GeoSyntec Consultants

2100 Main Street, Suite 150
Huntington Beach, California 92648
Tel. 714.969.0800 • Fax 714.969.0820

30 June 2006

William J. Fees, P.E.
Toxics Cleanup Program
Washington Department of Ecology
4601 North Monroe Street
Spokane, Washington 99205

Subject: Engineering Design Report, Consent Decree (CD 06-2-00034-6)
Lehigh Cement Company Closed Cement Kiln Dust Pile Site
Metaline Falls, Washington

Dear Mr. Fees:

On behalf of Lehigh Cement Company (Lehigh), GeoSyntec Consultants is pleased to submit the enclosed Engineering Design Report (EDR) for the Lehigh Closed Cement Kiln Dust Pile Site in Metaline Falls, Washington. The enclosed EDR was developed in accordance with the above-referenced Consent Decree (CD) and Washington Administrative Code, Section 173-340-400(4)(a). The EDR has been revised in accordance with your comments on the Draft EDR received via electronic mail on 2 June 2006 and our subsequent conversations.

In addition to the changes that were made to address your comments on the Draft EDR, an updated schedule is presented in this EDR that presents a plan for accomplishing a significant amount of construction in 2006. As you recall from our January 2005 meetings, we had discussed completing the Groundwater Remedy construction in 2006 based on an assumption that we would finalize the Cleanup Action Plan and CD by the fall of 2005. This would have given us several months over the winter and early spring of 2006 to complete the project documentation needed to construct the Groundwater Remedy and to bid and contract the construction for commencement of construction in spring 2006. However, we did not complete negotiations on the draft CAP and CD until January 2006, and those documents did not become final until 9 March 2006. At this point in time, the EDR and the NPDES permit still need to be finalized and the Construction Plans and Specifications, Compliance Monitoring Plan, and Operation and Maintenance Plan are being prepared in accordance with the CD schedule. As you know, the CD requires that these documents be prepared, reviewed, and approved before construction can begin.

Like you, we are disappointed that the project did not progress through the various steps as quickly as we had hoped in January 2005. The current CD schedule estimates that construction could begin sometime in late November or December 2006. As we have previously discussed, Lehigh does not think it is feasible to construct the remedy during the winter months. Working hours at that time of year would have to be shortened significantly because daylight is so limited. Also, low temperatures and the likelihood that snow will be on the ground throughout the winter make the subsurface work more difficult and increase the health and safety concerns for workers. Finally, most of the treatment system components cannot be built until the streambank work is finished, so construction would have to shut down until the Washington Department of Fish and Wildlife (WDFW)-approved Work Window for work near Sullivan Creek opens in July 2007.

Even though we cannot complete construction in 2006 or begin construction over the winter, Lehigh shares Ecology's desire to move forward with construction. Lehigh's proposed estimated schedule is presented in Table 7-1 of the enclosed Final EDR and as an attachment to this letter. Instead of waiting for 2007 to begin constructing the Groundwater Remedy, Lehigh has developed a plan for completing a significant amount of construction in 2006. This plan is based on the following assumptions:

- Project documents pertaining to 2006 work can be submitted and approved by Ecology earlier than currently scheduled according to the CD. Before Lehigh can begin construction, Ecology must approve the Final EDR being submitted along with this letter, and the construction plans and specifications for the 2006 work. Construction of the 2006 items would need to begin by 15 September 2006 to allow sufficient time to complete construction by 15 October 2006. Thus, we would need Ecology to review and approve the plans and specifications for the 2006 work by 1 September 2006. We would also need Ecology to review and approve the Compliance Monitoring Plan by 15 September 2006.

- Lehigh would submit the Operation and Maintenance Plan and project documents pertaining to the 2007 work slightly later than currently scheduled, but according to a schedule that would allow commencement of remaining construction activities in early spring of 2007.

- Lehigh submitted an erosivity waiver on 29 June 2006 that allows it to begin the proposed 2006 construction tasks even if its NPDES permit has not yet been issued.

- Lehigh will receive the building permit from Pend Oreille County to construct the foundation of the building expansion approximately two weeks after submitting the permit application.

- Lehigh is able to procure the necessary materials and retain qualified contractors to complete the proposed 2006 construction tasks.

- Lehigh receives approval from Washington State Department of Transportation for the work that will cross the State Route 31 right-of-way.

Table 7-1 shows how certain items would be completed even before the current CD schedule allows. Lehigh proposes to perform the following major construction items in 2006:

- Preliminary site preparation for the 2006 construction tasks;
- Construct the foundation for the building expansion;
- Evaluate the building utilities and upgrade if necessary;
- Install the gravity drain; and
- Prepare the site for 2007 work, including limited grading and site contouring.

These items were selected for construction in 2006 because they can be implemented as discrete construction tasks, the items can be designed and implemented relatively rapidly, and a costly and inefficient second mobilization of personnel and equipment could be avoided.

After much careful thought, Lehigh has concluded that it is neither possible nor recommended to construct other items this year. Beginning construction of the funnel-and-gate system in 2006 would be inefficient and costly, but more importantly, there is not enough time to finish the design and procure the materials we would need to start the work in 2006. There is still a significant amount of design work that must be completed and approved before Lehigh can begin constructing any part of the funnel-and-gate system, including the streambank stabilization measures that are to be constructed during the WDFW-approved Work Window of 1 July through 31 August. In fact, Lehigh and Ecology are still coming to a resolution of the streambank stabilization measures that are appropriate for this Site. In addition, some of the materials that will be used to construct the system, including the carbon dioxide tank, buried pipes, and tubing, are specialty items that will have to be ordered eight to twenty weeks in advance. It is too late to order and receive these materials for construction in 2006.

Please do not hesitate to contact either of the undersigned if you have questions or comments.

Sincerely,

Brian Petty, P.E.
Engineer

Eric Smalstig, P.E.
Project Manager

Attachment: Table 7-1 – Groundwater Remedy Proposed Revised Schedule

Copy to: Elizabeth Mikols, Lehigh Cement Company
Tanya Barnett, Esq., Cascadia Law Group
Hank Landau, Ph.D., P.E., Geosphere
Andrew Fitz, Esq., Washington State Attorney General's Office

ENGINEERING DESIGN REPORT
CONSENT DECREE 06-2-00034-6

LEHIGH CEMENT COMPANY
CLOSED CEMENT KILN DUST PILE SITE
METALINE FALLS, WASHINGTON

Prepared for:

WASHINGTON STATE DEPARTMENT OF ECOLOGY

Washington Department of Ecology
4601 North Monroe, Suite 202
Spokane, Washington 99205-1295
(509) 329-3572

On Behalf of:

LEHIGH
HEIDELBERGCEMENT Group

Lehigh Cement Company
7660 Imperial Way
Allentown, Pennsylvania 18195
(610) 366-4753

Prepared by:

GeoSyntec Consultants
2100 Main Street, Suite 150
Huntington Beach, California 92648
(714) 969-0800

www.geosyntec.com

30 June 2006

ENGINEERING DESIGN REPORT
CONSENT DECREE 06-2-00034-6
LEHIGH CEMENT COMPANY CLOSED CEMENT KILN DUST PILE SITE
METALINE FALLS, WASHINGTON

This document was prepared by the staff of GeoSyntec Consultants under the supervision of the engineers whose signatures appear hereon. The findings or professional opinions were prepared in accordance with generally accepted professional engineering and geologic practice. No attempt to verify the accuracy of the data provided by others was made. No warranty is expressed or implied.

BRIAN L. PETTY
STATE OF WASHINGTON
42563
REGISTERED PROFESSIONAL ENGINEER
EXPIRES 7/12/2007

Brian Petty, P.E.

Eric Smalstig, Project Manager

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1. INTRODUCTION

1.1 Terms of Reference

This Engineering Design Report (EDR) provides a basis for design and describes conceptual details of each element of the selected groundwater remedy as described in the Cleanup Action Plan (CAP) for the Lehigh Closed Cement Kiln Dust (CKD) Pile Site in Metaline Falls, Washington (Site). This document was prepared in accordance with the Consent Decree (CD – Pend Oreille County Superior Court No. 06-2-0034-6) between Lehigh Cement Company (Lehigh) and the Washington State Department of Ecology (Ecology) that took effect on 9 March 2006.

This EDR contains the information required by the Washington Administrative Code (WAC) 173-340-400(4)(a). Table 1-1 cross-references the WAC 173-340-400(4)(a) requirements with the location where the required information can be found in this EDR. This document, one of a series of deliverables required by the CD, has been prepared by GeoSyntec Consultants (GeoSyntec) on behalf of Lehigh for submittal to Ecology. The remaining deliverables required by the CD are listed later in this document.

1.2 Project Overview

Groundwater currently contacts CKD within the Closed CKD Pile and then migrates to Sullivan Creek. As a result of the contact with CKD, the groundwater pH increases. The increase in groundwater pH causes certain naturally occurring metals in soil to dissolve into the groundwater. Lehigh and Ecology have entered into a Consent Decree that provides a method and a timeline to address the CKD-affected groundwater. The five primary requirements of Lehigh that are specified in the CD are:

1. Install, operate, and maintain a groundwater remedy consisting of a funnel-and-gate system with a treatment system, as described in the CD (and herein);

2. Install, operate, and maintain a groundwater gravity drain along the southern edge of the Closed CKD Pile, as described in the CD (and herein);

3. Monitor groundwater in accordance with a Compliance Monitoring Plan (CMP);

4. Provide for and maintain institutional controls; and

5. Operate and maintain the existing Closed CKD Pile cover and stormwater conveyance systems.

This EDR describes the conceptual details and design basis for each of the components related to the first four primary requirements of the CD listed above. The remediation system components described in the CD are collectively referred to as the Groundwater Remedy in this EDR. The existing cover and stormwater conveyance systems (fifth CD requirement) are described in documents provided previously to Ecology [Dames & Moore (D&M), 1995, 1996, 1997].

1.3 Organization of the Engineering Design Report

The remainder of this EDR is organized into the following sections:

- Section 2, *Background*, summarizes findings of the Site Remedial Investigation (RI) and Feasibility Study Technical Report (FSTR), as well as the regulatory history of the Site, and CD cleanup goals.

- Section 3, *Design Parameters*, describes key design parameters and variables that will be considered to design the elements of the Groundwater Remedy.

- Section 4, *Construction*, presents the anticipated construction sequence and contractor management

- Section 5, *Compliance Monitoring*, describes the protection, performance, and confirmation monitoring to be performed at the Site.

- Section 6, *Operation and Maintenance*, summarizes the activities to be performed after installation of the system.

- Section 7, *Schedule and Other Considerations*, presents the anticipated project schedule and limitations.

- Section 8, *Conclusions*, summarizes the benefits to implementing the Groundwater Remedy.

References, tables, figures, and appendices are included at the end of the document.

2. BACKGROUND

2.1 General

This section describes the framework and rationale (i.e., Site setting and regulatory history) for constructing the Groundwater Remedy. Lehigh has performed site-specific environmental investigations and mitigation efforts since the late 1980s. For the purposes of this EDR, certain sections may contain summaries of the historical documents insofar as they contain information that affects the design of the Groundwater Remedy. Otherwise these documents are included by reference. Following this background, this section culminates by describing the goals of the CAP as listed in the CD.

2.2 Site Location and Layout

Figure 1-1 shows the Site location and the existing Site layout. The Site is located in a remote area of Washington State approximately 100 miles north of Spokane and 13 miles south of the Canadian border. Lehigh owns the property on which the Closed CKD Pile is located, in addition to land north and hydraulically downgradient of the Closed CKD Pile along Sullivan Creek (approximately 14 acres total). The majority of construction will occur on the relatively flat area east of State Route 31, between State Route 31 and Sullivan Creek. The Closed CKD Pile lies on approximately 7 acres of Lehigh's property adjacent to and west of State Route 31 across from where the majority of construction will occur. The Closed CKD Pile rises approximately 90 ft above State Route 31 at a slope of 2H:1V (Horizontal to Vertical) to a gently sloping upper deck with a maximum elevation of approximately 2,132 feet above mean sea level (ft MSL). The gravity drain will be installed from the relatively flat area east of State Route 31 to the area adjacent to the top deck of the Closed CKD Pile.

2.3 Site Description and Regulatory Overview

2.3.1 Summary of Remedial Investigation (RI) and Feasibility Study (FS) Activities

Several environmental investigations have been conducted prior to and after pile closure to evaluate the CKD Pile and its effects on groundwater. The results of these investigations, which form the basis for design of the Groundwater Remedy, are described in project documents, including:

- Preliminary Site Characterization Report [D&M, 1992];
- Addendum, Preliminary Site Characterization Report [D&M, 1993];
- Post-Closure Care Groundwater Monitoring Data Review [GeoSyntec, 1999];
- Final Remedial Investigation Report [GeoSyntec, 2001];
- Feasibility Study Technical Memorandum [GeoSyntec, 2003];
- Summer 2004 Investigation Report [Ecology, 2004]; and
- Feasibility Study Technical Report [GeoSyntec, 2005].

Considering the data presented during the RI, Lehigh conducted a feasibility study (FS) of potential remedial systems to address the CKD-affected groundwater. A screening-level FS document was submitted to Ecology that included the results of a comparison of over 20 remedial alternatives. Following the WAC-prescribed screening and detailed review, six alternatives were evaluated in greater detail Results of this process were documented in the Feasibility Study Technical Report (FSTR) [GeoSyntec, 2005].

Ecology used the information provided in project documents to select the Groundwater Remedy described in the CAP, as implemented by the CD. The FS process culminated in the selection of the Groundwater Remedy summarized in the CD. The process flow diagram and conceptual rendering of the Groundwater Remedy are presented in Figures 2-2 and 2-3, respectively, and the components are described in Section 3.

In addition, engineering data were presented to Ecology in the Engineering Report (ER) submitted in March 2006 as part of the National Pollutant Discharge Elimination System (NPDES) permit process [GeoSyntec, 2006]. The following sections contain a summary of information from these documents pertinent to the Groundwater Remedy design.

2.3.2 Site Geology

Based on the information gathered during the RI, two geologic strata at the Site are relevant to the Groundwater Remedy systems to be installed at the Site: glacial sediments and Holocene alluvium [GeoSyntec, 2005]. The gravity drain component of the Groundwater Remedy will be primarily installed within the glacial sediments underlying the Closed CKD Pile. The funnel-and-gate components of the Groundwater Remedy will be installed within the alluvium downgradient of the Closed CKD Pile. These components are described in more detail in Section 3.

- Glacial Sediments. Overlying the bedrock[(1)] are glacial sediments composed of glaciofluvial (river terrace) and glaciolacustrine (glacial lake) sediments that consist of sandy silt and clayey silt. The glacial sediments are subject to landsliding. Immediately to the south of the Closed CKD Pile is an historic landslide [D&M, 1997]. The historic landslide consists of disturbed sediments to an unknown depth along unknown slip planes. This area above the landslide rises in steep relief progressing south from the Closed CKD Pile.

- Holocene Alluvium. Sullivan Creek eroded a bowl into the glacial sediments. The creek deposited gravels with occasional cobbles and

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(1) See the RI for data about the bedrock, which is not considered relevant to this EDR.

boulders and interspersed zones of more clayey, silty, and sandy materials into the base of the bowl and on the floodplain. This layer is generally about 20 ft thick and overlays the glacial sediments.

The geology of the Site is a critical consideration of the engineering design and construction of the Groundwater Remedy, as it includes extensive subsurface activity. The geology will dictate the speed and extent of the construction to be performed.

2.3.3 Site Hydrogeology and Sullivan Creek Hydrology

The sources of groundwater at the Site include precipitation, upland recharge through the glacial sediments and Holocene alluvium, and, to a lesser extent, Sullivan Creek flow [GeoSyntec, 2005 and USGS, 2003].

The shallow groundwater levels that are present in the floodplain north of State Route 31 and the groundwater migrating through the upper glacial sediments beneath the Closed CKD Pile will be critical considerations when constructing the Groundwater Remedy. Steps will be taken to control the water flow from the saturated soil layers when installing the Groundwater Remedy. These steps are described in Section 3 for each of the Groundwater Remedy components.

2.3.4 Summary of Environmental Analysis and Sampling Results

During RI activities, Lehigh conducted evaluations of the environmental media at the Site, including the CKD, soil, surface water, and groundwater. Data are summarized in Appendix A. Findings of the RI activities include:

- CKD – Samples indicated that the CKD primarily consists of alkaline materials, such as calcium oxide. The chemical analytical results indicated that metals concentrations were generally below soil background concentrations and regulatory screening levels [D&M, 1992].

- Soil – The soil samples were characterized by pH values from approximately 7.7 to 10.8 standard units. Soil metals concentrations (for the Site indicator metals, each in milligram per kilogram, mg / kg): arsenic (<0.75 to 13.8), chromium (2.1 to 131), lead (2.6 to 93), and manganese (23.7 to 470). Organic constituents were generally not detected above laboratory detection limits.

- Surface Water – Water quality within Sullivan Creek upgradient and downgradient of the Site does not vary significantly [EIP, 1999]. For the indicator substances used for the Groundwater Remedy, data indicate that pH is between 8.4 and 8.49 standard units and concentrations for arsenic, chromium, and lead were below laboratory detection limits (manganese was not analyzed).

- Groundwater – The affected groundwater plume encompasses approximately 2.5 acres. The following is a summary of the effects of the Closed CKD Pile on the Site groundwater:

  - The Site groundwater table elevation under the Closed CKD Pile fluctuates seasonally and annually depending on precipitation and runoff conditions.

  - Groundwater contacts portions of the base of the Closed CKD Pile from underneath in the alluvial floodplain, as well as from seepage contacting the CKD along the glacial deposits. The groundwater pH increases as a result of the contact with CKD.

  - The high pH groundwater causes naturally occurring metals in the Site soils to dissolve into the groundwater. These metals, including arsenic, lead, and chromium, are not present in significant concentrations within the CKD, however.

– Groundwater treatment with carbon dioxide causes naturally occurring manganese to dissolve into the groundwater as other indicator substance metals precipitate.

2.3.5 Regulatory Overview and CAP Goals

The CD describes the regulatory history of the Site, including the history of on-site CKD management activities, CKD landfill closure activities, and groundwater assessment and remediation activities. The RI / FS activities were performed under the Ecology Model Toxics Control Act (MTCA) requirements. Ecology used the information from the RI/FS activities to select the Groundwater Remedy described in the CAP. In accordance with the CD which implements the CAP, Lehigh will construct and operate the Groundwater Remedy to address the CKD-affected groundwater that continues to migrate from the Closed CKD Pile. Lehigh performs post-closure care and maintenance activities for the Closed CKD Pile as described in the Post-Closure Care and Maintenance Plan [D&M, 1995], which is also incorporated into the CD. Table 2-1 summarizes the existing cleanup levels required by the CD.

After reviewing the project, Ecology issued a Determination of Nonsignificance (DNS) for the impacts of the proposed Groundwater Remedy on the environment in accordance with the State Environmental Policy Act (SEPA). Also, because the project is a MTCA cleanup action, it is exempt from obtaining state and local permits. Ecology instead compiles the substantive requirements of these permits and provides them to Lehigh. The substantive requirements are similar to permit conditions that will be followed during Groundwater Remedy implementation. The Groundwater Remedy is also subject to federal permit requirements under the Clean Water Act (National Pollutant Discharge Elimination System and Section 404 Dredge and Fill permits) and Rivers and Harbors Act. On 5 January 2006 the United States Army Corps of Engineers (USCOE) issued authorization under Nationwide Permit 38 for Lehigh to construct that portion of the Groundwater Remedy that is subject to Section 404 of the Clean Water Act and Section 10 of the Rivers and Harbors Act. Table 2-2 summarizes the regulatory requirements that result from the substantive requirement lists and the federal permits.

