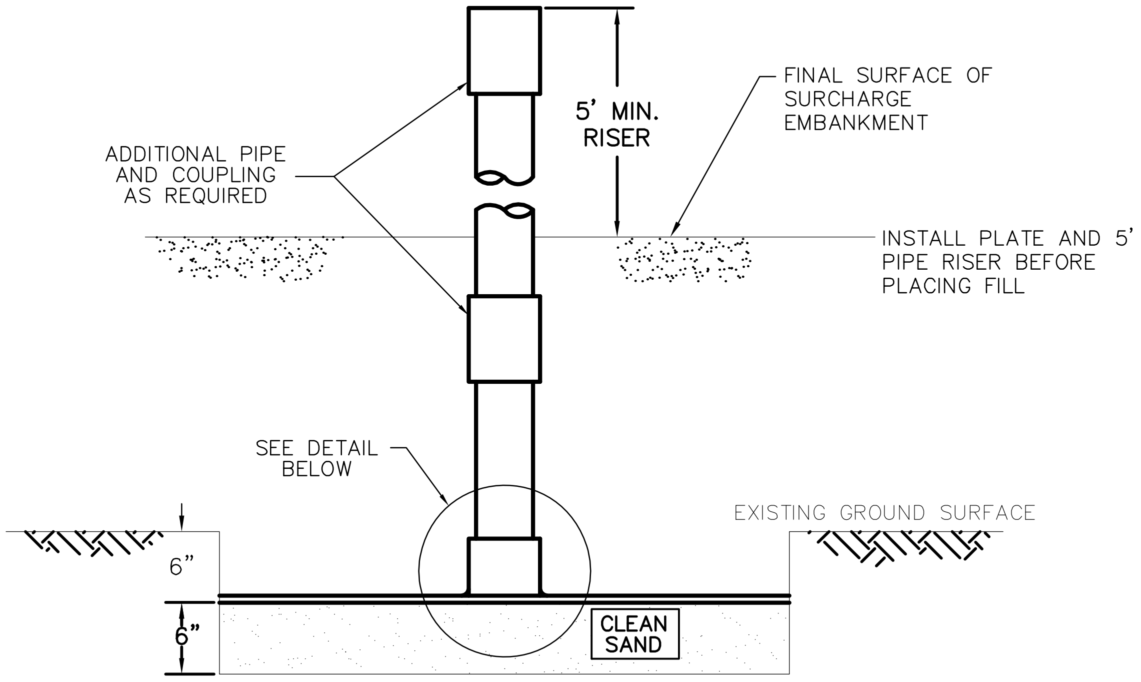
DWN BY: JRS
CHK'D BY: CE
DATUM:
PROJECTION:
SCALE: AS SHOWN

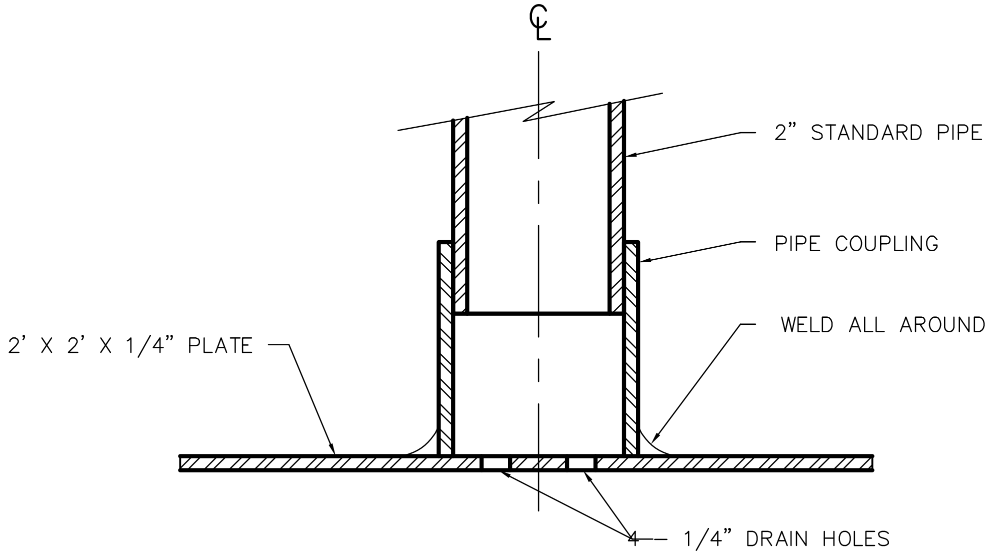
PROJECT
B&L WOODWASTE EQUIPMENT BUILDING

TITLE
SIT AND EXPLORATION PLAN

DATE: MARCH 2011
PROJECT NO: SE 10160010
REV. NO.:
FIGURE No. 2

G:_AMECGeomatrix\SE 10160010\se 10160010-02.dwg – S+E Plan – Mar. 25, 2011 11:02am – jeffrey.sanders





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PROJECT
B&L WOODWASTE EQUIPMENT BUILDING

DWN BY: JRS
DATUM:
DATE: MARCH 2011

TITLE
SETTLEMENT PLATE DETAIL

CHK'D BY: CE
REV. NO.:
PROJECT NO: SE 10160010

PROJECTION:
SCALE: NOT TO SCALE
FIGURE No. 3

G:_AMECGeomatrix\SE 10160010\se 10160010–03.dwg – Layout1 – Mar. 25, 2011 11:01am – jeffrey.sanders

APPENDIX A

Field Exploration Procedures and Logs

APPENDIX A
FIELD EXPLORATION PROCEDURES AND LOGS
SE10160010.4102

The following paragraphs describe our procedures associated with the field explorations and field tests that we conducted for this project. Descriptive logs of our explorations are enclosed in this appendix.

AUGER BORING PROCEDURES

Our exploratory borings were advanced with a hollow-stem auger, using a truck-mounted drill rig operated by an independent drilling firm working under subcontract to AMEC. A geotechnical specialist from our firm continuously observed the borings, logged the subsurface conditions, and collected representative soil samples. All samples were stored in watertight containers and later transported to our laboratory for further visual examination and testing. After each boring was completed, the borehole was backfilled with a mixture of bentonite chips and soil cuttings, and the surface was patched with asphalt or concrete (where appropriate).

Throughout the drilling operation, soil samples were obtained at 2.5- or 5-foot depth intervals by means of the Standard Penetration Test (SPT) per ASTM:D-1586. This testing and sampling procedure consists of driving a standard 2-inch-diameter steel split-spoon sampler 18 inches into the soil with a 140-pound hammer free-falling 30 inches. The number of blows required to drive the sampler through each 6-inch interval is counted, and the total number of blows struck during the final 12 inches is recorded as the Standard Penetration Resistance, or "SPT blow count." If a total of 50 blows are struck within any 6-inch interval, the driving is stopped and the blow count is recorded as 50 blows for the actual penetration distance. The resulting Standard Penetration Resistance values indicate the relative density of granular soils and the relative consistency of cohesive soils. Where soft soils were encountered, these split-spoon samples were supplemented with Shelby tube samples. A Shelby tube consists of a 3-inch-diameter thin-wall steel tube that is pushed into the soil by means of hydraulic rams.