As stated in MTCA, the overall goal of a cleanup action is to have the site-specific indicator substances meet the cleanup levels at a prescribed location on site (i.e., point of compliance). The goals of the site-specific CAP include:

- Implement source control by diverting water away from the Closed CKD through a gravity drain;

- Capture CKD-affected groundwater that migrates from the Closed CKD Pile toward Sullivan Creek;

- Treat the captured groundwater to meet site-specific cleanup levels for pH, arsenic, chromium, lead, and manganese (Table 2-1); and

- Allow the treated groundwater to flow into Sullivan Creek.

This EDR provides the engineering basis for designing, operating, maintaining and monitoring a system that will achieve the CAP goals.

3. DESIGN PARAMETERS

3.1 Introduction

This section presents site-specific information and conditions that affect the design of the Groundwater Remedy components, and how they are considered during design. Long-term operability and sustainability will also be considered during design. Table 3-1 summarizes key design considerations for each of the Groundwater Remedy components.

The Groundwater Remedy consists of a combination of existing technologies and an innovative treatment system. The Groundwater Remedy consists of two major components:

1. Funnel-and-Gate Treatment – installed downgradient of the Closed CKD Pile, the system intercepts the groundwater that is affected by the Closed CKD Pile. The intercepted groundwater is treated in a subsurface engineered treatment zone for release to Sullivan Creek through a subsurface engineered outfall that will be subject to an NPDES permit.

2. Gravity Drain – installed along the southeastern edge of the Closed CKD Pile, the gravity drain captures groundwater that might otherwise contact the Closed CKD Pile.

The funnel-and-gate concept uses a slurry wall, or similar barrier wall technology, to passively intercept the groundwater and direct the water toward a central treatment corridor. The upgradient side of the barrier wall funnel would be supplemented with a gravel French drain. The gravel would help to convey water along the barrier wall funnel to the treatment corridor, and it would lower the groundwater table in the vicinity of the funnel. The treatment corridor will use the technology evaluated during bench and pilot-scale testing to treat groundwater by diffusing carbon dioxide into the CKD-affected groundwater [GeoSyntec, 2003]. Carbonic acid is formed when carbon dioxide is diffused into the groundwater. The carbonic acid lowers the pH, which causes the dissolved indicator substances (i.e., metals) to precipitate. The treated groundwater will then migrate to Sullivan Creek.

The gravity drain is a source control technology designed to supplement the funnel-and-gate components. Horizontal directional drilling techniques will be used to install a drain pipe under the southernmost CKD, connecting the barrier wall funnel and the upland area above and upgradient of the Closed CKD Pile. The gravity drain will be installed on the southern side of the Closed CKD Pile. Depending on water quality, the intercepted water will be routed to the barrier wall funnel for treatment or routed to the downgradient side of the barrier wall funnel.

3.2 Design Considerations

3.2.1 Summary of Geology, Hydrogeology and Groundwater Conditions

A general geologic and hydrogeologic description of the Site is summarized above in Sections 2.3.2 and 2.3.3. Key design considerations are summarized in Table 3-1. Details central to the design of the Groundwater Remedy include vertical and horizontal hydraulic conductivity, groundwater table elevation, and lithology. These data are included in Appendix A and Figures 3-2 and 3-3, and are summarized below:

- Holocene alluvium (sands and gravels) – horizontal hydraulic conductivity, average 1×10^{-3} ft / min;
- Glacial sediments (silt and clay) – vertical hydraulic conductivity, average 1×10^{-6} ft / min; and
- Groundwater table generally within three feet of existing ground surface within floodplain area.

The lithology is highly variable within the floodplain. Boulders present within the alluvial deposits will affect layout and construction schedules. The finer materials within the excavated alluvial sediments may be considered for re-use within the project (e.g., fines within soil-bentonite backfill, sands and gravels for Site grading, and larger aggregate size for natural creek bank stabilization).

3.2.2 Creek Bank Geomorphology

A critical component of design involves the connection of the treatment system corridor to Sullivan Creek. This connection will be constructed and reinforced using biostructural elements appropriate to the Sullivan Creek geomorphology and to maintain the natural aesthetic of the area.

As described in previous documents submitted to Ecology, upstream of the Site Sullivan Creek is confined within a canyon where the stream channel is deeply incised in the bedrock substrate [EIP, 1999]. Downgradient of the former Sullivan Creek Hydroelectric Plant, Sullivan Creek passes under State Route 31 in the immediate vicinity of the Site. It is approximately there that the creek exits the canyon into an alluvial floodplain. This floodplain constitutes the terminal 0.4-mi section of Sullivan Creek prior to its confluence with the Pend Oreille River.

A few miles upstream of the Site, both Sullivan Lake and Mill Pond trap gravel and finer sediments from the contributing flows to Sullivan Creek [EIP, 1999]. Due to the high water velocities through and out of the canyon, the lower reaches of Sullivan Creek contain primarily erosional products from the bedrock substrate, generally large, rounded cobbles and boulders. Historically, the highly-braided stream channel has then meandered through the floodplain in the immediate vicinity of the Site. The current creek flow path leads a braided channel of Sullivan Creek to the base of an eroding bluff, less than 20 ft downgradient of Lehigh property along Sullivan Creek. The creek bank at the toe of the eroding bluff has been temporarily stabilized by an engineered "chaotic crib" consisting of irregularly-placed tree trunks and logs.

The Sullivan Creek bank along the Site consists of geologic deposits of varying aggregate sizes, dominated by large cobbles and boulders immediately along the water's edge. Historical overland flow from upland areas above the Closed CKD Pile has carried erosional sediments to Sullivan Creek. As these overland flows reached the floodplain, finer sediments and vegetative debris were deposited over the larger aggregate sizes contributed by Sullivan Creek. As a result, a veneer of finer sediments currently exists overtop of the creek deposits with scattered vegetation rooted in this matrix along portions of the water's edge adjacent to the Site.

3.2.3 Quantities and Site Constraints

Key design considerations for Groundwater Remedy installation and operation include: Site lithology and groundwater flow within the upper groundwater aquifer, and surface water hydrology (both upgradient and downgradient of the system). Key design considerations for long-term system efficacy include: efficiency of the gravity drain, efficiency of the treatment system, system remoteness, and climatological influences (e.g., flooding).

Construction will occur mostly in the surficial Holocene alluvium soils at the Site where the CKD-affected groundwater flows. The quantity of geologic materials to be excavated during construction of the funnel-and-gate portions of the Groundwater Remedy is anticipated to be approximately 7,000 to 8,000 cubic yards (CY). An additional approximately 2,000 CY will be excavated from the treatment corridor. Although portions of this material may be re-used (e.g., as part of the soil-bentonite backfill, or natural cobbles along the creek bank), some of the material will be disposed off-site. During the excavation of these components and installation of integral systems, dewatering will be necessary. The volume and chemical characteristics of the water extracted during construction dewatering, as well as the duration of the construction dewatering, will depend on conditions encountered in the field. Water generated during construction dewatering will be treated by: (1) injecting it into the pilot system during construction; (2) storing it above-ground for treatment with CO_2 or later injection to the treatment system; or (3) direct discharge to Sullivan Creek without treatment, based on the water quality testing requirements that are to be specified in the NPDES permit.

One portion of the excavation, the treatment corridor, is excavated adjacent to the Sullivan Creek bank. This excavation work will be performed during a time specified in the substantive requirements of Hydraulic Project Approval (HPA) from the Washington Department of Fish and Wildlife (Fish and Wildlife), known as the Fish and Wildlife-approved Work Window, which is typically between 1 July and 31 August for this portion of Sullivan Creek. However, Fish and Wildlife may extend the Work Window due to the historically low creek levels in September. The schedule and cost of the construction described in this document are based on the understanding that the remainder of the construction will not be subject to the Fish and Wildlife Work Window. Also note that this project is to be installed within the Sullivan Creek floodplain. The flows within Sullivan Creek are largely regulated by controlled discharges from Sullivan Lake and Mill Pond. Although certain elements of the Groundwater Remedy will incorporate flood-resistant components (e.g., tie-downs), the project will not include provisions to impede flooding of the Site.

A large construction area will be required to prepare, excavate and handle the excavated material. The construction and staging operations will be handled within Lehigh property boundaries. Because Washington State Department of Transportation (WSDOT) plans to re-align State Route 31 in the vicinity of the Site, Lehigh will be coordinating needed work space with WSDOT.

Also of note are the seasonal climate variations. Temperatures vary significantly, with monthly average temperature extremes ranging from below 10°F to above 90°F [GeoSyntec, 2001]. The Site mean annual precipitation is 28 in. [GeoSyntec, 2001]. The working area is typically covered by snow from November or December through March.

The Groundwater Remedy is anticipated to be operating for several decades. Based on the anticipated design life and the remoteness of the area, specific design considerations will be incorporated to facilitate operation and maintenance of the Groundwater Remedy. These include automated systems such as telemetric operation to allow the system's status to be monitored from remote locations.

3.3 Groundwater Remedy Elements

3.3.1 General Description

The Groundwater Remedy consists of several elements. Each of the elements is described in the following sections, including:

- Site Preparation;
- Building Expansion;
- Carbon Dioxide Tanks;
- Diaphragm Walls;
- Carbon Dioxide Treatment System;
- Treatment Corridor;
- French Drains;
- Groundwater Barrier Walls;
- Streambed Erosion Control – Treated Water Discharge Location;
- Gravity Drain;
- Wetlands Mitigation Measures;
- Site Restoration; and
- Institutional Controls.

This section also describes Site preparation and restoration activities. Preliminary design calculations are provided in Appendices B and C for anticipated flow within the treatment corridor and carbon dioxide dosage, respectively. Design details provided in the following sections and the appendices are for general reference and scaling, and may be modified during the design of the Groundwater Remedy. Where appropriate, standard engineering specifications will be followed during the design and installation of system components (e.g., WSDOT and / or American Society of Testing and Materials (ASTM) or equivalent).

3.3.2 Site Preparation

Site preparation activities will be performed in accordance with a Site Management Plan to be prepared by Lehigh's contracting team. The Site Management Plan will include a description of storm water and surface water controls, outlining of equipment staging areas, Site clearing and preliminary grading, security and Site access, institutional controls during construction, and general health and safety precautions.

Site preparation is divided into two phases: Phase I, encompassing work in 2006, and Phase II, encompassing work scheduled for 2007 (see Section 7 and Table 7-1 for a more detailed description of the work schedule). Site preparation measures include controlled vegetation removal (i.e., protecting in-place as much of the woody vegetation as practicable, maintaining natural vegetative "screening," removing only the vegetation that will impact construction operations). An area of degraded wetland (designated Category IV by the USCOE) will be impacted by Site construction activities. Lehigh will mitigate these impacts following construction of the Groundwater Remedy. Site preparation measures will also include rough grading to prepare the area for each of the system components, as well as protect it from surface water drainage during the construction phase. Appropriate Best Management Practices (BMPs) for limiting uncontrolled discharges from the Site will be employed by Site contractors. Phase I Site preparation measures include preparing the area where the building expansion foundation will be constructed as well as rough grading activities and contouring the site to allow for more efficient stormwater drainage. Phase II Site preparation measures include additional grading and vegetation removal to prepare for installation of the subsurface components of the Groundwater Remedy. Site activities will disturb more than one acre of ground, thereby requiring an NPDES permit for construction stormwater. The NPDES permit is expected to be issued by Ecology prior to commencement of site activities. The NPDES permit will include provisions for addressing water discharges during the construction process. Lehigh has also applied for an erosivity waiver from Ecology to allow a work to occur in 2006 in advance of the NPDES permit.

Excavation dewatering will likely be needed to construct the treatment zone and other associated subsurface engineered components. The water collected during dewatering will likely be discharged to Sullivan Creek for a limited period of time during construction. The treatment system will also not be operational for a period of time after it is constructed and prior to start-up. During this time water will migrate through the treatment zone and into Sullivan Creek without being treated with carbon dioxide. The NPDES permit is expected to allow for untreated discharges under these scenarios since they are integral to construction of the Groundwater Remedy.

3.3.3 Building Expansion

The existing Site improvements include a structure with dedicated electrical and plumbing. The existing structure is made of cinder-block and fiberglass corrugated panel walls and metal roofing. Portions of the structure are occupied by a machine shop. The existing building houses the control components for the pilot scale treatment system [GeoSyntec, 2003].

To create space for dedicated storage for the components of the full scale treatment system, the building will be expanded. The expansion will house the new components to be added for the full scale treatment system. Prior to beginning construction of the expansion, utilities such as water and electrical services will be evaluated and updated, as needed. The building expansion will likely be a one-story addition, having a plan area of approximately 1,200 square feet (30 ft by 40 ft). The building expansion will be in keeping with the existing structure aesthetic. The building will include a poured reinforced concrete foundation designed to support a carbon dioxide tank including tank mountings, and a structure having wide doors so the tank may be installed following completion of the building, or removed in case of malfunction.

An automated Supervisory Control and Data Acquisition (SCADA) system will be housed in the new building expansion along with other equipment necessary to distribute carbon dioxide to the full scale system and monitor the system remotely. The building expansion will be equipped with carbon dioxide sensors and alarms; these alarms will sound if levels in the air within the structure are above pre-determined action levels. The building will be secured and placarded to notify passersby of the building contents.

3.3.4 Carbon Dioxide Tanks

The existing structure houses a 14-ton tank containing carbon dioxide. In order to accommodate the design demand for a greater amount of carbon dioxide to be used in the full-scale system, the on site storage capacity will be increased (allowing the treatment system to function for longer periods of time before a carbon dioxide recharge is necessary). The existing system will be augmented with a second 14-ton unit: a pre-manufactured skid-mounted, steel, carbon dioxide storage and distribution tank will be installed. The tank will be ASME certified, with Underwriters Laboratories (UL) listed components. The total carbon dioxide capacity will be 56,000 lbs.

The tanks will have the following features: automated refrigeration capabilities, pressure relief controls, and system automation for carbon dioxide distribution to the manifolds. The treatment skid will also include tie-downs for flood contingencies.

The pilot system will be abandoned after it is no longer needed and only the carbon dioxide tank and associated piping hardware will be re-used. The underground piping used for the pilot system will be de-commissioned and left in place.

3.3.5 Diaphragm Walls

The gate portion of the funnel-and-gate consists of a treatment corridor where carbon dioxide will be diffused into the groundwater. The treatment corridor will be excavated so that the treatment components may be installed. Diaphragm walls will be installed in-situ to provide structural integrity to the area to be excavated, as well as serve as the low permeability barrier walls for the gate through which groundwater is directed. The diaphragm walls will be constructed of reinforced concrete.

Construction of the diaphragm walls will be performed using slurry trench excavation techniques. First an elevated platform will be constructed to create a sufficient head differential between slurry and the surrounding groundwater table. Using extended track-mounted backhoes, the excavation will be advanced through the slurry and subsurface material. The diaphragm walls are approximately parallel to the groundwater flow direction through the gate. The walls will be constructed approximately 20-25 ft deep, and keyed into the underlying aquitard. The walls will be approximately 3 ft thick. The design dimensions will be based on the effective stresses (soil and water pressures) that will be present on the walls once the treatment corridor is excavated. Diaphragm wall reinforcement materials will be pre-assembled and lowered into the excavation. Cement slurry will be tremied into the excavation around the reinforcement to complete the wall.

Groundwater flow and high pH conditions are important considerations for the long-term integrity of the diaphragm walls. The diaphragm walls will be constructed with materials that will be able to withstand the shear forces caused by the groundwater flowing through the treatment corridor and that will resist corrosion under the pH conditions that will occur in parts of the treatment corridor.

The diaphragm wall construction and design are influenced by the lithology encountered in the excavations in which the concrete walls will be built. The lithology will dictate the ease with which excavation and installation will occur. Lehigh will evaluate options such as installing the diaphragm walls deep into the confining layer of the aquitard or an anchor system (tie backs) to counteract the soil and water pressures that will be present. The diaphragm wall design will also consider the method of connection between the diaphragm walls and the groundwater barrier walls. This connection will likely be grouted in order to reduce groundwater seepage between the two subsurface walls.

Water will flow through the treatment corridor without being treated until the treatment system is connected and operational. See Appendix A for analytical data that describe the untreated water that will be discharged.

3.3.6 Carbon Dioxide Treatment System

The selection of the treatment process for the Groundwater Remedy was based on engineering calculations, chemical stoichiometry, and bench-scale and pilot treatment studies [GeoSyntec, 2000 through 2003]. A flexible carbon dioxide delivery system and a performance monitoring system within the treatment corridor will allow Lehigh to fine-tune operation, in particular, carbon dioxide delivery rates. Components of the Groundwater Remedy will be modified during installation and operation of the systems, based on site-specific constraints and field observations. After the two-year Optimization Phase specified in the CAP, the treatment system is expected to meet cleanup levels when operational. During the two-year Optimization Phase, cleanup levels may not be met prior to discharge to Sullivan Creek even when the Groundwater Remedy is operational.

The carbon dioxide treatment system includes the mechanisms by which carbon dioxide is dissolved into Site groundwater. The two carbon dioxide storage tanks (Section 3.3.4) will contain the carbon dioxide that is diffused into the groundwater. The tanks store the carbon dioxide as a liquid and gas mixture, at approximately 300 pounds per square inch (psi). Shatter-resistant plastic pipe conduits such as high density polyethylene (HDPE) or acrylonitrile butadiene styrene (ABS) will connect the carbon dioxide tanks to the silicone tubing in the treatment corridor. These conduits will be equipped with moisture drop-outs to keep the lines clear. The carbon dioxide will pass through a series of pressure regulators that reduce the carbon dioxide from approximately 300 psi at the tanks to approximately 40 psi in the silicone tubing.

The treatment corridor lies at the mouth of the funnel and consists of in-situ carbon dioxide delivery system components (i.e., perforated pipes and silicone tubing) arranged and installed in the gravel corridor as shown in Figure 3-4. Mass transfer of carbon dioxide into the high pH water is achieved at the exterior walls of the gas-permeable silicon tubing. Treatment geochemistry is described in other documents previously submitted to Ecology as part of the FS process, and is summarized herein. Figure 3-5 shows a process flow diagram for the carbon dioxide diffusion process. Figure 3-4 shows the treatment corridor in plan and cross-sectional views. Figure 2-2 shows a process flow diagram for the overall treatment system. Carbon dioxide is distributed into the silicone tubing under approximately 40 psi of pressure. The pressure causes diffusion of carbon dioxide through the walls of the tubing into the groundwater.

The design will consider how to increase the efficiency of the treatment system. The efficiency of the carbon dioxide treatment system will be affected by a number of factors including: dosing, mixing, number of silicone tubes and the flow through the carbon dioxide treatment corridor. The silicon tube bundles will be placed in segments of pipes in U-shapes (see Figure 3-4). The high hydraulic conductivity gravel in the treatment corridor will encourage mixing. Several segments of carbon dioxide distribution pipes will be installed to give greater dosing control. System monitoring and maintenance wells will be placed within the treatment corridor to monitor dosing. A "surface completion" will be added over the manifolds in the treatment corridor to protect the weather sensitive parts, and secure those areas.

3.3.7 Treatment Corridor Construction

The treatment corridor has been located in an area that:

- is relatively low topographically;
- contains a lower density of boulders and cobbles than the rest of the streambank; and
- is located as far as feasible from the bluff and the river bend to reduce the amount of energy that is imparted on the discharge location and surrounding streambank.

The mixing of carbon dioxide with CKD-affected groundwater occurs within the treatment corridor. The treatment corridor will be constructed by excavating the soil between the diaphragm walls and replacing it with fill material having high hydraulic conductivity relative to surrounding materials, and the carbon dioxide treatment system. The depth of the treatment corridor side walls is about the same depth as the barrier wall funnel (approximately 10 to 20 ft). The treatment corridor components are placed after approximately 2,000 CY of material from the treatment corridor are excavated. During construction, the treatment corridor will be dewatered to expose the full treatment corridor for the placement of treatment system components. The fill used in the treatment corridor will have a high hydraulic conductivity to allow flow throughout the corridor (i.e., reduce back-up in the system). The grain size of the fill will directly affect the groundwater flow though the treatment corridor. The fill will consist of non-reactive aggregate (likely granitic) to withstand the high pH that will be present in parts of the treatment corridor.