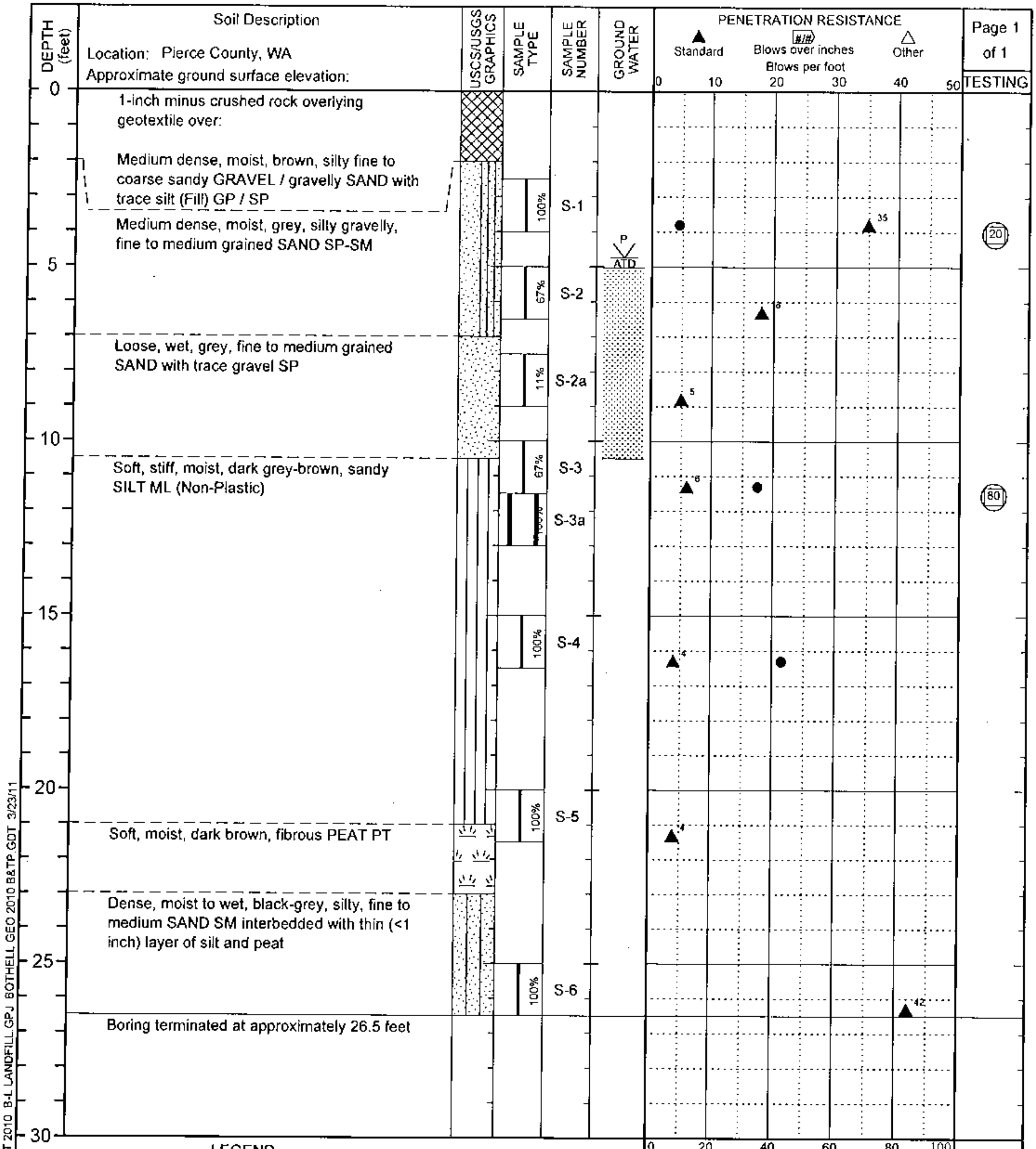
The enclosed *Boring Logs* describe the vertical sequence of soils and materials encountered in each boring, based primarily on our field classifications and supported by our subsequent laboratory examination and testing. Where a soil contact was observed to be gradational, our logs indicate the average contact depth. Where a soil type changed between sample intervals, we inferred the contact depth. Our logs also graphically indicate the blow count, sample type, sample number, and approximate depth of each soil sample obtained from the borings, as well as any laboratory tests performed on these soil samples. If any groundwater was encountered in a borehole, the approximate groundwater depth is depicted on the boring log. Groundwater depth estimates are typically based on the moisture content of soil samples, the wetted height on the drilling rods, and the water level measured in the borehole after the auger has been extracted.

PROJECT: *B&L Woodwaste Landfill Equipment Bldg* JOB No. *SE10160010.4102* BORING No. *B-1*

Soil Description

Location: Pierce County, WA

Approximate ground surface elevation:



1-inch minus crushed rock overlying geotextile over:

Medium dense, moist, brown, silty fine to coarse sandy GRAVEL / gravelly SAND with trace silt (Fill) GP / SP

Medium dense, moist, grey, silty gravelly, fine to medium grained SAND SP-SM

Loose, wet, grey, fine to medium grained SAND with trace gravel SP

Soft, stiff, moist, dark grey-brown, sandy SILT ML (Non-Plastic)

Soft, moist, dark brown, fibrous PEAT PT

Dense, moist to wet, black-grey, silty, fine to medium SAND SM interbedded with thin (<1 inch) layer of silt and peat

Boring terminated at approximately 26.5 feet

LEGEND

▯	2.00-inch OD split-spoon sampler
▯	Shelby Tube
P ATD	Perched water level at time of drilling
○	200 Wash (% fines shown)

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11810 North Creek Parkway N
Bothell, Washington 98011

Drilling Method: HSA Hammer Type: Auto Hammer Date drilled: *February 17, 2011* Logged By: *CE*