Prior to excavation in the treatment corridor, a system will be put in place to impede groundwater from flowing into the treatment corridor during excavations. One possible alternative is an engineered low permeability groundwater barrier temporarily placed at both ends of the corridor. Another alternative is a groundwater dewatering collection trench placed near the ends of the treatment trench that diverts groundwater from the corridor and then is treated and surface discharged or pumped into surrounding drainage courses. These systems would be removed subsequent to completion of the corridor. These two systems and other alternatives will be evaluated as part of detailed design.

3.3.8 French Drains

The funnel portion of the funnel-and-gate consists of a groundwater barrier wall and high permeability wall (i.e., French drain). The French drains provide a relatively high permeability zone within the subsurface that will be used to conduct high pH groundwater to the treatment corridor. The French drains are upgradient and located several feet from the groundwater barrier walls (described in Section 3.3.9). The French drains will have a thickness of approximately two to three feet, depth of approximately 20 to 25 ft, and length of approximately 600 feet.

Prior to construction, the subsurface conditions along the proposed alignment will be evaluated, and, if needed, additional borings along the alignment will be installed to evaluate subsurface conditions (specifically depth to the aquitard along the precise alignment, and distribution of large sediments that would make construction difficult). The French drains will be excavated in a similar fashion to the diaphragm walls. Biodegradable slurry will be used to excavate the trench for the French drain. As the trench is excavated, biodegradable slurry will be added to keep the excavation open. Once the excavation is complete the gravel fill material will be added to the excavation. Slurry will be displaced by non-reactive (likely granitic), high permeability aggregate. A degradable slurry breakdown solution may be added to the wall to increases the rate of degradation of the biodegradable slurry.

3.3.9 Groundwater Barrier Walls

The second element of the funnel portion of the funnel-and-gate is the groundwater barrier walls. The barrier wall is a relatively low permeability zone within the subsurface that will be used to conduct high pH groundwater to the treatment corridor. The barrier walls are downgradient and within several feet of the French drains (described in Section 3.3.8). The barrier wall will have a thickness of approximately two to three feet, depth of approximately 20 to 25 ft, and length of approximately 600 feet.

The barrier walls will be excavated in a similar fashion to the diaphragm walls, likely using slurry wall techniques. The barrier walls are aligned across the CKD-affected groundwater plume to capture and direct it to the treatment corridor. The barrier walls key into the upper few feet of the low-permeability glacial sediments that underlie the Site. The slurry composition, likely bentonitic slurry, will be compatible with high pH conditions.

The barrier walls will most likely be constructed using a soil-bentonite or soil-cement-bentonite mix. Though a slurry groundwater barrier wall is most likely, other low permeable barrier methods, such as PVC sheet pile or HDPE wall are being considered. If a slurry wall is installed, soil from the treatment corridor excavations may be used as fill in the slurry mix. Soil would be stockpiled to allow water to drain from it before re-use. The soil will have to be sieved to remove large rocks. This process could require a considerable amount of space on the construction site, but would limit the quantity of soil importation.

3.3.10 Streambed Erosion Control - Treated Water Discharge Location

After passing through the treatment corridor, the treated groundwater will discharge passively to the bank of Sullivan Creek. Although this flow is passive (i.e., not pumped), an increase in groundwater flow velocity occurs in the treatment corridor. This is due to constriction of flow area by the funnel-and-gate. The discharge location will be designed to dissipate the increased groundwater flows, control streambank erosion, and resist energy imparted by Sullivan Creek flow.

Lehigh will follow the Washington Department of Fish and Wildlife approach for design of erosion control structures in the Integrated Streambank Protection Guidelines (ISPG). The design will feature structural and biotechnical components that integrate the use of native material to create an ecologically and aesthetically-focused system that does not exacerbate erosion along Sullivan Creek. Design considerations include:

1. The treatment system structures need to be well protected and buried.

2. The amount of energy and associated erosion potential is relatively high where Sullivan Creek makes a sharp turn immediately down gradient from the outfall.

3. Bank erosion should be controlled to protect the outfall and to reduce new sources of turbidity in Sullivan Creek.

4. A highly porous medium (i.e., high hydraulic conductivity) is required along the bank to facilitate outflow of the treated water through the treatment system.

The ISPG provides guidelines for selecting and designing streambank protection structures, including "structural" and "biotechnical" techniques. Biotechnical techniques use natural materials like rock, wood, and live plants. Mixed structural and biotechnical solutions are strong initially and grow stronger with time as the vegetation roots become established. There are many combinations of vegetation and structures that are referred to as biotechnical solutions. Because the treatment systems need to be well-protected and buried, the streambank protection will likely include a heavily armored core. A biotechnical solution could then be used to conceal the heavily armored core and build the streambank. A potential biotechnical solution for this Site consists of reinforced soil placed in lifts along the bank overtop a rock toe to address scour. Vegetation would be placed between the soil lifts and planted at the surface. The strength of such a structure increases over time as the vegetation becomes established. Vegetation provides habitat along stream banks, shaded riverine aquatic cover, temperature control, and provides hiding places and food supplies for aquatic animals. The armored rock core and toe overlain by vegetated soil would also resemble the existing Sullivan Creek streambank in the area.

Figure 3-4 presents a concept that uses an armored core, a rock toe, and biotechnical solutions to rebuild the streambank after construction, and provide a conduit to discharge groundwater. The vegetation acts to sequester fine sands and silts during higher flows and build streambank. The vegetation root system grows down into the gravel and helps anchor the soil lifts, vegetation, and rock toe. The soil lifts may be amended to provide more suitable growing conditions for plants. Specific plant types will be selected consistent with ISPG guidelines and site-specific considerations. Plants such as willows become well-established in 3 to 5 years. Once grown, the plants will provide the added hydraulic roughness as recommended in the ISPG.

To limit the potential for increased suspended solids and turbidity in Sullivan Creek, a temporary barrier will be placed in the creek prior to construction of the discharge location. The temporary barrier, which will not impede the majority of Sullivan Creek flow, will be located between the construction area and the main channel of Sullivan Creek. Temporary barrier usage is consistent with USCOE provisions and WDFW guidelines for preventing sediment to be released into Sullivan Creek. The USCOE has provided a Nationwide Permit 38 to allow construction of the streambank protection structures and placement of the temporary barrier waterward of the Sullivan Creek ordinary high water mark.

3.3.11 Gravity Drain

The gravity drain is a perforated drain pipe installed in the alluvium between the CKD and the underlying clay aquitard, under the southernmost margins of the Closed CKD Pile using horizontal directional drilling techniques. The gravity drain intercepts groundwater moving northward toward the Closed CKD Pile and conveys it to the southern tip of the south barrier wall (Figure 2-1). Since the purpose of the gravity drain is to intercept water before it contacts the Closed CKD Pile, water from the gravity drain should meet cleanup levels without treatment for discharge into Sullivan Creek via an outfall diversion near the existing sedimentation basin. If testing of the water intercepted by the gravity drain indicates that treatment is necessary, the water will join the water captured by the barrier wall funnel for eventual treatment and discharge to Sullivan Creek.

Directional drilling techniques will be used to install the gravity drain underneath State Route 31, beneath the Closed CKD Pile, and into the hillside. These directional drilling techniques allow the gravity drain to be installed following a near-horizontal path under the toe of the Closed CKD Pile, followed by an increasingly vertical path as the gravity drain extends farther under the Closed CKD Pile through the hillside. The final gravity drain design will include pipe diameter, boring diameter, location, pipe curvature, length and frequency of perforation, and expected flow from drain. The final design will also include the manner in which the gravity drain will be developed (e.g., surging, pumping, etc.) A critical design consideration is the geology that will be encountered while installing the drain using horizontal directional drilling. Large rocks or boulders or very soft soil will cause the gravity drain to change course. The course will be monitored and adjusted during construction to avoid installing the gravity drain within CKD.

A subsurface vault will be installed at the downgradient opening of the gravity drain. Inside the vault the gravity drain will be equipped with a valve that will be closed until the remainder of the Groundwater Remedy is constructed. Once the Groundwater Remedy is constructed the valve will be opened and used to direct the water toward the treatment corridor if needed, or for discharge without treatment if the water meets cleanup levels.

3.3.12 Wetlands Mitigation Measures

The existing Category IV wetlands will be damaged or filled during construction of the Groundwater Remedy components. The USCOE has issued a Nationwide Permit 38 to cover these activities. Efforts will be made to limit the damage to the wetlands, however some wetland damage is not avoidable.

The wetlands lost will be replaced 1:1, meaning for each acre impacted, an acre will be restored. A pre-survey of the wetland area exists and has been reviewed by the USCOE [USCOE, 2006]. The mitigation area will likely be along the natural drainage course that exists downgradient of the sedimentation pond, along the eastern boundary of the Site.

3.3.13 Site Restoration

Following construction of each of the Groundwater Remedy components, Site restoration activities will be performed to address the disturbances caused by construction. These activities will include:

- removing construction equipment and debris;
- grading the Site for storm water run-off; and
- re-vegetating areas of vegetation that were destroyed during construction.

3.3.14 Institutional Controls

After construction equipment has been removed and concurrent with final restoration activities, the construction phase will be completed with the implementation of several institutional controls at the project site. These will include:

- Fencing will be placed around the project area with proper signage in place.

- Restrictive covenants will be recorded to limit the uses of the property (including use of groundwater and disturbance of the Closed CKD Pile).

4. CONSTRUCTION

4.1 General

Following approval of the final EDR, Lehigh will prepare plans and specifications in accordance with CD and WAC requirements. The plans and specifications will be used to obtain bids from contractors. During the time leading up to implementation of the work described in the plans and specifications, the contractor may provide design recommendations to facilitate implementation. If these recommendations are accepted by the Site Engineer, the plans and specifications will be modified.

Items that may affect construction of the Groundwater Remedy are summarized in Section 3.2.3 and include weather constraints, and storage and workspace constraints. A summary of the anticipated construction sequence and contractor management procedures are provided in the following sections.

4.2 Anticipated Construction Sequence

4.2.1 Introduction

The total project schedule is contained within the CD and is based on the date the CD took effect, 9 March 2006. Based on the deliverables due to Ecology prior to construction, and their respective review times, the tasks will be divided into two phases: 2006 construction activities and 2007 construction activities. The anticipated construction sequence (2006 and 2007 construction activities) is presented graphically in Figures 4-1 through 4-7.

The construction activities planned for 2006 will help to ready the Site for the construction activities planned for 2007. Lehigh proposes to construct the gravity drain and the foundation for the building expansion in 2006. Lehigh also proposes to evaluate the status of the wet and dry utilities that service the existing building and upgrade them in 2006, if necessary. Based on the proposed alignment of the barrier walls and French drain segments, Lehigh may drill exploratory borings along the alignment in 2006 to evaluate subsurface conditions.

The Construction will occur in 2007, commencing in the spring after temperatures rises, the snow melts, and relatively dry conditions are reached. Details of the anticipated project schedule are presented in the Section 7, Schedule and Other Considerations.

The conceptual construction sequence for major components of the Groundwater Remedy is described below. This sequence could change based on final design, contractor input, and other construction and time restrictions. Compliance monitoring will be performed throughout the Groundwater Remedy construction process and its long term operation.

4.2.2 2006 Construction Activities

The following is a summary of the construction activities planned for 2006:

Task 1: Site Preparation

- Install Storm Water / Surface Water Control Features
- Remove Vegetation In The Building Expansion Area
- Grade the Foundation Area In Preparation of Concrete Pour

Task 2: Exploratory Drilling

- Layout Proposed Alignment and Drill Borings Along Alignment In Areas Where Additional Data May Be Needed

Task 3: Gravity Drain

- Use Directional Drilling Techniques to Drill Horizontal Drain Under State Route 31 and Along the Southern Edge of the Closed CKD Pile
- Construct gravity drain

- Close the gravity drain valve until the Groundwater Remedy is constructed

Task 4: Building Expansion - Foundation

- Pour Concrete for the Foundation

Task 5: Utility Evaluation

- Evaluate Electrical, Water, and Sewer Connections
- Upgrade Utilities If Necessary

Task 6: Site Clean-Up

- Remove Equipment and Debris
- Winterize the New Foundation and Area of Construction

4.2.3 2007 Construction Activities

The following is a summary of 2007 construction tasks:

Task 1: Site Preparation

- Install Storm Water / Surface Water Control Features
- Remove Vegetation in Construction Area
- Grade Construction Area in Preparation for Construction
- Initiate Compliance Monitoring

Task 2: Building Expansion - Structure and Carbon Dioxide Tank

- Complete Tank Mount
- Install the Tank
- Erect the Roof and Walls of the Building Expansion

Task 3: Diaphragm Wall Installation

- Build Excavation Platform
- Excavate Trench / Pour Slurry
- Install Reinforcement into Slurry
- Pour Concrete and Collect the Displaced Slurry
- Install the Intrusion Water Management System

Task 4: Carbon Dioxide Treatment System Installation

- Assemble Carbon Dioxide Diffusion Segments (Silicone and HDPE)

Task 5: Treatment Corridor Completion

- Install Dewatering System
- Excavate Soil From Between Diaphragm Walls
- Establish Soil Stockpile Area, Begin Sieving Soil for Groundwater Barrier Wall
- Install Carbon Dioxide Diffusion Assemblies
- Install Gravel Fill
- Install Carbon Dioxide Delivery System

Task 6: French Drain Installation

- Excavate Trench / Pour Slurry
- Displace Slurry / Install Gravel

Task 7: Streambed Erosion Control

- Install Silt Curtain in Sullivan Creek
- Install Biostructural Treated Water Discharge Structures

Task 8: Groundwater Barrier Walls

- Excavate Wall Segments
- Add Bentonite-Soil Slurry Mixture
- Install Clay Cap Above the Slurry
- Grade Slurry Wall Excavation

Task 9: Wetlands Mitigation Measures

- Restore Wetlands on 1:1 Basis

Task 10: System Start up

- Install Electrical Components
- Start Up Carbon Dioxide Treatment System

Task 11: Site Restoration

- Establish Final Grade
- Re-vegetate Disturbed Areas

Task 12: Institutional Controls

- Place Fencing and Signage
- Install Storm water BMP's
- Continue Compliance Monitoring

4.3 Construction Quality Management

Prior to mobilizing for construction, Lehigh and the Site contractors will prepare a Construction Quality Management (CQM) Plan. The CQM Plan will include provisions for health and safety, materials management, erosion and storm water control, traffic control, pre-survey controls, in-place protections, and documentation procedures.

Safety is an integral component of Lehigh's operations. The Site contractors will be selected, at least in part, based on their safety record. Each contractor will be responsible for the health and safety of their employees. The work will be performed in accordance with all applicable State, County, and local codes and ordinances.

Progress of the construction activities will be reported by the contractor. These data will be included, at least in part, in the Cleanup Action Completion Report to be submitted following construction.

5. COMPLIANCE MONITORING

5.1 Introduction

Compliance monitoring includes protection, performance, and confirmation monitoring (WAC 173-340-410). The CD provides additional details on these three components of compliance monitoring. Lehigh will submit a Compliance Monitoring Plan (CMP) in accordance with the CD that describes how compliance monitoring will be implemented at this Site. The CMP will include a Sampling and Analysis Plan (SAP) and a Quality Assurance Project Plan (QAPP). The remainder of this section summarizes the elements that will be included in the CMP.

5.2 Protection Monitoring

Protection monitoring is used to "confirm that human health and the environment are adequately protected during construction and the operation and maintenance period of an interim action or cleanup action as described in the safety and health plan (WAC 173-340-410(a))."

Protection monitoring will include:

- Health and Safety Plan (HASP) – The existing HASP, last revised in August 2002, will be reviewed and revised as needed to address the potential Site hazards due to construction and operation of the Groundwater Remedy. Each contractor will also prepare a site-specific HASP that evaluates Site hazards and describes mitigation measures to limit the exposure of Site workers to those hazards. The HASPs will be compliant with federal OSHA requirements [29 CFR 1910.120] and Washington Department and Labor Industries Requirements [WAC-296-843-120]. The HASPs will be located on Site during construction and future maintenance and monitoring activities.

- Daily meetings – Site crews will conduct daily "tailgate" meetings prior to field activities to discuss health and safety issues and address concerns.

- Monitoring – Lehigh will periodically assess the Site to evaluate whether Site activities comply with the HASP. Lehigh will also evaluate storm water pollution prevention, erosion control, and waste storage methods and procedures.

5.3 Performance Monitoring

Performance monitoring is used to "confirm that the interim action or cleanup action has attained cleanup standards and, if appropriate, remediation levels or other performance standards such as construction quality control measurements or monitoring necessary to demonstrate compliance with a permit or, where a permit exemption applies, the substantive requirements of other laws (WAC 173-340-410(b))." Performance monitoring is intended to demonstrate that the system, as designed, has been installed in accordance with substantive requirements and is effective in achieving cleanup standards. This demonstration will take place both during construction and during the two year Optimization Phase. As the system is being monitored and tuned during the Optimization Phase, performance monitoring will account for limited and periodic downtimes while the system is not operational, as needed to adjust treatment dosage. Long-term monitoring, as will be described in the CMP, will be conducted to document the effectiveness of the system.

Performance monitoring begins as the Groundwater Remedy is implemented. Performance monitoring will include:

- Closed CKD Pile – Lehigh will monitor waste containment systems as described in the Post-Closure and Maintenance Plan [D&M, 1995].

- Treated Groundwater – Lehigh will collect groundwater samples from groundwater monitoring wells installed just upgradient of

Sullivan Creek. These samples will be analyzed for indicator substances to document progress toward meeting cleanup levels. The data from these samples will be used during the two-year Optimization Phase to adjust treatment variables such as carbon dioxide dosage to improve system performance. Groundwater samples will also be collected from groundwater wells upgradient and within the treatment corridor. The data from these wells will also be used to adjust treatment variables.

- Remnant Plume – Lehigh will collect groundwater samples from existing groundwater Monitoring Wells MW-12, PM-1, PM-5, PM-15, and PM-19 in the remnant plume areas that are not captured by the treatment system. These samples will be analyzed for indicator substances to document progress toward meeting cleanup levels.

- Gravity Drain – The gravity drain will be equipped with a total flow gauge to measure the amount of water captured by the gravity drain. In addition, two piezometers will be installed on the eastern side of State Route 31 near the gravity drain. Groundwater levels will be measured in these piezometers. Groundwater levels will also be collected from existing wells that are not abandoned during Groundwater Remedy construction. Such wells may include MW-8, PM-10, and PM-16. The groundwater level data from the two new piezometers and the existing wells will be combined to evaluate the floodplain groundwater elevation over time. The chemical data from pre-treatment wells may also be used to assess the pH of the captured groundwater plume over time.

5.4 Confirmation Monitoring

Confirmation monitoring is used to "confirm the long-term effectiveness of the interim action or cleanup action once cleanup standards and, if appropriate, remediation levels or other performance standards have been attained (WAC 173-340-410(c))."

Confirmation monitoring begins once cleanup levels are met in the compliance monitoring wells. Confirmation monitoring activities include:

- Treated Groundwater – After the two-year Optimization Phase, groundwater data will be evaluated for compliance with cleanup levels and NPDES permit levels. Confirmation monitoring samples will be collected from groundwater wells installed downgradient of the treatment system and may involve a mixing zone with Sullivan Creek. These samples will be analyzed for indicator substances and additional chemicals specified in the NPDES permit, if any. Confirmation monitoring will be continued until treatment is no longer needed and a statistical analysis of the data indicates that cleanup levels have been met for two years.