Drilled by: *Holocene*

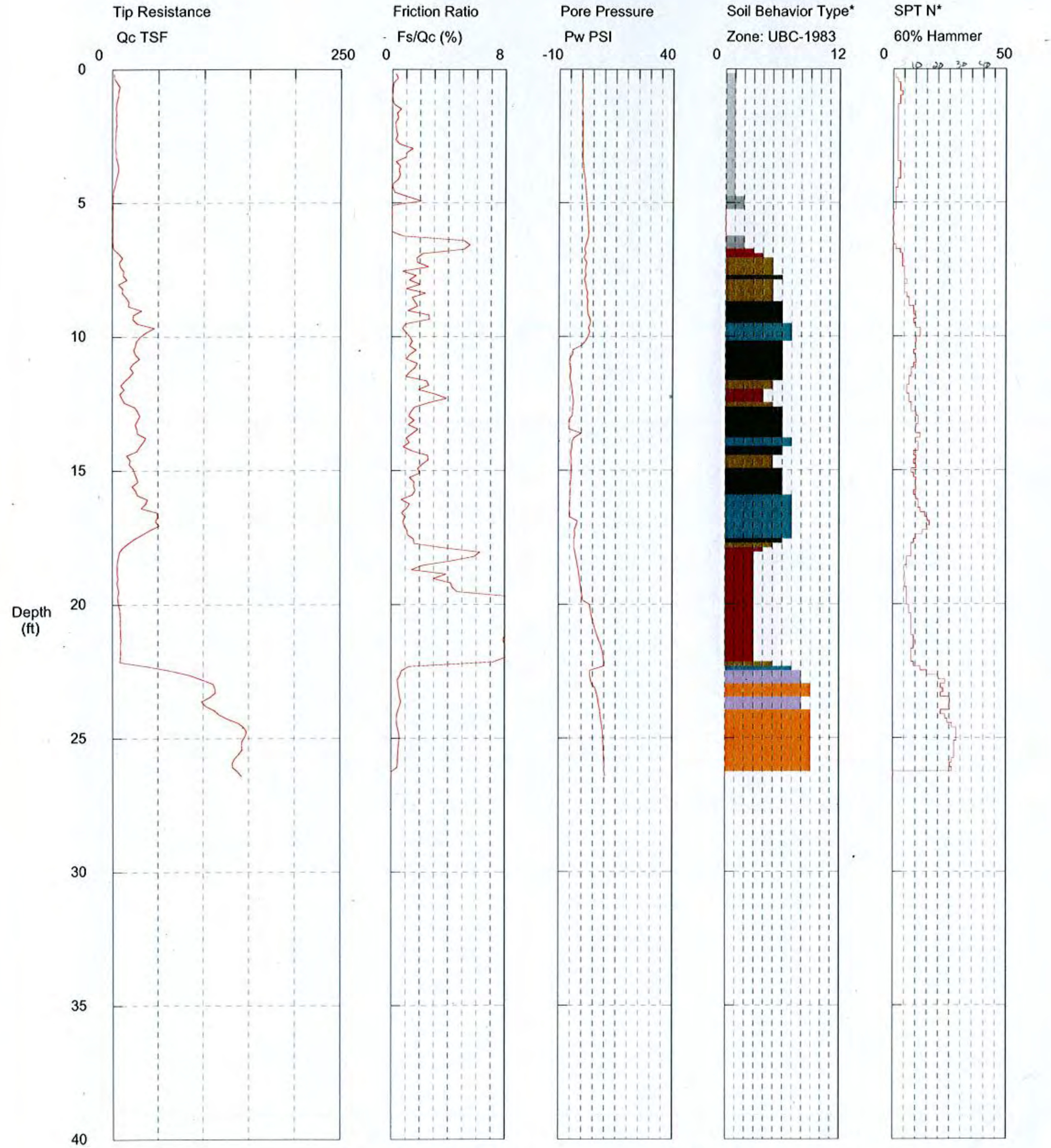
APPENDIX A.1

Field Exploration Logs by Others

Floyd Snider Amec Team

Operator: Brown
Sounding: CPT-22
Cone Used: DSG1015

CPT Date/Time: 9/25/2008 11:57:09 AM
Location: B & L Wood Waste Site
Job Number: BL RIM 304



Maximum Depth = 26.41 feet

Depth Increment = 0.164 feet

■ 1 sensitive fine grained
■ 2 organic material
■ 3 clay

■ 4 silty clay to clay
■ 5 clayey silt to silty clay
■ 6 sandy silt to clayey silt

■ 7 silty sand to sandy silt
■ 8 sand to silty sand
■ 9 sand

■ 10 gravelly sand to sand
■ 11 very stiff fine grained (*)
■ 12 sand to clayey sand (*)

Top 7 feet predrilled and then backfilled.

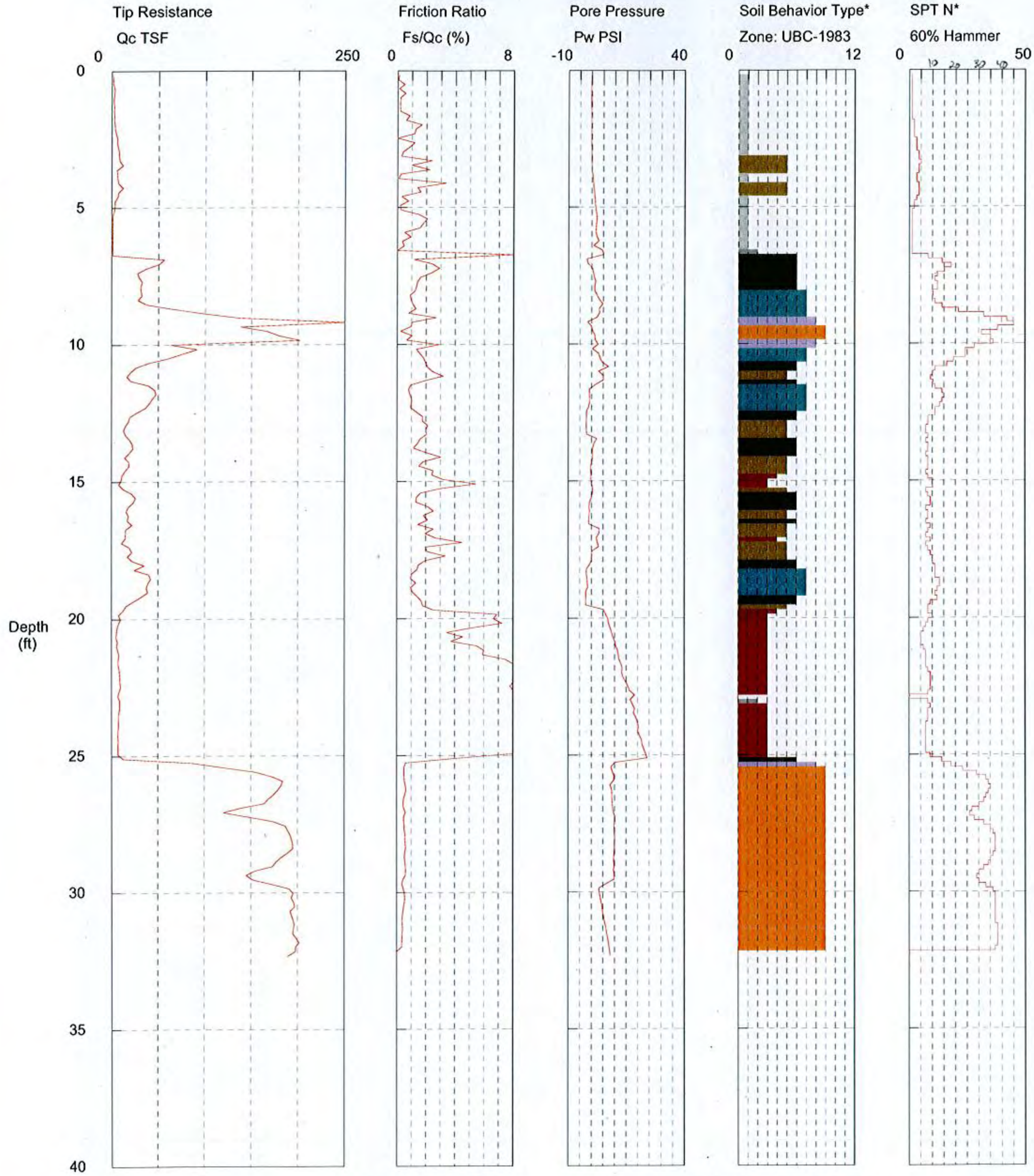
In Situ Engineering

*Soil behavior type and SPT based on data from UBC-1983

Floyd Snider Amec Team

Operator: Brown
Sounding: CPT-21
Cone Used: DSG1015

CPT Date/Time: 9/25/2008 12:21:09 PM
Location: B & L Wood Waste Site
Job Number: BL RIM 304



Maximum Depth = 32.32 feet

Depth Increment = 0.164 feet

■ 1 sensitive fine grained
■ 2 organic material
■ 3 clay
■ 4 silty clay to clay
■ 5 clayey silt to silty clay
■ 6 sandy silt to clayey silt
■ 7 silty sand to sandy silt
■ 8 sand to silty sand
■ 9 sand
■ 10 gravelly sand to sand
■ 11 very stiff fine grained (*)
■ 12 sand to clayey sand (*)

Top 7 feet predrilled and then backfilled.