- Remnant Plume – Confirmation monitoring of the remnant plume will be used to evaluate whether the area affected by the remnant plume will continue to meet cleanup levels over the long term. Confirmation monitoring of the remnant plume wells will be continued until statistical analysis of the data indicates that cleanup levels have been met for two years.

Confirmation monitoring data will be analyzed using the data analysis and statistical procedures described in WAC 173-340-720(9) and the guidance document titled *Statistical Guidance for Ecology Site Managers* [Ecology, 1992]. These procedures will be used to demonstrate whether cleanup levels are being met in each compliance monitoring well. With the approval of Ecology, Individual monitoring wells may be removed from the monitoring program as cleanup levels are met.

6. OPERATION AND MAINTENANCE

6.1 General

Lehigh will develop an Operation and Maintenance (O&M) Plan in accordance with WAC 173-340-400(4)(c) that includes:

- Contact names and phone numbers of responsible individuals;
- Process description and operating principles;
- Design criteria and operating parameters and limits;
- General operating procedures;
- Detailed discussion of treatment unit operation;
- Maintenance and sampling forms;
- Spare part inventory, ordering procedures, warranties, and catalogues;
- Equipment maintenance schedules, including manufacturer recommendations;
- Contingency procedures for spills, releases, and personnel accidents; and
- Procedures for long-term maintenance of the facility.

The remainder of this section provides a general description of anticipated operation and maintenance activities.

6.2 Procedures

The treatment system will generally be controlled automatically using an on-site programmable logic controller (PLC). The PLC will be connected to a personal computer (PC) interface with the software and hardware to facilitate on-site or remote supervisory control and data acquisition (SCADA). O&M activities will be implemented remotely using the SCADA system. Remote O&M activities include:

- Review operating data on regular intervals;
- Download operating data on regular intervals;
- Adjust operating parameters such as carbon dioxide pressures and open or close carbon dioxide valves as needed; and
- Disable the treatment system if needed.

On-site O&M activities involve the physical operation, maintenance, and monitoring of Closed CKD Pile waste containment systems, Groundwater Remedy components, and compliance monitoring components. O&M of the Closed CKD Pile waste containment systems is described in the Post-Closure Care and Maintenance Plan [D&M, 1995]. The O&M Plan will describe the O&M of Groundwater Remedy systems and compliance monitoring components. On-site gravity drain operation and maintenance includes:

- Monitoring and recording flow measurement readings;
- Monitoring the discharge point for sediment and clogging;
- Periodically manipulating valves and other moving parts to limit the potential for sticking; and
- Periodically rehabilitating the drain if impeded flow is suspected.

On-site carbon dioxide tank operation and maintenance includes:

- Fill the carbon dioxide tanks with liquid carbon dioxide after the low carbon dioxide level warning alarm, but before the tank is empty;
- Implement procedures described in the manufacturer's maintenance manual for O&M of the pressure vessel, air conditioner, vaporizer, and vapor heater; and
- Document tank gauge readings (e.g., pressure, mass of contents, outlet pressure, etc.).

On-site carbon dioxide treatment system operation and maintenance includes:

- Visual and auditory leak detection monitoring;
- Adjusting valves and regulators as needed to fine-tune carbon dioxide dosage;
- Periodically manipulating valves and other moving parts to limit the potential for sticking;
- Replacing silicone tubing if it is punctured or degraded;
- Maintaining and replacing carbon dioxide distribution systems when needed; and
- Calibrating, maintaining, and replacing pH probes and monitors.

7. SCHEDULE AND OTHER CONSIDERATIONS

Exhibit C to the CD describes the scope of work and schedule for implementing the CAP. Table 7-1 shows a projection of the "Current Estimated Schedule" based on a translation of the schedule dates from the CD into calendar dates. As shown in Table 7-1, there are several project deliverables to complete before beginning construction. The earliest that construction could begin according to the current estimated schedule is sometime in late November or December 2006, which is not feasible due to winter conditions and would cause construction to be postponed until spring 2007. Instead of waiting for 2007 to begin constructing the Groundwater Remedy, Lehigh has developed a plan for completing a significant amount of construction in 2006. Table 7-1 shows the Lehigh's "Proposed Estimated Schedule" that would allow a significant amount of work to be accomplished in 2006.

Table 7-1 shows how certain items would be completed even before the current CD schedule allows. Lehigh proposes to perform the following major construction activities in 2006:

- Preliminary site preparation for the 2006 construction tasks;
- Construct the foundation for the building expansion;
- Evaluate the building utilities and upgrade if necessary;
- Install the gravity drain; and
- Prepare the site for 2007 work, including limited grading and site contouring.

Lehigh requests that Ecology approve the commencement of 2006 construction activities (see Section 4.2.2) prior to finalization of the Groundwater Remedy Plans. These activities are planned for 2006 partly because they do not affect the creek bank or involve major excavations and they can be implemented as discrete construction tasks. At this time, Lehigh envisions that the 2006 construction activities will start in 2006 about mid-September and end by 31 October. Lehigh proposes to begin 2007 construction activities after winter ends, approximately 1 May. The precise start date in 2007 will depend on the weather and water level in Sullivan Creek. Certain components of the Groundwater Remedy are neither safe nor efficient to construct in the winter months in Metaline Falls, due to snow, freezing temperatures and ambient light conditions.

Depending on the progression of Lehigh's project deliverables and Ecology reviews, the construction schedule may be modified, as needed, following discussions with Ecology. The site and nature of the work poses some challenges for the construction crew. Many of the tasks involve significant sub-surface work in areas, for which Lehigh has imperfect knowledge. In many cases, Lehigh will use an "observational approach," whereby the project will progress based on knowledge obtained on the ground during the actual construction. The site is tight, bounded by State Highway 31 and Sullivan Creek, whose flow volume fluctuates. Another constraint is the Fish and Wildlife approved Work Window, during which Lehigh is permitted to work along the creek bank. With careful pre-planning, good communication between Lehigh and Ecology and limited delays caused by weather, Lehigh believes that it can meet the 2006 and the 2007 construction schedule proposed in this document.

8. CONCLUSIONS

An extensive MTCA feasibility study process was used to evaluate several options for treating the groundwater at this Site. The Groundwater Remedy described in this EDR was selected due to several factors, including:

- The Groundwater Remedy includes a practical source control component in the gravity drain along the southern edge of the Closed CKD Pile;
- The Groundwater Remedy uses a treatment technology that has been demonstrated to be effective at treating Site groundwater during bench and pilot-scale studies; and
- The Groundwater Remedy is expected to meet cleanup levels.

In accordance with WAC 173-340-400(4)(a), this EDR describes Site-specific design and construction considerations for the Groundwater Remedy. The process of evaluating the design and construction considerations increases the potential that the Groundwater Remedy will be constructed in a manner that protects human health and the environment. This process also increases the potential that the Groundwater Remedy will be effective over the long term at protecting human health and the environment.

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TABLE 1-1
CROSS-REFERENCE: WAC173-340-400(4)(a) ENGINEERING DESIGN REPORT (EDR) REQUIREMENTS
LEHIGH CEMENT COMPANY CLOSED CKD PILE SITE
METALINE FALLS, WASHINGTON

WAC173-340-400		ENGINEERING DESIGN REPORT SECTION CONTAINING REQUIRED INFORMATION
4(a)(i)	Goals of the cleanup action including specific cleanup or performance requirements;	2.3.5, Table 2-1
4(a)(ii)	General information on the facility including a summary of information in the remedial investigation/feasibility study updated as necessary to reflect the current conditions;	2.2, 2.3.1, 2.3.2, 2.3.3, 2.3.4
4(a)(iii)	Identification of who will own, operate, and maintain the cleanup action during and following construction;	1.2, 6.1
4(a)(iv)	Facility maps showing existing site conditions and proposed location of the cleanup action;	Figures 1-1, 2-1
4(a)(v)	Characteristics, quantity, and location of materials to be treated or otherwise managed, including ground water containing hazardous substances;	3.2.3, 3.3
4(a)(vi)	A schedule for final design and construction;	7.2
4(a)(vii)	A description and conceptual plan of the actions, treatment units, facilities, and processes required to implement the cleanup action including flow diagrams;	3.3, Figures 2-1, 2-2, 2-3, 3-4, 3-5
4(a)(viii)	Engineering justification for design and operation parameters, including:	See below

TABLE 1-1 (continued)
CROSS-REFERENCE: WAC173-340-400(4)(a) ENGINEERING DESIGN REPORT REQUIREMENTS
LEHIGH CEMENT COMPANY CLOSED CKD PILE SITE
METALINE FALLS, WASHINGTON

WAC173-340-400		ENGINEERING DESIGN REPORT SECTION CONTAINING REQUIRED INFORMATION
4(a)(viii)(A)	Design criteria, assumptions and calculations for all components of the cleanup action;	3.2, 3.3, Table 3-1, Appendices
4(a)(viii)(B)	Expected treatment, destruction, immobilization, or containment efficiencies and documentation on how that degree of effectiveness is determined; and	3.3.6, Appendix C
4(a)(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;	2.3.1, 3.3.6
4(a)(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);	3.3, Table 3-1
4(a)(x)	Design features to assure long-term safety of workers and local residences (for example, hazardous substances monitoring devices, pressure valves, bypass systems, safety cutoffs);	3.3
4(a)(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;	3.2.3
4(a)(xii)	Facility specific characteristics that may affect design, construction, or operation of the selected cleanup action, including:	See below

TABLE 1-1 (continued)
CROSS-REFERENCE: WAC173-340-400(4)(a) ENGINEERING DESIGN REPORT REQUIREMENTS
LEHIGH CEMENT COMPANY CLOSED CKD PILE SITE
METALINE FALLS, WASHINGTON

WAC173-340-400		ENGINEERING DESIGN REPORT SECTION CONTAINING REQUIRED INFORMATION
4(a)(xii)(A)	Relationship of the proposed cleanup action to existing facility operations;	Not applicable
4(a)(xii)(B)	Probability of flooding, probability of seismic activity, temperature extremes, local planning and development issues; and	2.3.1, Table 3-1, Figure 3-4
4(a)(xii)(C)	Soil characteristics and ground water system characteristics;	2.3, 3.2, Appendix A
4(a)(xiii)	A general description of construction testing that will be used to demonstrate adequate quality control;	4.3
4(a)(xiv)	A general description of compliance monitoring that will be performed during and after construction to meet the requirements of WAC 173-340-410;	5.
4(a)(xv)	A general description of construction procedures proposed to assure that the safety and health requirements of WAC 173-340-810 are met;	3.3, 5.2
4(a)(xvi)	Any information not provided in the remedial investigation/feasibility study needed to fulfill the applicable requirements of the State Environmental Policy Act (chapter 43.21C RCW);	Not applicable
4(a)(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;	To be provided by Ecology

TABLE 1-1 (continued)
CROSS-REFERENCE: WAC173-340-400(4)(a) ENGINEERING DESIGN REPORT REQUIREMENTS
LEHIGH CEMENT COMPANY CLOSED CKD PILE SITE
METALINE FALLS, WASHINGTON

WAC173-340-400		ENGINEERING DESIGN REPORT SECTION CONTAINING REQUIRED INFORMATION
4(a)(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 assurance and, a draft financial assurance document;	To be provided to Ecology in a separate submittal in accordance with the Consent Decree.
4(a)(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; and	Restrictive Covenant is incorporated into the Consent Decree as Exhibit F. 3.3.14
4(a)(xx)	Other information as required by the department.	None

TABLE 2-1
CLEANUP LEVELS
LEHIGH CEMENT COMPANY CLOSED CKD PILE SITE
METALINE FALLS, WASHINGTON

CONTAMINANT	METHOD B CLEANUP LEVEL	BASIS
pH	**6.5-8.5 standard units**	Ch. 173-201A
Arsenic	**5 μg/L**	Background
Chromium (total)	**10 μg/L**	Ch. 173-201A, NTR
Lead	**2.5 μg/L**	CWA, NTR
Manganese	**2.24 mg/L**	MTCA Method B

Notes: Ch. 173-201A: Washington Administrative Code Section 173-201A
CWA: Clean Water Act
NTR: National Toxics Rule
μg/L: micrograms per liter
MTCA Method B – Model Toxics Control Act Method B Cleanup Level for Human Health

TABLE 2-2
REGULATORY STATUS SUMMARY
LEHIGH CEMENT COMPANY CLOSED CKD PILE SITE
METALINE FALLS, WASHINGTON

ITEM	STATUS	REQUIREMENTS
Post-Closure Care and Maintenance Plan	Ongoing	• Provide for groundwater monitoring and reporting (WAC 173-303-610(7)(a)(i)). • Provide for maintenance and monitoring of waste containment systems as applicable (WAC 173-303-610(7)(a)(ii)).
Consent Decree	CD – 06-2-0034-6 (Section VI)	• Install, operate, and maintain an in-situ groundwater treatment system east of the Closed CKD Pile between State Route 31 and Sullivan Creek. The treatment system will consist of a hydraulic barrier that will intercept contaminated groundwater and direct it toward a treatment corridor. • Install, operate, and maintain a gravity drain along the southern edge of the Closed CKD Pile to direct uncontaminated groundwater away from the Closed CKD Pile. • Provide for groundwater monitoring to assess treatment system performance. • Provide for and maintain institutional controls in the form of: (1) fences; (2) signs; and (3) recording a restrictive covenant. • Provide for operation and maintenance of the cover and stormwater systems for the Closed CKD Pile, in accordance with the Post-Closure Care and Maintenance Plan (see above).

TABLE 2-2 (CONTINUED)
REGULATORY STATUS SUMMARY
LEHIGH CEMENT COMPANY CLOSED CKD PILE SITE
METALINE FALLS, WASHINGTON

ITEM	STATUS	REQUIREMENTS
Substantive Requirements	In process – Ecology provided various substantive requirements via electronic mail on 25 April 2006 and 21 June 2006.	• Hydraulic Projects Approval (HPA) o Washington Fish and Wildlife recommends that a biotechnical solution be constructed on the bank of Sullivan Creek. o The Washington Fish and Wildlife-approved Work Window for Sullivan Creek near the project site is from 1 July through 31 August. The Work Window may be modified by Washington Fish and Wildlife on a case-by case basis. • Shoreline Management Act o Stabilize the streambank utilizing a biostructurally engineered approach in keeping with the Integrated Streambank Protection Guidelines (ISPG). o Plant suitable native species in the biostructurally stabilized bank. o Provide for fish and riparian habitat. • Pend Oreille County Shoreline Master Program o Ecology has determined that there are no additional requirements for the Pend Oreille County Shoreline Master Program. • Floodplain Development o Ecology to compile requirements of the Flood Damage Prevention Ordinance, if any. • Building Permits (or substantive requirements from Pend Oreille County) • Clean Water Act Section 401 Certification Letter of Verification provided by Ecology – no further coordination with Ecology is required.

TABLE 2-2 (CONTINUED)
REGULATORY STATUS SUMMARY
LEHIGH CEMENT COMPANY CLOSED CKD PILE SITE
METALINE FALLS, WASHINGTON

ITEM	STATUS	REQUIREMENTS
Clean Water Act, Section 404 Rivers and Harbors Act, Section 10	Nationwide Permit 38 (Permit Number 200501240)	• Provide for minimal limited adverse effect on navigation. • Provide for proper maintenance, including maintenance for public safety. • Use and maintain effective soil erosion and sediment controls. • Provide for no substantial disruption of aquatic life movements. • Use mats or other measures to limit disturbances to wetlands by heavy equipment. • Comply with Regional Conditions. • Include no impairment of tribal rights. • Obtain substantive requirements of a Section 401 Water Quality Certification from Ecology, unless waived. • Do not harm threatened or endangered species or a species proposed for such designation under the Federal Endangered Species Act. • Submit a post-construction certification to the Corps of Engineers Seattle District Engineer that work was conducted in accordance with permit conditions. • Do not use unsuitable materials such as trash, debris, etc. in the structures or discharge these materials during work. • Implement mitigation measures as needed. • Avoid work in spawning areas to the maximum extent practical. • Maintain pre-construction flow conditions to the maximum extent practical. Limit adverse effects from water impoundments to the maximum extent practical. • Avoid activities in waterfowl breeding areas to the maximum extent practical. • Remove temporary fill materials. • Comply with applicable FEMA-approved state or local floodplain management requirements. • Complete construction work by 5 January 2008, unless Nationwide Permit is modified or reissued before that date, in which case construction must be complete within twelve months from the date of modification or reissuance. • Provide Corps of Engineers access to the project to conduct inspections. • Conduct no construction activities within one-quarter mile of occupied bald eagle nests, nocturnal roost sites, or wintering concentration areas during prohibited time periods. • Conduct no construction activities within one-half mile by line of sight of occupied bald eagle nests, nocturnal roost sites, or wintering concentration areas during prohibited time periods.

TABLE 2-2 (CONTINUED)
REGULATORY STATUS SUMMARY
LEHIGH CEMENT COMPANY CLOSED CKD PILE SITE
METALINE FALLS, WASHINGTON

ITEM	STATUS	REQUIREMENTS
National Pollutant Discharge Elimination System (Water Discharge Permit)	Under Ecology review	• To be determined

TABLE 3-1
KEY REMEDY ELEMENT CONSIDERATIONS
LEHIGH CEMENT COMPANY CLOSED CKD PILE SITE
METALINE FALLS, WASHINGTON

ELEMENT	KEY FUNCTION(S)	CONSIDERATIONS
Site Preparation	Prepare the site for construction and put in place site controls.	• Stormwater and erosion controls will be installed prior to disturbing soil. • Sullivan Creek is relatively close to the working area. • State Route 31 traffic will need to be monitored.
Building Expansion	Increase the space available to store carbon dioxide and other items.	• The foundation will be designed of a thickness and composition to support a full carbon dioxide tank and other miscellaneous loads. • The structure surrounding the tank should be erected after the carbon dioxide tank is delivered and installed. However, large doors will be installed to facilitate future maintenance and potential tank replacement.
Carbon Dioxide Tank	Store carbon dioxide in the liquid state.	• The tank will be similar to the tank that already exists on-site. • The tank will be pre-manufactured and shipped to the Site with refrigeration, heating, and pressure relief components. • The tank capacity will be a standard manufactured size (14 tons). • Together, the capacity of the existing tank and new tank will accommodate treatment for several months. • The tank will be equipped with pressure relief devices. • The tank will be tied down to the foundation for flood contingencies.

TABLE 3-1 (CONTINUED)
KEY REMEDY ELEMENT CONSIDERATIONS
LEHIGH CEMENT COMPANY CLOSED CKD PILE SITE
METALINE FALLS, WASHINGTON

ELEMENT	KEY FUNCTION(S)	CONSIDERATIONS
Diaphragm Walls	Provide low permeability walls that are capable of resisting adjacent soil and groundwater pressures during excavation of the treatment corridor.	• The design depth, thickness, and structure will be developed to allow open excavation of the treatment corridor. The design depth will be deeper than the top of the underlying clay aquitard • Tie-backs or support struts may be needed during excavation of the treatment corridor to limit the potential for the diaphragm walls to overturn or otherwise move from their design location. • The diaphragm walls will be designed to be resistant to corrosion by the groundwater. • The connection between the diaphragm walls and groundwater barrier walls will later be fortified to reduce the potential for water seepage through the gap between the two components. • The treatment corridor may be partially excavated and installed (as opposed to fully excavated and installed in one pass). This would help reduce the load placed on the diaphragm walls while the excavation is open.
Treatment Corridor	Deliver carbon dioxide to the groundwater.	• The treatment corridor fill materials will be high permeability to facilitate movement of the large section of captured groundwater through a small section of the site. However, the treatment corridor fill materials will also be selected to allow the water to contact carbon dioxide treatment components for time sufficient to accomplish pH adjustment. • To limit the potential for untreated groundwater to pass through the treatment corridor without receiving carbon dioxide treatment, the following components may be installed in the treatment corridor: o Horizontal or vertical diffusers (i.e., baffles) to increase mixing of the water. o Gunite coating of a contoured treatment corridor floor that follows the curvature of the carbon dioxide treatment pipes to limits the potential for water to pass under the carbon dioxide treatment systems.
Carbon Dioxide Treatment System	Provide a carbon dioxide dosage to the groundwater that will reduce the pH to meet cleanup levels.	• The expected flow and groundwater quality of the untreated groundwater influent will be estimated to calculate the carbon dioxide demand flow rate to treat the groundwater. • Based on the permeability of the silicone tubing, the amount of tubing needed to deliver the carbon dioxide at pressures of approximately 5 to 40 pounds per square inch will be calculated. • Assuming that 20 silicone tubes will be encased in each HDPE pipe, the number of HDPE pipes will be estimated.
French Drain	Assist water to flow toward the treatment corridor.	• The French drain will be installed to the top of the underlying clay aquitard and will be composed of high-permeability materials. A perforated drain pipe may also be installed along the length of the French drain if design calculations indicate that such a pipe would be beneficial.