In Situ Engineering

*Soil behavior type and SPT based on data from UBC-1983

APPENDIX B

Laboratory Testing Procedures and Results

APPENDIX B
LABORATORY TESTING PROCEDURES AND RESULTS
SE10160010.4102

The following paragraphs describe our procedures associated with the laboratory tests that we conducted for this project. Graphical results of certain laboratory tests are enclosed in this appendix.

VISUAL CLASSIFICATION PROCEDURES

Visual soil classifications were conducted on all samples in the field and on selected samples in our laboratory. All soils were classified in general accordance with the United Soil Classification System, which includes color, relative moisture content, primary soil type (based on grain size), and any accessory soil types. The resulting soil classifications are presented on the exploration logs contained in Appendix A.

MOISTURE CONTENT DETERMINATION PROCEDURES

Moisture content determinations were performed on representative samples to aid in identification and correlation of soil types. All determinations were made in general accordance with ASTM:D-2216. The results of these tests are shown on the exploration logs contained in Appendix A.

ATTERBERG LIMIT DETERMINATION PROCEDURES

Atterberg limits are used primarily for classifying and indexing cohesive soils. The liquid and plastic limits, which are defined as the moisture contents of a cohesive soil at arbitrarily established limits for liquid and plastic behavior, respectively, were determined for selected samples in general accordance with ASTM:D-423 and ASTM:D-414. The results of these tests are presented on the enclosed Atterberg limit graphs and on the exploration logs contained in Appendix A.

GRAIN SIZE ANALYSIS PROCEDURES

A grain size analysis indicates the range of soil particle diameters included in a particular sample. Grain size analyses were performed on representative samples in general accordance with ASTM:D-422. The results of these tests are presented on the enclosed grain-size distribution graphs and were used in soil classifications shown on the exploration logs contained in Appendix A.

MOISTURE CONTENT AND MINUS 200 WASH

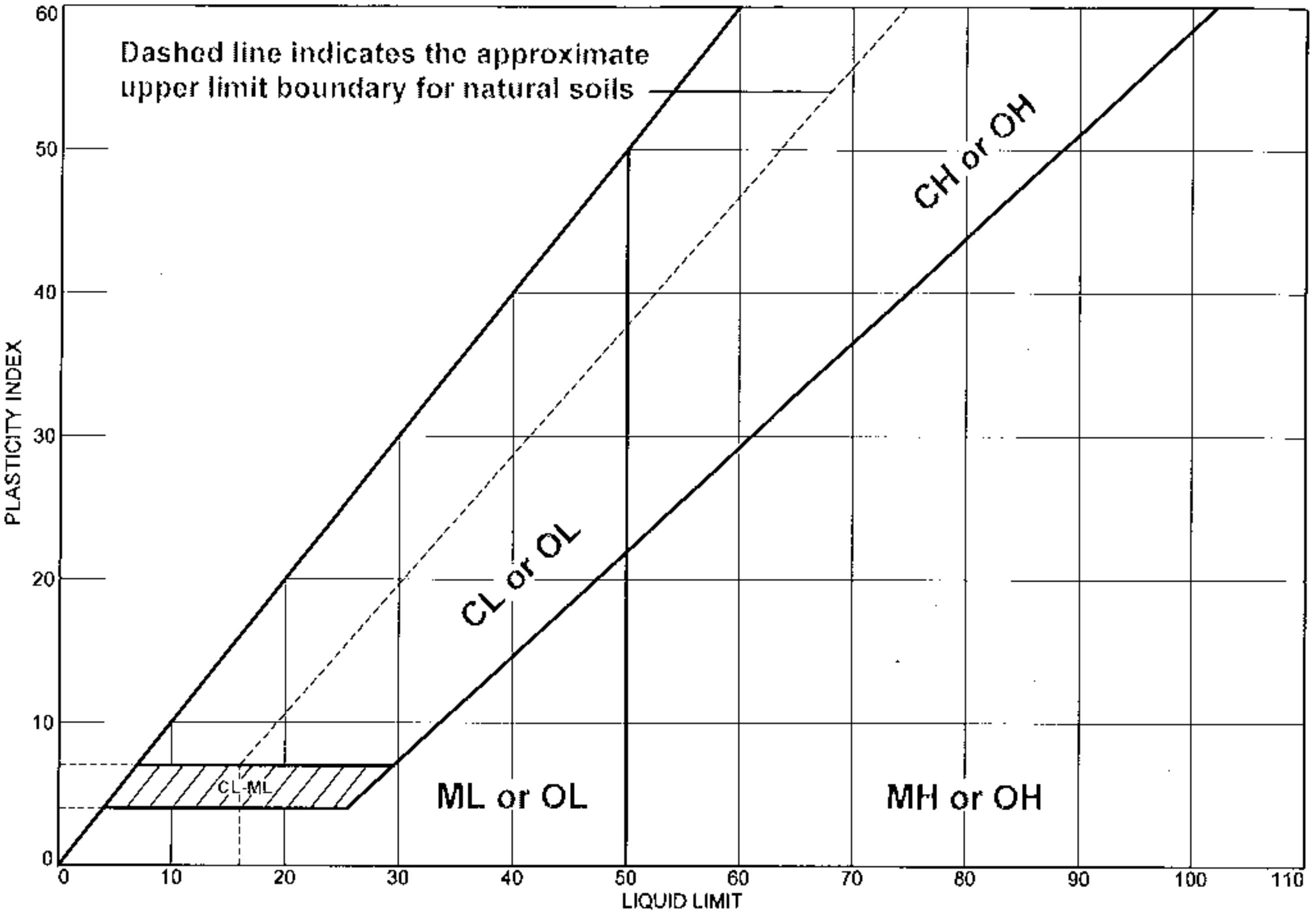
ASTM: D2216-92, D1140-97

Job Name: B&L Woodwaste Tank Structure
Job Number: 10160010/C8111006C
Date: 02/22/2011
Client: B&L Woodwaste/AMEC
Sample Date: 02/17/2011
Sampled By: CE

ID Number:	9526.1	9526.2					
Exploration:	B-1	B-1					
Sample Number:	S-1	S-3					
Depth:	2.5'	10.5'					
Sample Description:	Gray silty Sand	Brown Silt					
Moisture Content:	8.9%	35.4%					
% -200 Wash	20.21%	79.73%					

Terracon
Consulting Engineers & Scientists

LIQUID AND PLASTIC LIMITS TEST REPORT



	MATERIAL DESCRIPTION	LL	PL	PI	%<#40	%<#200	USCS
●	Brown sandy Silt Moisture: 43.1%	NV	NP	NP			

Project No. SE10160010 **Client:** B&L Woodwaste

Project: B&L Woodwaste Tank Structure

●**Location:** B-1, S-4 **Depth:** 15' **Sample Number:** 9532

Remarks:

●ASTM: D4318
Non-Plastic

Terracon Consultants, Inc.

Redmond, Washington

Figure

Tested By: Jeff W **Checked By:** Tyler M

HYDROMETRICS INC.
Consulting Scientists and Engineers
Tacoma, Washington

MW-23

Hole Name: MW-23

Date Hole Started: 3/25/01 Date Hole Finished: 4/1/02

Client: ASARCO, Inc.
Project: B&L Contingency Plan (1227 52.105)
County: Pierce State: Washington
Property Owner: Executive Bark Inc.
Legal Description: R04E, T20N, SQ08 NW NW
Descriptive Location: east of landfill

Recorded By: Bob Miller
Drilling Company: Hydrometrics, Inc.
Driller: Jeff Cross
Drilling Method: hollow stem auger
Drilling Fluids Used: mud
Purpose of Hole: groundwater monitoring
Target Aquifer: shallow alluvial
Hole Diameter (in): 7 7/8"
Total Depth Drilled (ft): 20.5