TABLE 3-1 (CONTINUED)
KEY REMEDY ELEMENT CONSIDERATIONS
LEHIGH CEMENT COMPANY CLOSED CKD PILE SITE
METALINE FALLS, WASHINGTON

ELEMENT	KEY FUNCTION(S)	CONSIDERATIONS
Streambed Erosion Control – Treated Water Discharge Location	Allow treated groundwater to discharge to Sullivan Creek while limiting the potential for treatment zone and streambank erosion.	• The discharge location will be designed using biostructural components to the extent practical, while still maintaining a high permeability discharge channel. • The energy of Sullivan Creek flow increases as it approaches the bluff, which increases shear forces and erosion along the bank of Sullivan Creek. The discharge location will be located as far upstream of the bluff as practical where the Sullivan Creek flow has less energy.
Groundwater Barrier Walls	Provide a low-permeability layer that captures groundwater.	• The method for constructing the groundwater barrier walls will be selected based on low-permeability requirements, constructability, and cost-effectiveness. Potential methods include: o Soil-bentonite or cement-bentonite slurry barrier walls; o HPDE membranes installed along the downgradient side of the trench used to install the French drain; and o PVC sheet piles installed using vibratory methods.
Gravity Drain	Capture groundwater and route it to downgradient floodplain.	• The size, materials, and radius of the drain pipe will be selected based on: o The depth of the Closed CKD Pile (the gravity drain is to be installed under CKD); o The diameter of pipe that accommodates the groundwater flow; o A valve will be installed at the lower end of the gravity drain to close the gravity drain to flow or direct the flow; and o Available, cost-effective drilling methods.
Wetlands Mitigation Measures	Mitigate for the wetlands that are degraded during construction.	• At least a 1:1 mitigation will occur, likely in the drainage course between the sedimentation basin and Sullivan Creek. • An area of riparian restoration and enhancement will also be completed to enhance the biological function of the site and mitigate for lost vegetation due to new Remedy structures.
Site Restoration	Restore the site to its long-term state.	• The surface grading will be completed to induce stormwater flow to enter drainage courses to limit erosion. Disturbed areas will be re-vegetated.
Institutional Controls	Augment the engineering controls.	• The permanent fence will restrict access and contain warning signs. • The restrictive covenant will include restrictions on property uses.

Notes:

WAC – Washington Administrative Code

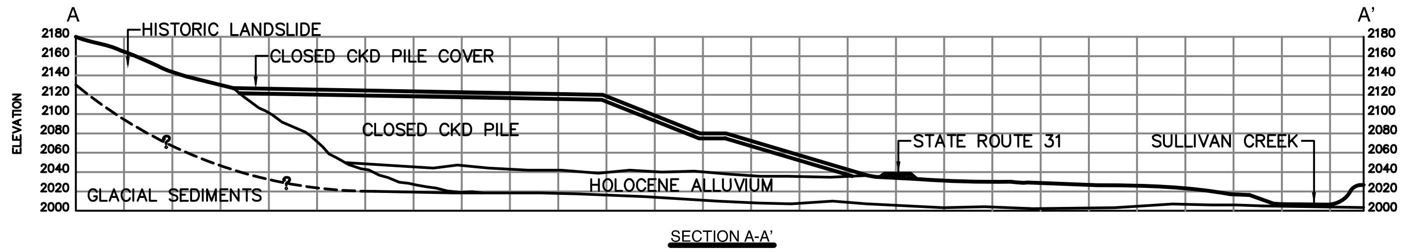
HDPE – High density polyethylene

PVC – Polyvinyl chloride

TABLE 7-1
GROUNDWATER REMEDY PROPOSED SCHEDULE
LEHIGH CEMENT COMPANY CLOSED CKD PILE SITE
METALINE FALLS, WASHINGTON

MILESTONE / DELIVERABLE	CD SCHEDULE	PROPOSED ESTIMATED SCHEDULE	CURRENT ESTIMATED SCHEDULE
Effective date of Consent Decree	Start	Complete	9 Mar 06
Lehigh submits Draft Engineering Design Report	60 days after start	Complete	5 May 06
Lehigh submits estimate of costs associated with carrying out the Consent Decree	60 days after start	Complete	8 May 06
Lehigh submits an erosivity waiver for work to be completed in 2006	NA	29 Jun 06	NA
Ecology approves the estimate of costs	Not specified	7 July 06	7 July 06
Lehigh submits Final Engineering Design Report	30 days after receiving Ecology's written comments	3 July 06	3 July 06
Ecology provides Lehigh with the final list of substantive conditions in lieu of permits	NA	7 July 06	7 July 06
Lehigh submits Financial Assurance	60 days after Ecology approval	5 Sep 06	5 Sep 06
Ecology is required to approve the Final Engineering Design Report	30 days after receipt of revised EDR	1 Aug 06	1 Aug 06
Lehigh submits construction plans and specs related to the following items: building expansion, Phase I site preparation, and gravity drain	NA	15 Aug 06	NA
Ecology approves plans and specs related to the following items: building expansion, Phase I site preparation, and gravity drain	NA	1 Sep 06	NA
Lehigh provides Ecology with a copy of the Site Management Plan, Phase I	NA	1 Sep 06	NA
Lehigh submits the Compliance Monitoring Plan	NA (for the 2006/2007 split approach)	1 Sep 06	9 Oct 06
Ecology issues the NPDES permit	NA	1 Sep 06	1 Sep 06
Ecology approves the Compliance Monitoring Plan	NA (for the 2006/2007 split approach)	15 Sep 06	NA
Lehigh begins Phase I site preparation, building expansion foundation and gravity drain activities	NA	15 Sep 06	NA
Lehigh completes Phase I site preparation, building expansion foundation, and gravity drain construction	NA	15 Oct 06	NA
Lehigh suspends Site work during winter conditions	NA	Early November 2006 - April 2007 (approximate)	NA
Lehigh submits construction plans and specs for the remainder of construction items	30 days after Ecology approves the Final EDR	1 Dec 06	NA
Lehigh submits the Operations and Maintenance Plan	30 days after submittal of Plans and Specifications	1 Jan 07	9 Oct 06
Lehigh provides Ecology with a copy of the Site Management Plan, Phase II	NA	15 Apr 07	NA
Lehigh begins construction of the remainder of the remedy, including:	120 days after Ecology approves Final EDR	1 May 07	29 Nov 06
Complete building expansion and install additional carbon dioxide tank		1 May 07 - 31 May 07	
Diaphragm Walls (includes concrete cure time)		1 May 07 - 31 May 07	-
Phase II Site Preparation		15 May 07 - 31 May 07	-
Treatment Zone		1 June 07 - 30 June 07	-
Streambank Structures		1 July 07 - 21 July 07	-
French Drain		22 July 07 - 15 Aug 07	-
Groundwater Barrier		16 Aug 07 - 7 Sep 07	-
Wetlands Mitigation		8 Sep 07 - 1 Oct 07	-
Site Restoration		8 Sep 07 - 1 Oct 07	-
Institutional Controls (fencing, signage, BMPs etc.)		8 Sep 07 - 1 Oct 07	-
Construction to be completed	180 days after construction begins	28 Oct 07	TBD
Lehigh implements institutional controls	90 days after construction is complete	26 Jan 08	TBD
Lehigh submits Draft Cleanup Action Report	120 days after construction is complete	Construction to be completed	TBD
Lehigh submits Progress Reports	In accordance with CD Section XI	TBD	TBD

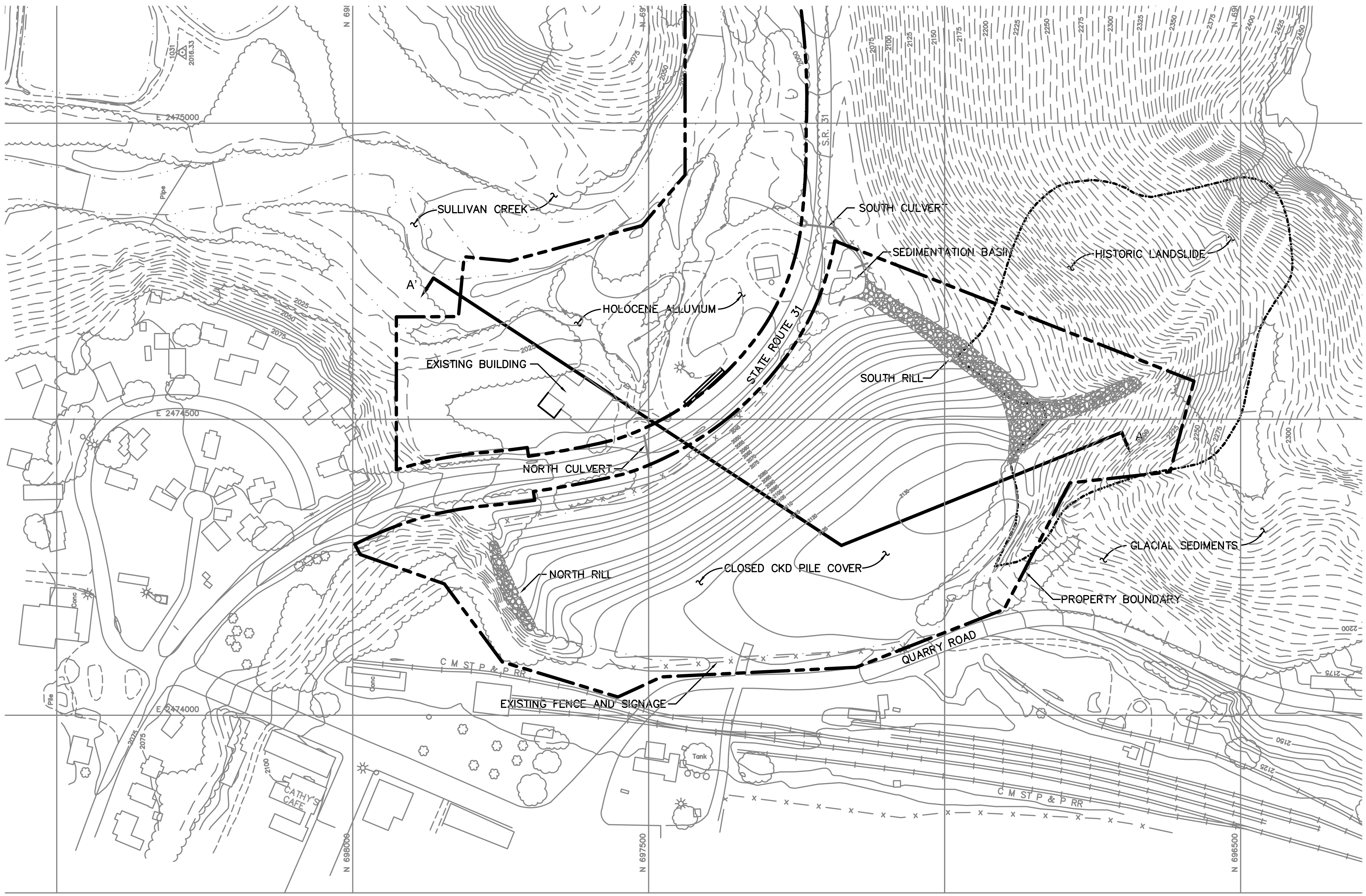
Notes
NA - Not Applicable
TBD - To Be Determined

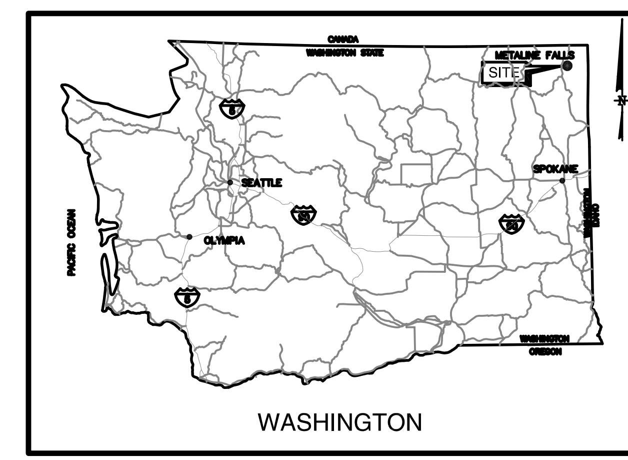


SECTION A-A'

LEGEND

1760	TOPOGRAPHY (FEET ABOVE M.S.L.)
	CLOSED CKD PILE (EXTENTS)
	LIMITS OF HISTORIC LANDSLIDE
	PILOT SYSTEM
— x — x — x —	EXISTING FENCE AND SIGNAGE
	PROPERTY BOUNDARY





LOCATION MAP

LEHIGH HEIDELBERGCEMENT Group

GeoSyntec Consultants
2100 MAIN STREET, SUITE 150
HUNTINGTON BEACH, CALIFORNIA 92648
TELEPHONE: (714) 969-0800

PROJECT:
LEHIGH CEMENT COMPANY CLOSED CKD PILE SITE
METALINE FALLS, WASHINGTON

TITLE:
SITE LOCATION AND FEATURES

DATE: JUNE 2006	CHECKED BY: EDS	SCALE: AS SHOWN	FIGURE NO:
DESIGN BY: BLP	REVIEWED BY: (PROJ. MGR.) EDS	JOB NO.: HR0996-03	1-1
DRAWN BY: SLB	DOCUMENT NO: EDR	FILE NO: 0996-004	

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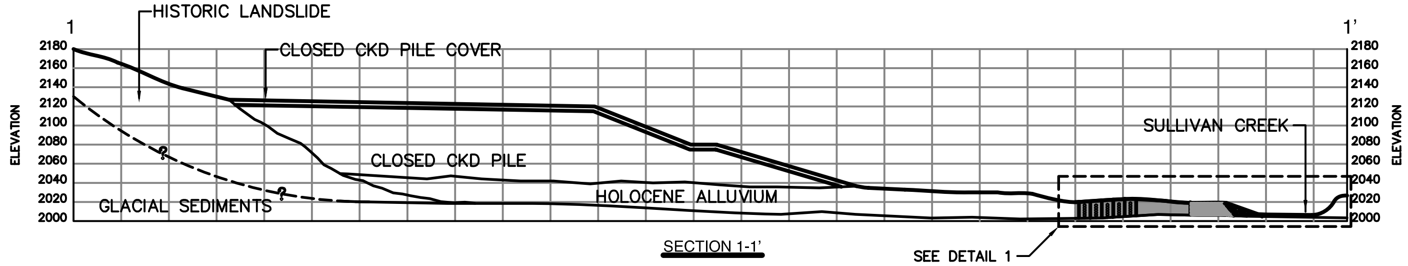
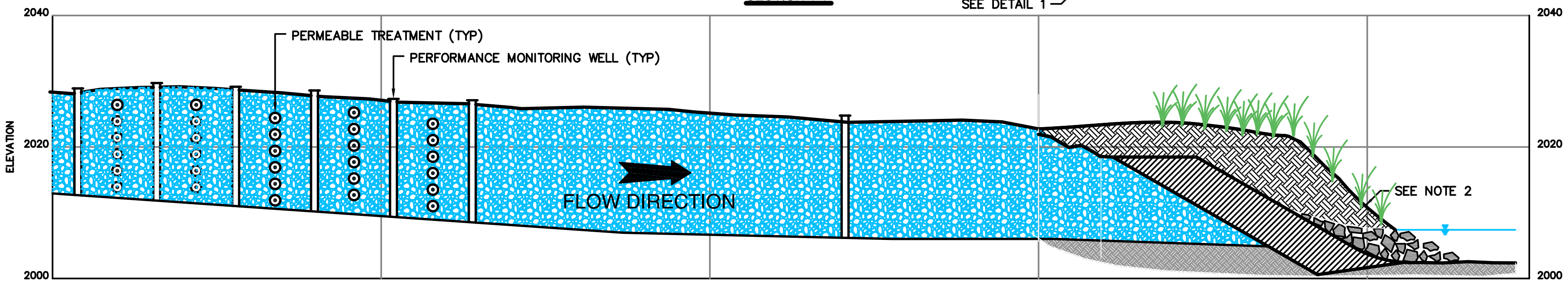
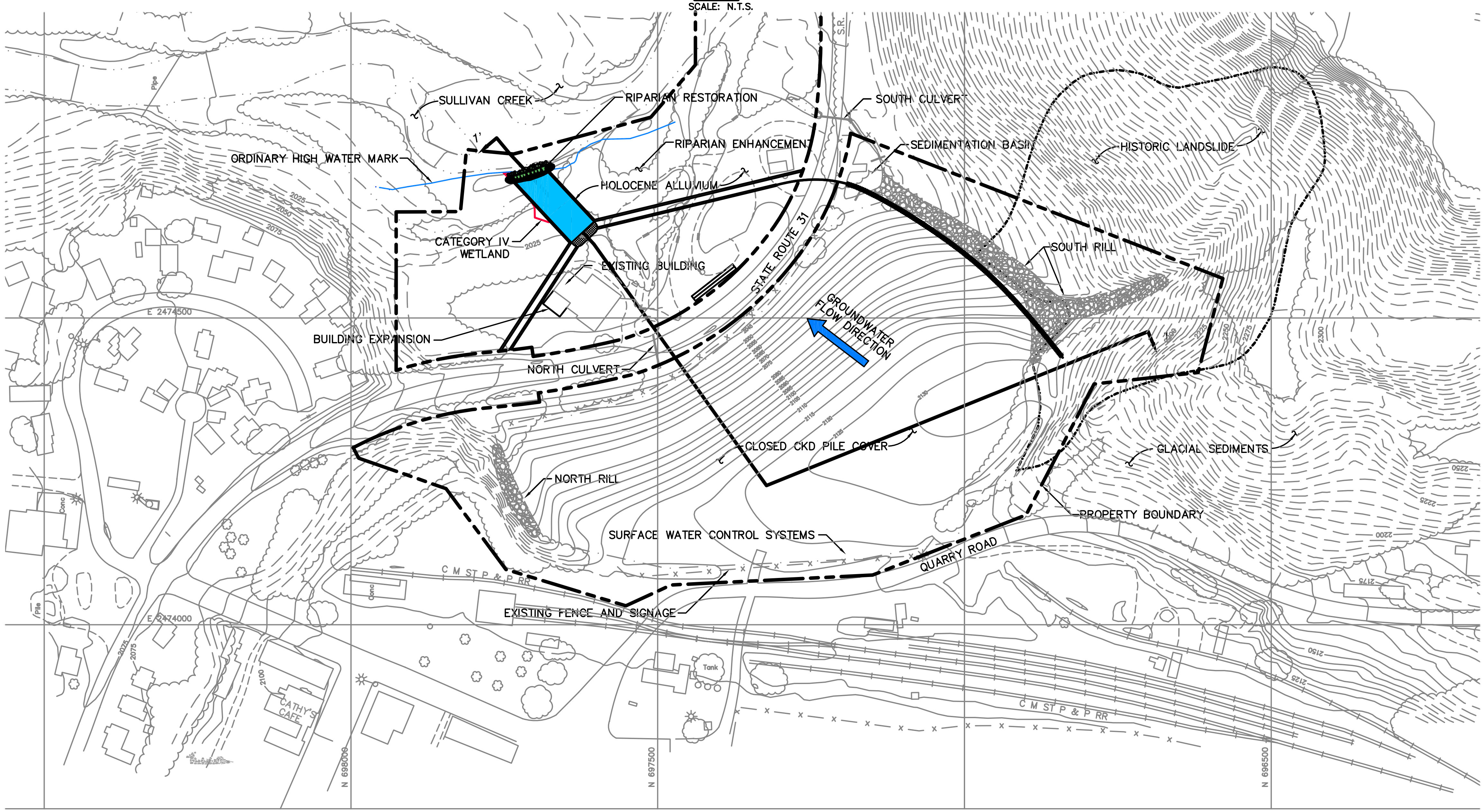


SECTION 1-1'



DETAIL 1
SCALE: N.T.S.



LEGEND

TOPOGRAPHY (FEET ABOVE M.S.L.)	1760
CLOSED CKD PILE (EXTENTS)	
HISTORIC LANDSLIDE	
PROPERTY BOUNDARY	
DIAPHRAGM WALL	
CUT-OFF WALL	
FRENCH DRAIN	
GRAVEL CORRIDOR	
PERMEABLE TREATMENT	
GRAVITY DRAIN	
EXISTING FENCE AND SIGNAGE	— x — x —
CATEGORY IV WETLAND AREA	

NOTES:

1. THE GROUNDWATER REMEDY LAYOUT SHOWN ON THIS EXHIBIT IS INTENDED ONLY FOR THE PURPOSE OF ILLUSTRATION. THE GROUNDWATER REMEDY LAYOUT, LOCATION, EXTENT, AND DESIGN DETAILS WILL BE PREPARED AND OUTLINED IN DESIGN DOCUMENTS. ACCORDINGLY, THE LOCATION, LAYOUT AND DETAILS OF ALTERNATIVE COMPONENTS AS SHOWN HERE WILL VARY.
2. STREAMBANK STRUCTURES WILL BE DESIGNED CONSISTENT WITH THE WASHINGTON DEPARTMENT OF FISH AND WILDLIFE INTEGRATED STREAMBANK PROTECTION GUIDELINES.

N

100 50 0 100 200
SCALE IN FEET

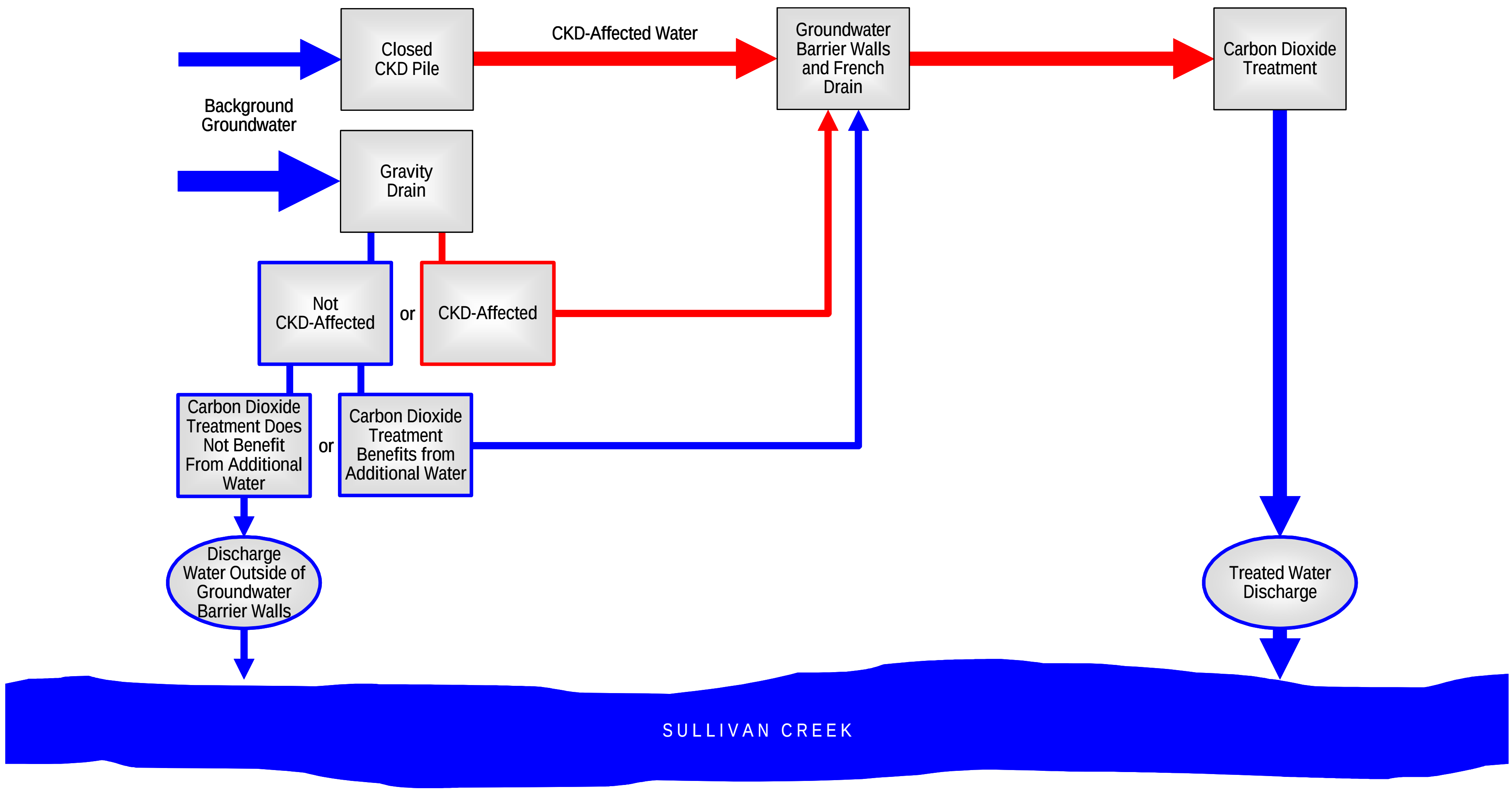
LEHIGH HEIDELBERGCEMENT Group

GEOSYNTEC CONSULTANTS
2100 MAIN STREET, SUITE 150
HUNTINGTON BEACH, CALIFORNIA 92648
TELEPHONE: (714) 969-0800

PROJECT: LEHIGH CEMENT COMPANY CLOSED CKD PILE SITE
METALINE FALLS, WASHINGTON

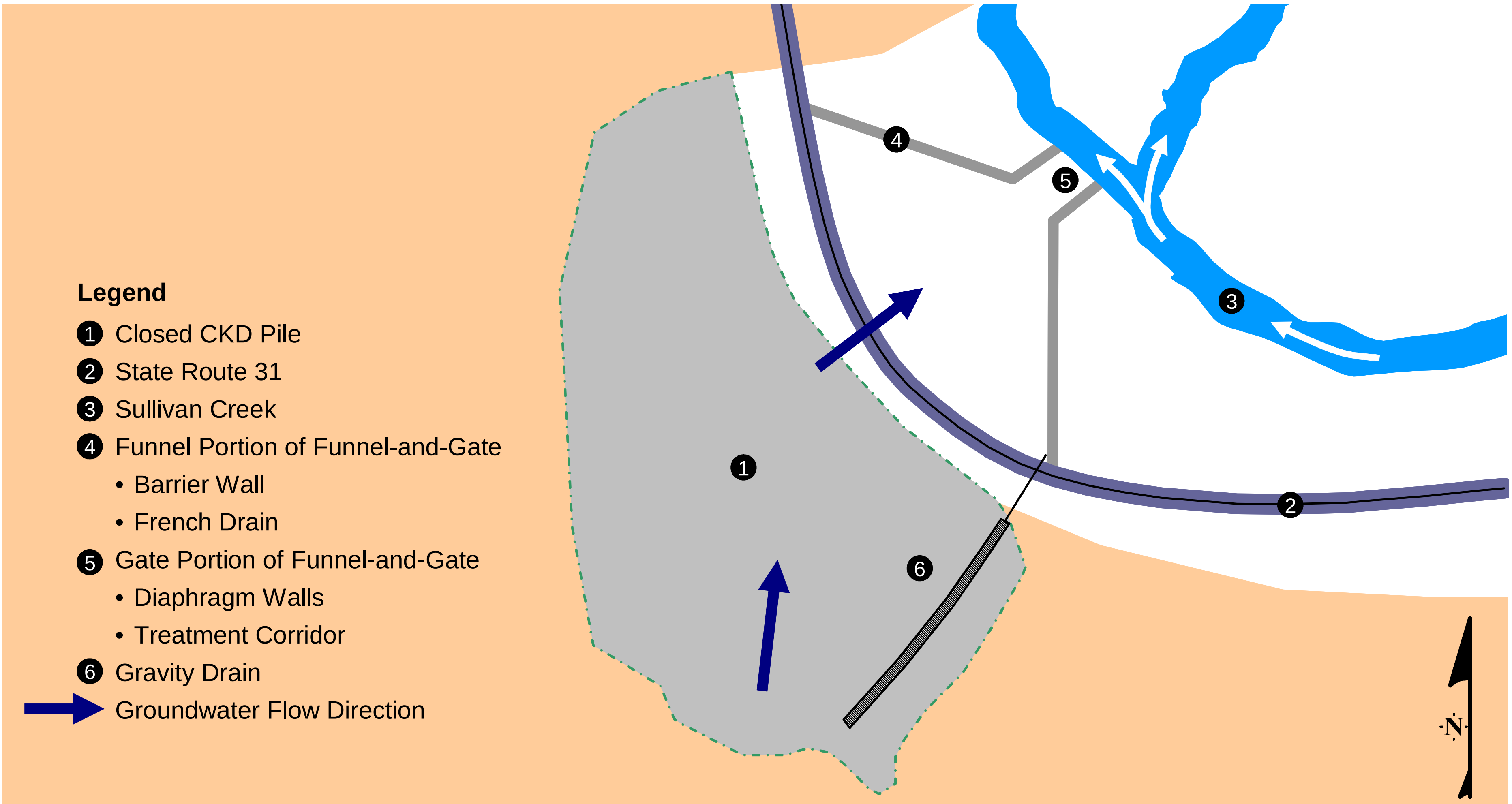
TITLE: GROUNDWATER REMEDY OVERVIEW

DATE: JUNE 2006	CHECKED BY:	EDS	SCALE:	AS SHOWN	FIGURE NO:	
DESIGN BY: BLP	REVIEWED BY: (PROJ. MGR.)	EDS	JOB NO.:	HR0996-03	2-1	
DRAWN BY: SLB	DOCUMENT NO:	EDS	FILE NO:	0996-013		



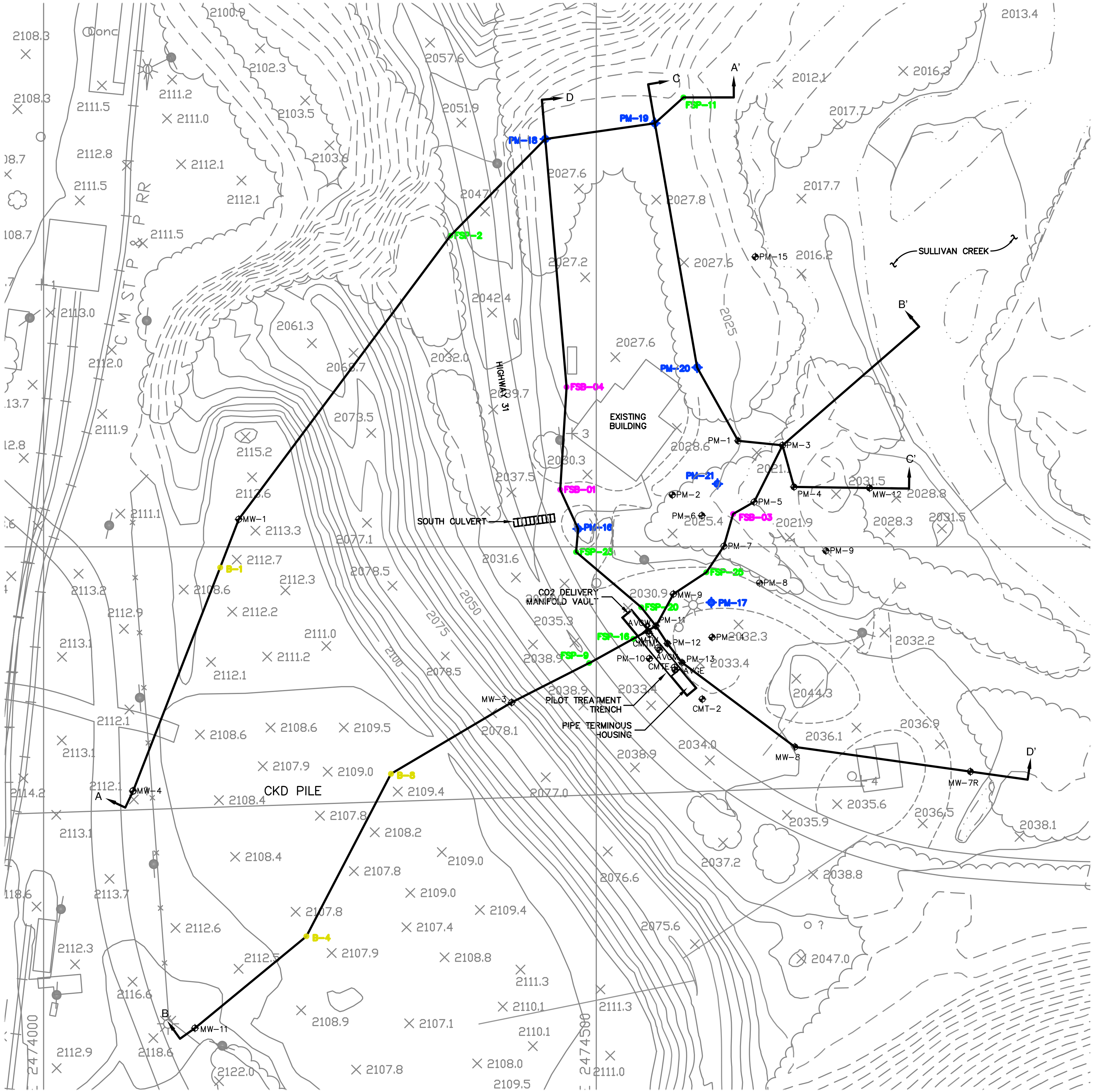
GEOSYNTEC CONSULTANTS

OVERALL PROCESS FLOW DIAGRAM LEHIGH CEMENT COMPANY CLOSED CKD PILE SITE METALINE FALLS, WASHINGTON	FIGURE NO.: 2-2 PROJECT NO.: EDR DATE: May 2006



GEOSYNTEC CONSULTANTS

GROUNDWATER REMEDY COMPONENTS LEHIGH CEMENT COMPANY CLOSED CKD PILE SITE METALINE FALLS, WASHINGTON	FIGURE NO.: 2-3 PROJECT NO.: EDR DATE: June 2006



LEGEND

- TOPOGRAPHY (FEET ABOVE M.S.L.)
- GROUNDWATER MONITORING LOCATIONS
- PERFORMANCE MONITORING LOCATION
- APPROXIMATE DIRECT PUSH BORING LOCATIONS (JULY 2003)
- APPROXIMATE ROTASONIC BORING LOCATIONS (JULY 2003)
- BORING LOCATION (DAMES AND MOORE, 1992)

N

50 25 0 50 100

SCALE IN FEET

LEHIGH HEIDELBERGCEMENT Group

GEOSYNTEC CONSULTANTS
2100 MAIN STREET, SUITE 150
HUNTINGTON BEACH, CALIFORNIA 92648
TELEPHONE: (714) 969-0800

PROJECT: LEHIGH CEMENT COMPANY CLOSED CKD PILE SITE
METALINE FALLS, WASHINGTON

TITLE:

CROSS SECTION LOCATIONS

DATE:	JUNE 2006	CHECKED BY:	EDS	SCALE:	AS SHOWN
DESIGN BY:	BLP	REVIEWED BY: (PROJ. MGR.)	AJB	JOB NO.:	HR0996-03
DRAWN BY:	SLB	DOCUMENT NO:		FILE NO:	0996-006

FIGURE NO: 3-1

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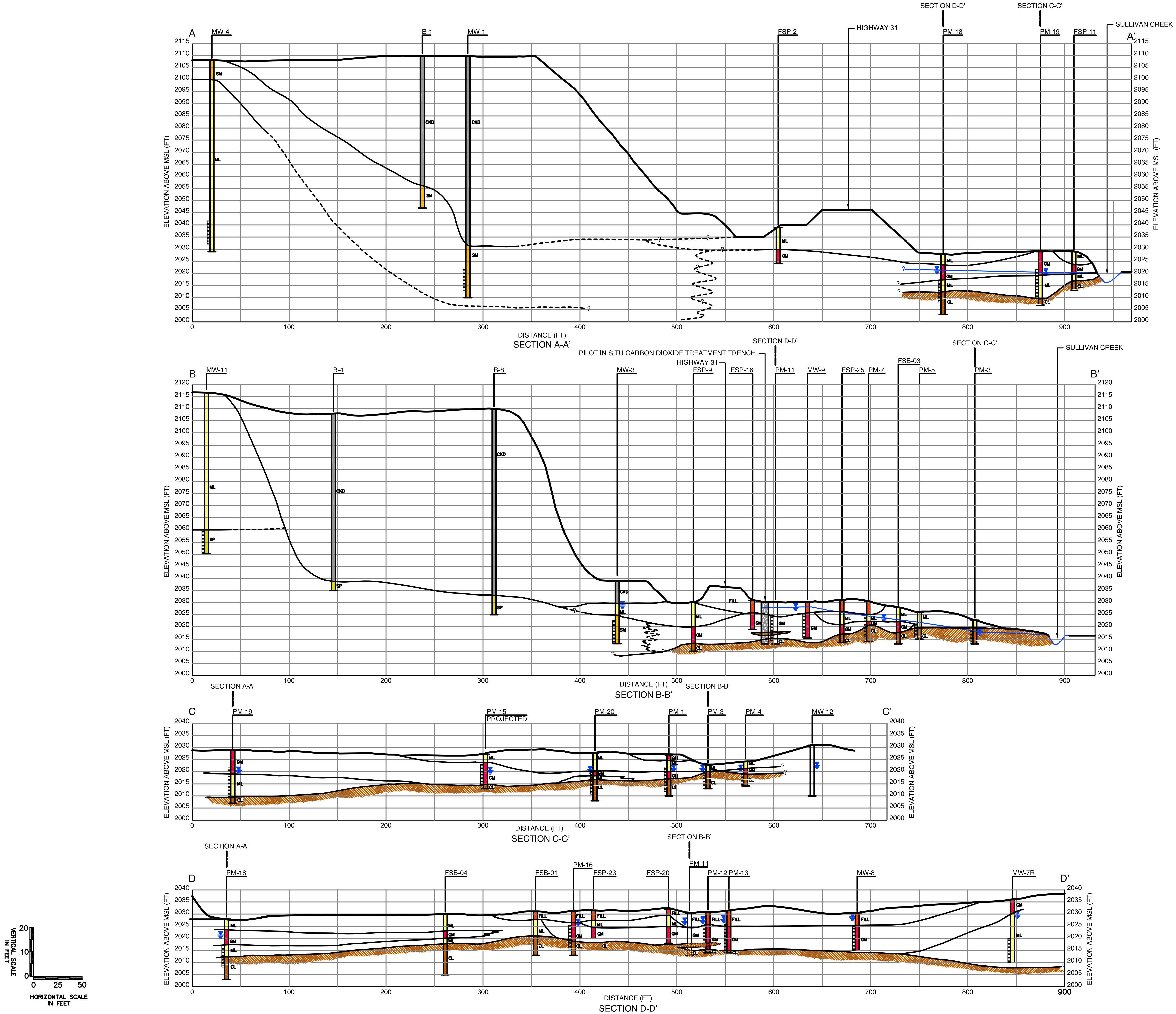