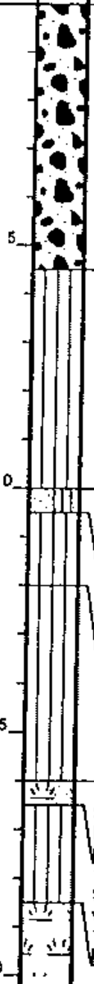
WELL COMPLETION	Y/N	DESCRIPTION	INTERVAL
Well Installed?	Y	2-inch, flush threaded, Sch 40, PVC	0.0-17.28'
Surface Casing Used?	Y	6" x 6" steel casing w/ locking lid	+3.52-5.0
Screen/Perforations?	Y	0.020-inch slot, Sch 40 PVC	7.28-17.28'
Sand Pack?	Y	10/20 Colorado silica sand	6.0-17.28'
Annular Seal?	Y	bentonite chips, med.	1.0-6.0'
Surface Seal?	Y	concrete	0.0-3.0'
DEVELOPMENT/SAMPLING			
Well Developed?	N		
Water Samples Taken?	N		
Boring Samples Taken?	Y	EDXRF analyses (Cu, As, Pb, Fe)	0.0-20.5'

Static Water Level Below MP: 2.65 ft
Date: 4/3/02
MP Description: top of PVC riser
MP Height Above or Below Ground (ft): 3.22 ft

Surface Casing Height (ft): 3.52 ft
Riser Height (ft): 3.22 ft
Ground Surface Elevation (ft): 13.94
MP Elevation (ft): 17.16

Remarks: Drilled w/ a Piper 2000 using a 7 7/8 OD/ 4 1/4 ID hollow stem auger. Sampled w/ a 2" OD split spoon under a 140-lb hammer, 30" drop. Samples obtained for XRF analyses.

DEPTH	SAMPLE NUMBER	SAMPLE TYPE	BLOW COUNT	RECOVERY (feet)	DRILLING AND GEOTECHNICAL NOTES
	MW-23-1	SS	6/20/14	1.00	0.0 - 1.5'
	MW-23-2	SS	7/9/11	0.30	1.5 - 3.0'
	MW-23-3	SS	4/30/50	1.00	3.0 - 4.5' Duplicate Sample: MW-23-3D
	MW-23-4	SS	8/8/16/24	2.00	4.0 - 6.0' Using 3 inch spoon and B-61 Drill Rig
5					
	MW-23-5	SS		0.00	6.0 - 8.0' No Sample
	MW-23-6	SS	1/2/2/1	2.00	8.0 - 10.0'
10	MW-23-7	SS	1/2/1/1	2.00	10.0 - 12.0' Water at 10 feet. Stratigraphy Change in Drive. MW-23-7A: 10-10.5 ft. MW-23-7B: 10.5-12.0 ft.
	MW-23-8	SS	1/2/2/3	2.00	12.0 - 14.0' MW-23-8D 14:45 Duplicate
15	MW-23-9a	SS	2/2/2/2	2.00	14.5 - 16.0' Stratigraphy change in drive. MW-23-9a: 14-14.5 ft. MW-23-9b: 14.5-16 ft.
	MW-23-10	SS	1/1/1/2	2.00	16.5 - 18.5'
	MW-23-11	SS	1/1/1/1	2.00	18.5 - 20.5'
20					



GEOLOGICAL DESCRIPTION

0.0 - 5.5'
GRAVEL,
sandy, silty, well graded, backfill placed during soil consolidation of landfill.
[Road Base Fill]

5.5 - 10.0'
SILT,
dark brown, very low density.
[Recent Alluvium]

10.0 - 10.5'
SILT AND SAND,
with some minor amounts of gravel, gray, saturated.
[Recent Alluvium]

10.5 - 12.0'
SILT
soft, dark brown, with occasional wood chips.
[Recent Alluvium]

12.0 - 16.0'
SILT
soft, gray, with occational organic debris and wood chips, sandier and wet at 12-12.5 and 14.14.5.
[Recent Alluvium]

16.0 - 16.5'
SOIL-LOAM
buried soil horizon, moist but not saturated.
[Recent Alluvium]

16.5 - 18.5'
SILT,
very soft, saturated, gray, with 1-2 inch horizons of peat or wood debris a 17.5 and 18.4 feet, general black-brown color.
[Recent Alluvium]

Continued Next Page

MW-23

Hole Name: MW-23

Date Hole Started: 3/25/01 Date Hole Finished: 4/1/02

(Continued)

DEPTH	SAMPLE NUMBER	SAMPLE TYPE	BLOW COUNT	RECOVERY (feet)	DRILLING AND GEOTECHNICAL NOTES	GRAPHICS	GEOLOGICAL DESCRIPTION
							18.5 - 20.5' **PEAT** moist but not saturated, highly organic, includes wood, grass, seeds an other well preserved vegetation, extremely low density. (Recent Alluvium)
25					25		
30					30		
35					35		
40					40		
45					45		
50					50		