EXPLANATION

- FSP-11 — BOREHOLE OR WELL NAME
- EXISTING GROUND
- STATIC GROUNDWATER LEVEL (31 JULY 2003)
- BOREHOLE LOCATION WITH PREDOMINATE LITHOLOGIC DESCRIPTION (ASTM CLASSIFICATIONS OF LITHOLOGY)
- SCREENED INTERVAL (IF APPLICABLE)

ASTM CLASSIFICATIONS OF LITHOLOGY

- ML – GRAVELLY SILT
- GM – WELL-GRADED SILTY GRAVEL
- CL – SILTY CLAY
- FILL – ARTIFICIAL FILL
- SP – SANDY GRAVEL
- CKD – CEMENT KILN DUST
- SM – SANDY SILT
- CONFINING SILTY CLAY LAYER

LEHIGH HEIDELBERGCEMENTGroup

GEOSYNTEC CONSULTANTS
2100 MAIN STREET, SUITE 150
HUNTINGTON BEACH, CALIFORNIA 92648
TELEPHONE: (714) 969-0800

PROJECT: LEHIGH CEMENT COMPANY CLOSED CKD PILE SITE
METALINE FALLS, WASHINGTON

TITLE: GEOLOGIC CROSS SECTIONS

DATE:	JUNE 2006	CHECKED BY:	EDS	SCALE:	AS SHOWN
DESIGN BY:	BLP	REVIEWED BY: (PROJ. MGR.)	AJB	JOB NO.:	HR0996-03
DRAWN BY:	SLB	DOCUMENT NO:		FILE NO:	0996-007

FIGURE NO: 3-2

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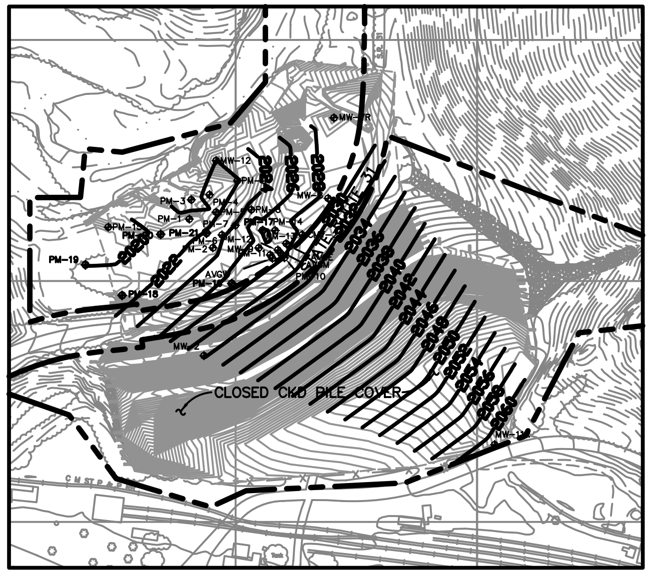
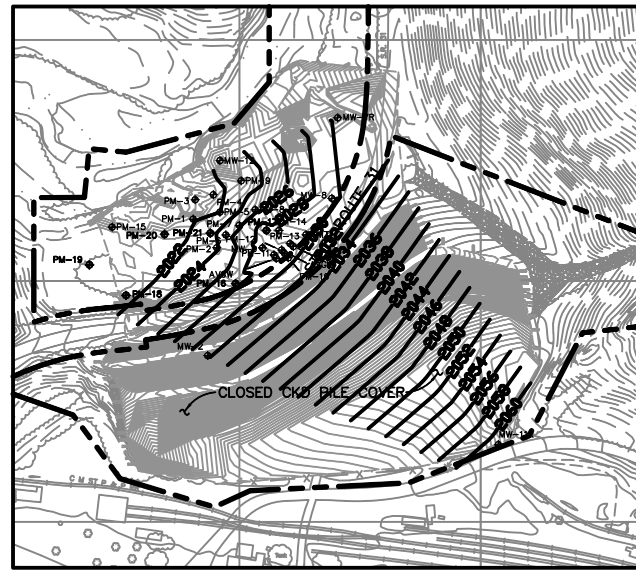
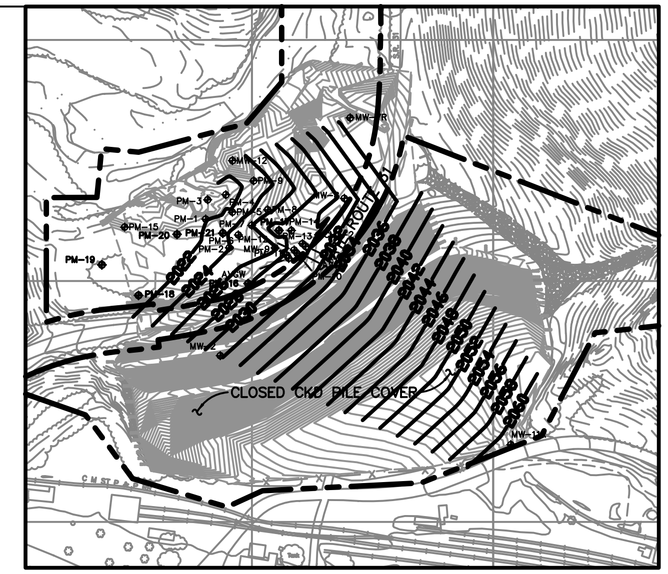


AUGUST 2003



NOVEMBER 2003



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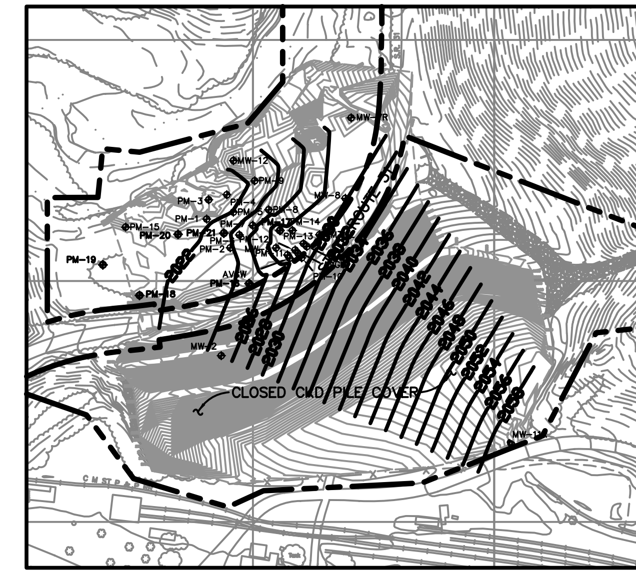
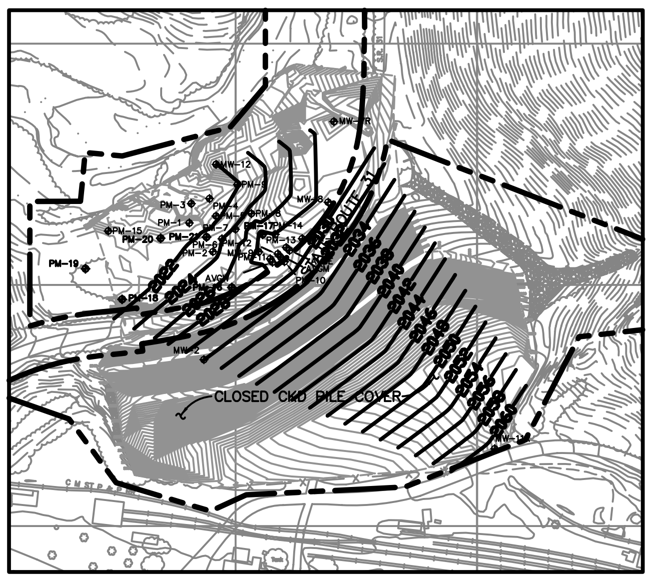
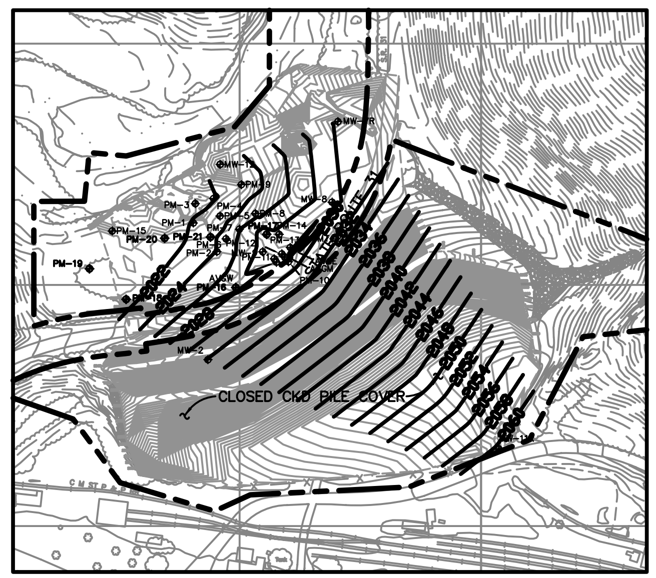


MAY 2004



JULY 2004



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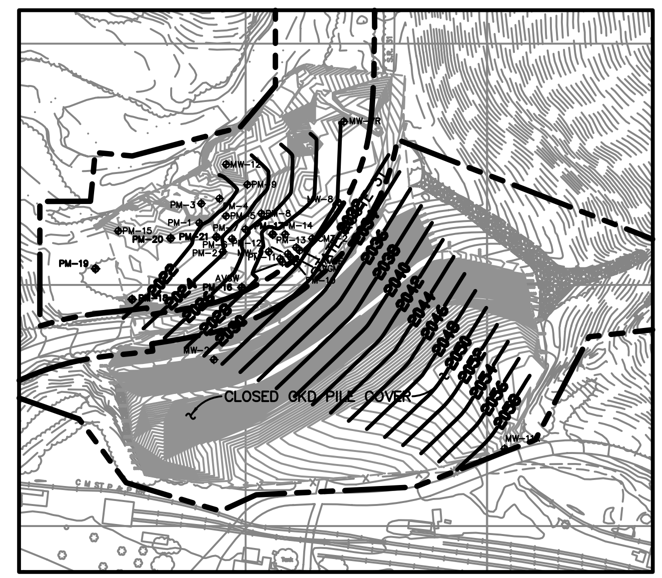
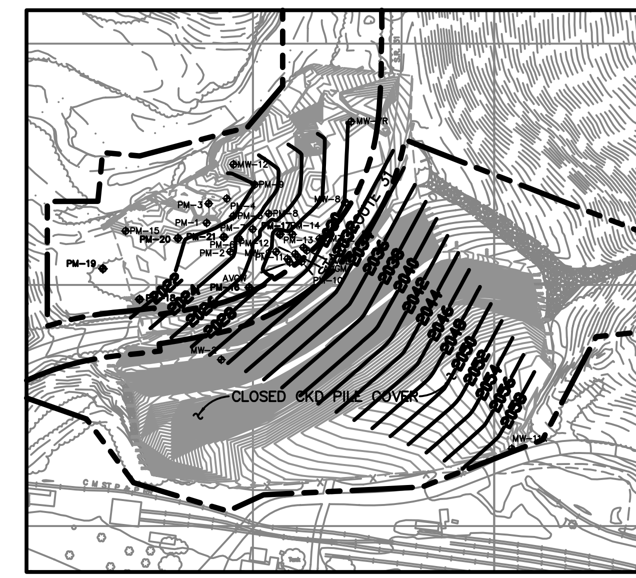
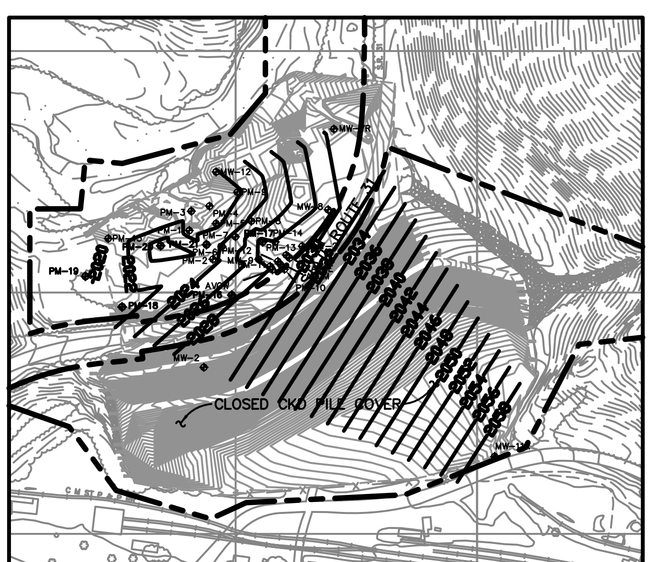


MARCH 2005



JUNE 2005



DECEMBER 2005

LEGEND

TOPOGRAPHY	1760
CLOSED CKD PILE (EXTENTS)	
HISTORIC LANDSLIDE	
PROPERTY BOUNDARY	
GROUNDWATER CONTOUR (FEET ABOVE MEAN SEA LEVEL)	2058
EXISTING FENCE AND SIGNAGE	
GROUNDWATER MONITORING LOCATION	

N

200 100 0 200 400

SCALE IN FEET

LEHIGH HEIDELBERGCEMENT Group

GEOSYNTEC CONSULTANTS
2100 MAIN STREET, SUITE 150
HUNTINGTON BEACH, CALIFORNIA 92648
TELEPHONE: (714) 969-0800

PROJECT: LEHIGH CEMENT COMPANY CLOSED CKD PILE SITE
METALINE FALLS, WASHINGTON

TITLE: POTENTIOMETRIC SURFACE MAPS (AUGUST 2003 – DECEMBER 2005)

DATE: JUNE 2006	CHECKED BY:	EDS	SCALE:	AS SHOWN	FIGURE NO:	
DESIGN BY: BLP	REVIEWED BY: (PROJ. MGR.)	EDS	JOB NO.:	HR0996-03	3-3	
DRAWN BY: VGC	DOCUMENT NO:	EDR	FILE NO:	0996-008		

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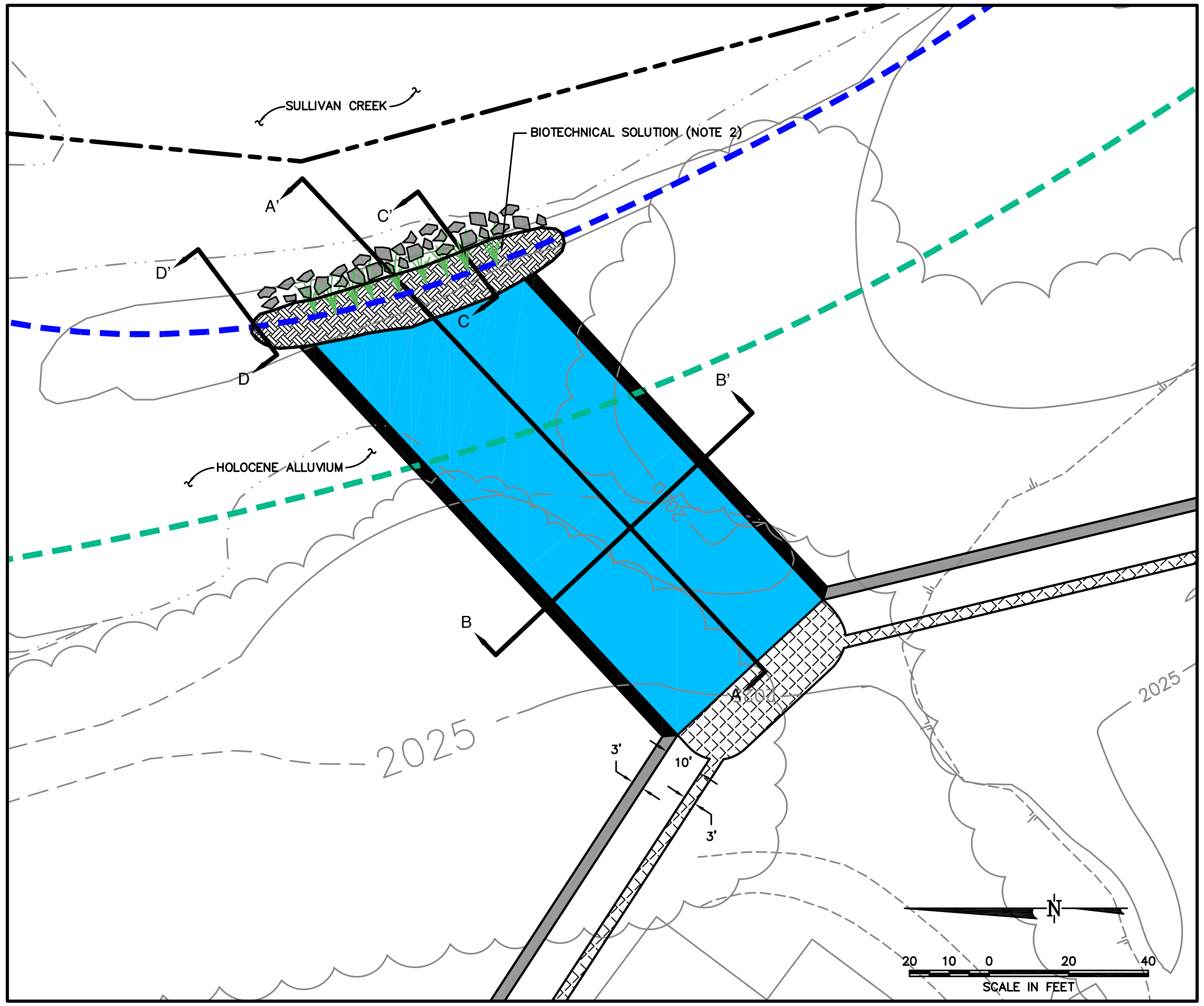
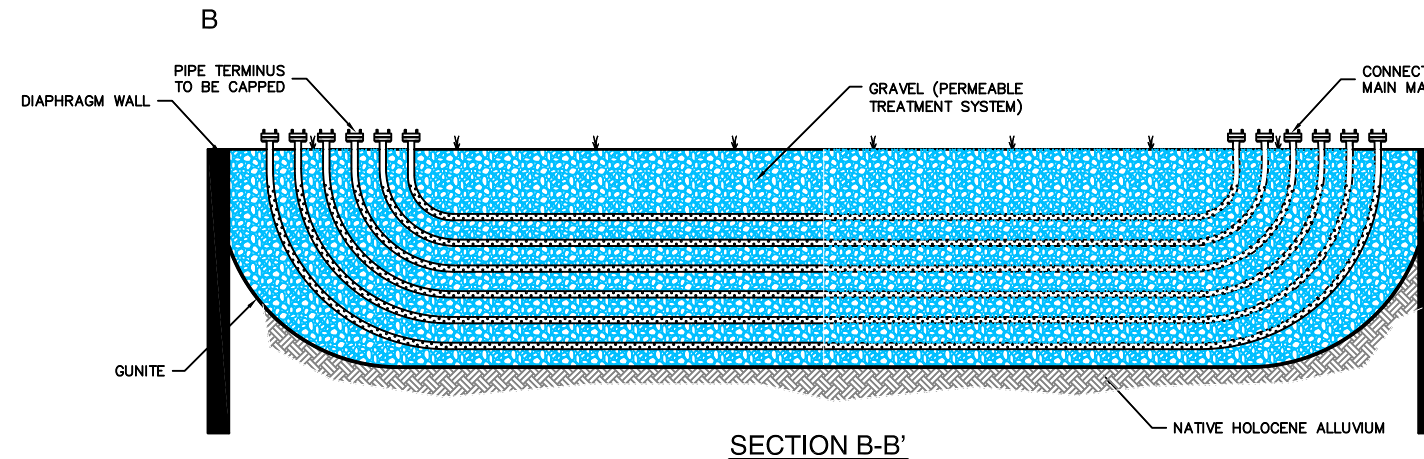


PLAN VIEW

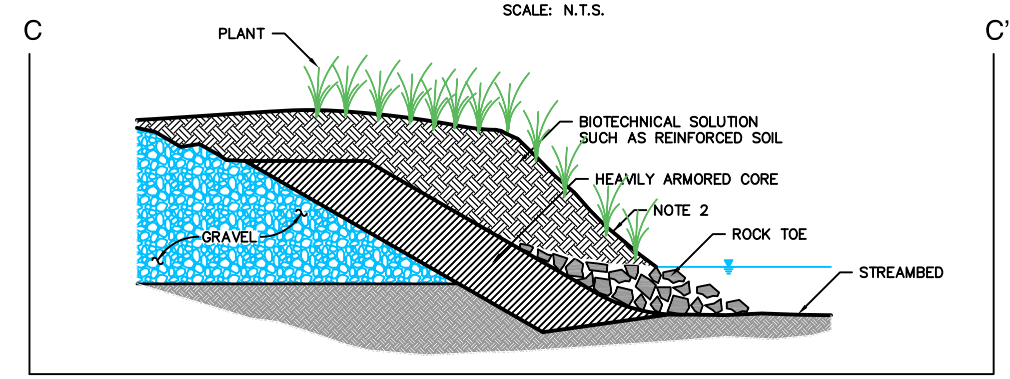
LEGEND

- TOPOGRAPHY (FEET ABOVE M.S.L. 1995) — 1760 —
- PROPERTY BOUNDARY
- DIAPHRAGM WALL
- GROUNDWATER BARRIER WALL
- FRENCH DRAIN
- GRAVEL CORRIDOR (PERMEABLE TREATMENT)
- SHORELINE PROTECTION
- APPROXIMATE SULLIVAN CREEK LIMITS
- APPROXIMATE FEMA FLOOD INSURANCE ZONE A LIMITS



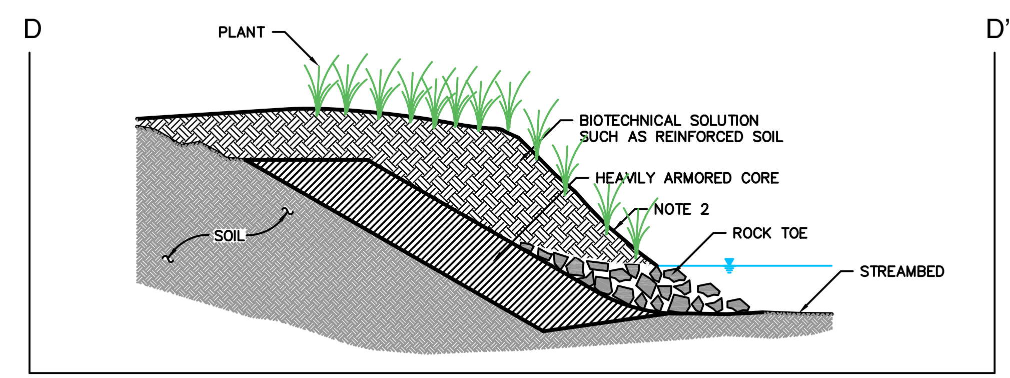
SECTION B-B'
CORRIDOR/PIPING LAYOUT

SCALE: N.T.S.



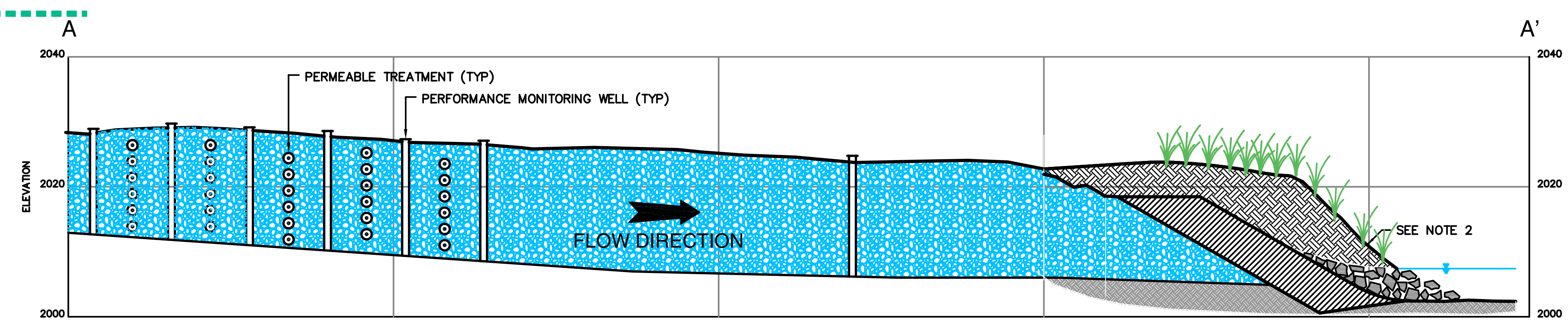
SECTION C-C'
CONCEPTUAL STREAMBANK CRIB WALL OVERVIEW - DISCHARGE

SCALE: N.T.S.



SECTION D-D'
CONCEPTUAL STREAMBANK CRIB WALL OVERVIEW - ADJACENT TO DISCHARGE

SCALE: N.T.S.



SECTION A-A'

SCALE: N.T.S.

NOTES:

1. THE DIMENSIONS AND LAYOUT OF REMEDY COMPONENTS SHOWN HERE ARE APPROXIMATE. FINAL DESIGN DETAILS WILL BE COMPLETED AS DESCRIBED IN THE CLEANUP ACTION PLAN.
2. STREAMBANK DESIGNED IN ACCORDANCE WITH THE ISPG – WASHINGTON DEPARTMENT OF FISH AND WILDLIFE INTEGRATED STREAM BANK PROTECTION GUIDELINES, AS WELL AS SITE SPECIFIC GUIDANCE PROVIDED BY ECOLOGY AND WDFW RESPRENTSATIVES.

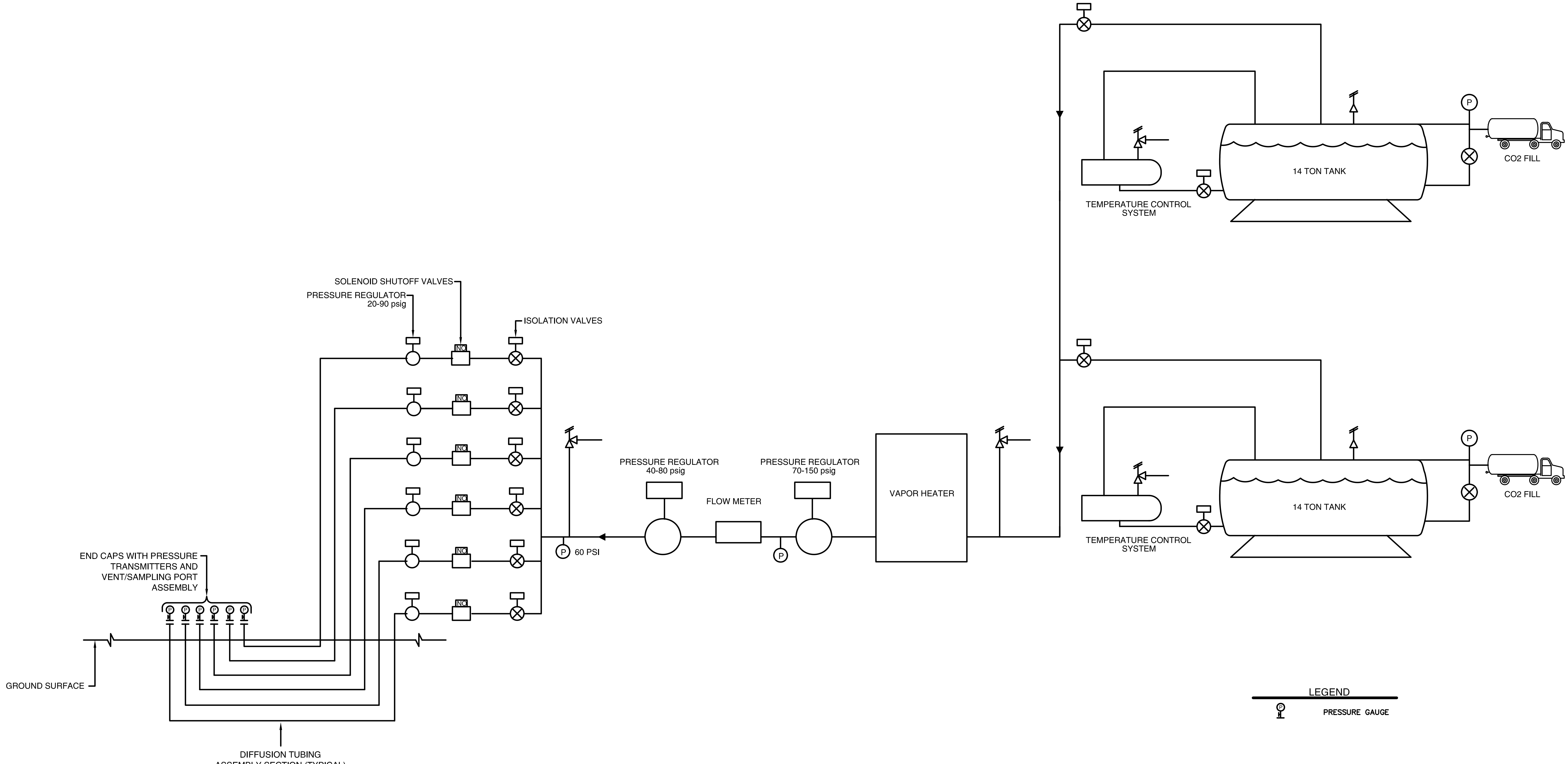
LEHIGH HEIDELBERGCEMENT Group

GEOSYNTEC CONSULTANTS
2100 MAIN STREET, SUITE 150
HUNTINGTON BEACH, CALIFORNIA 92648
TELEPHONE: (714) 969-0800

PROJECT: LEHIGH CEMENT COMPANY CLOSED CKD PILE SITE
METALINE FALLS, WASHINGTON

TITLE: TREATMENT CORRIDOR OVERVIEW

DATE:	JUNE 2006	CHECKED BY:	BLP	SCALE:	AS SHOWN	FIGURE NO:
DESIGN BY:	BLP	REVIEWED BY: (PROJ. MGR.)	EDS	JOB NO.:	HR0996-03	3-4
DRAWN BY:	VGC	DOCUMENT NO:	ER	FILE NO:	0996-012	



LEHIGH HEIDELBERGCEMENT Group

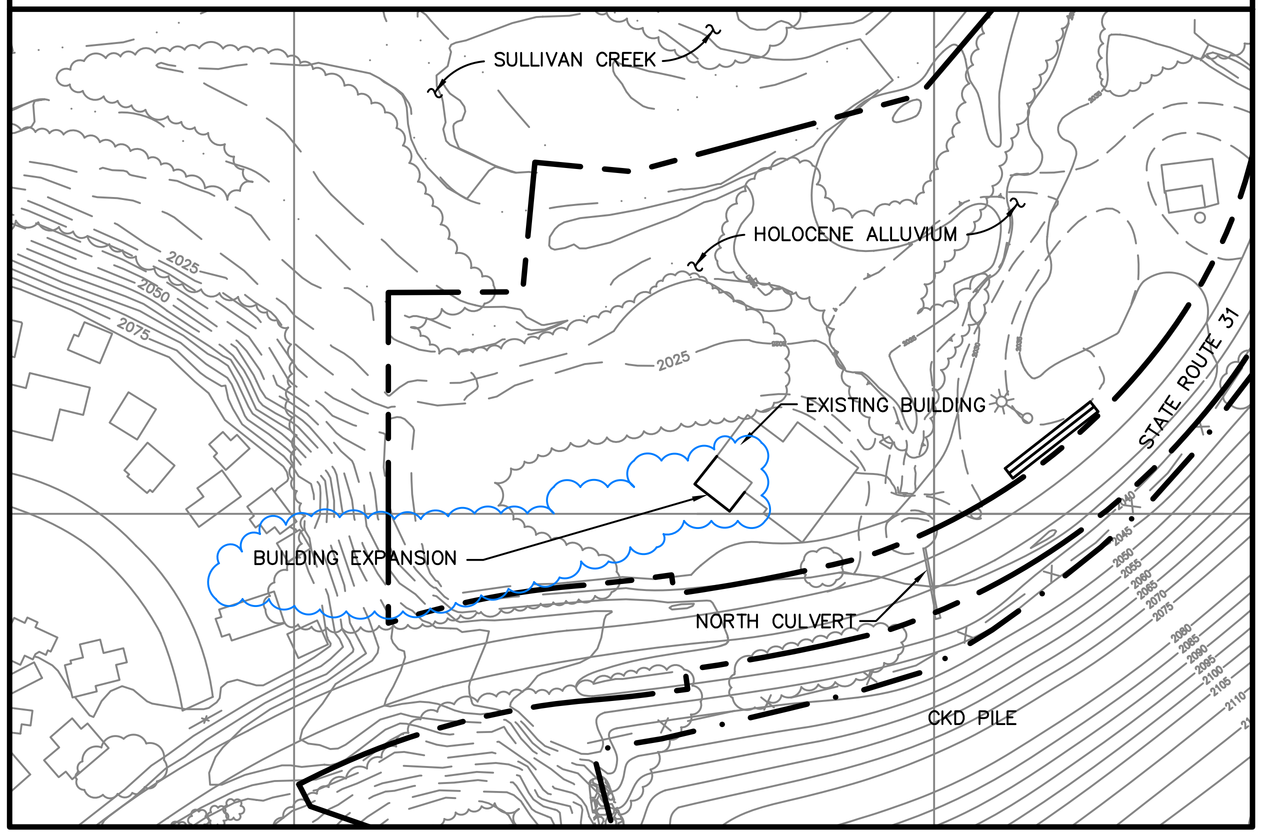
GEOSYNTEC CONSULTANTS
2100 MAIN STREET, SUITE 150
HUNTINGTON BEACH, CALIFORNIA 92648
TELEPHONE: (714) 969-0800

PROJECT: LEHIGH CEMENT COMPANY CLOSED CKD PILE SITE
METALINE FALLS, WASHINGTON

TITLE: CARBON DIOXIDE PROCESS FLOW DIAGRAM

DATE:	JUNE 2006	CHECKED BY:	EDS	SCALE:	AS SHOWN	FIGURE NO:
DESIGN BY:	BLP	REVIEWED BY: (PROJ. MGR.)	EDS	JOB NO.:	HR0996-03	3-5
DRAWN BY:	SLB	DOCUMENT NO:	EDR	FILE NO:	0996-010	

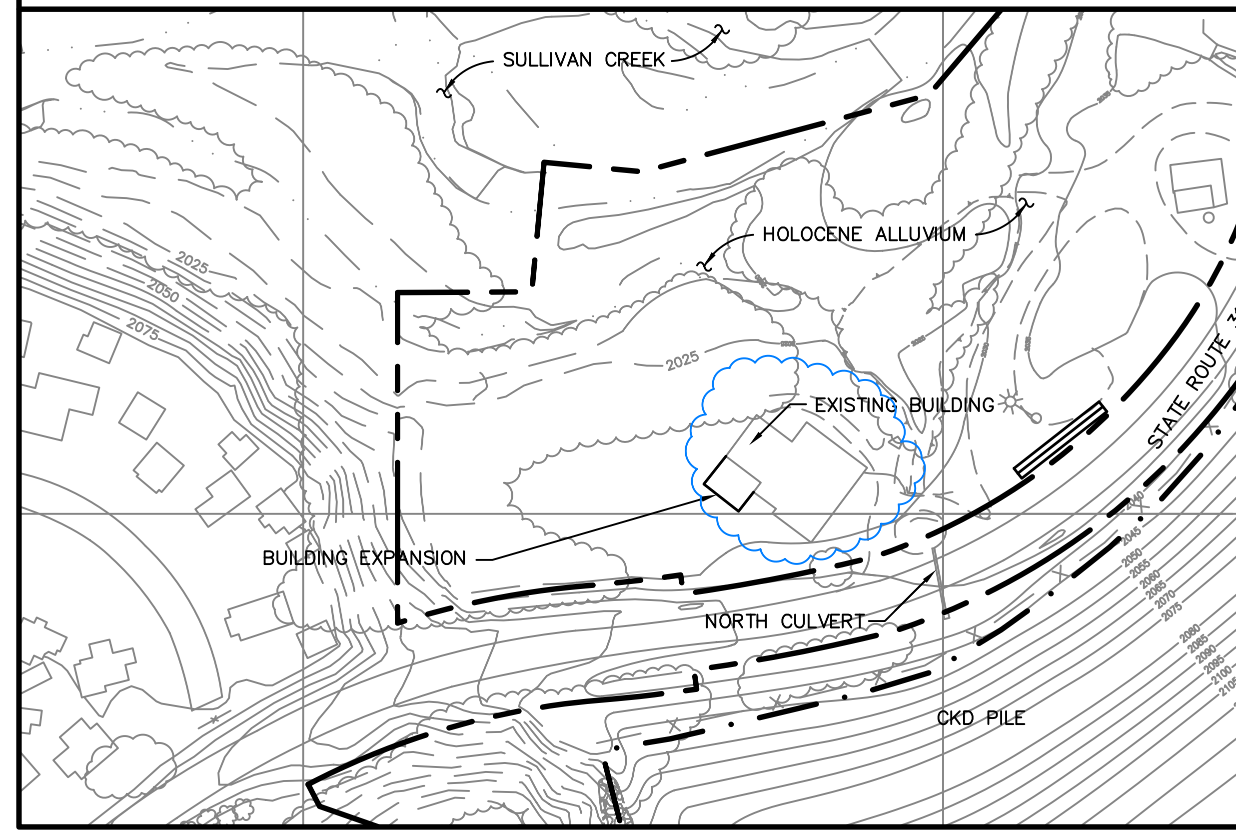
BUILDING EXPANSION FOUNDATION



ACTIVITIES

1. CLEAR AND GRUB BUILDING EXPANSION AREA
2. PREPARE FOUNDATION AREA FOR CONCRETE
3. POUR FOUNDATION

WET AND DRY UTILITY EVALUATION AND UPGRADE



ACTIVITIES

1. CHECK POWER SUPPLY TO BUILDING
2. CHECK WATER SUPPLY TO BUILDING
3. CHECK SEWER CONNECTION
4. UPGRADE UTILITIES IF NECESSARY

LEGEND

— · — · —	CLOSED CKD PILE (EXTENTS)
═══	PILOT SYSTEM
— — —	PROPERTY BOUNDARY
(cloud)	FOCUS OF ACTIVITY

N

0 75 150

SCALE IN FEET

GEOSYNTEC CONSULTANTS

CONCEPTUAL CONSTRUCTION SEQUENCE (1 OF 7)
LEHIGH CEMENT COMPANY CLOSED CKD PILE SITE
METALINE FALLS, WASHINGTON

FIGURE NO.	4-1
PROJECT NO.	HR0996-03
DATE:	JUNE 2006

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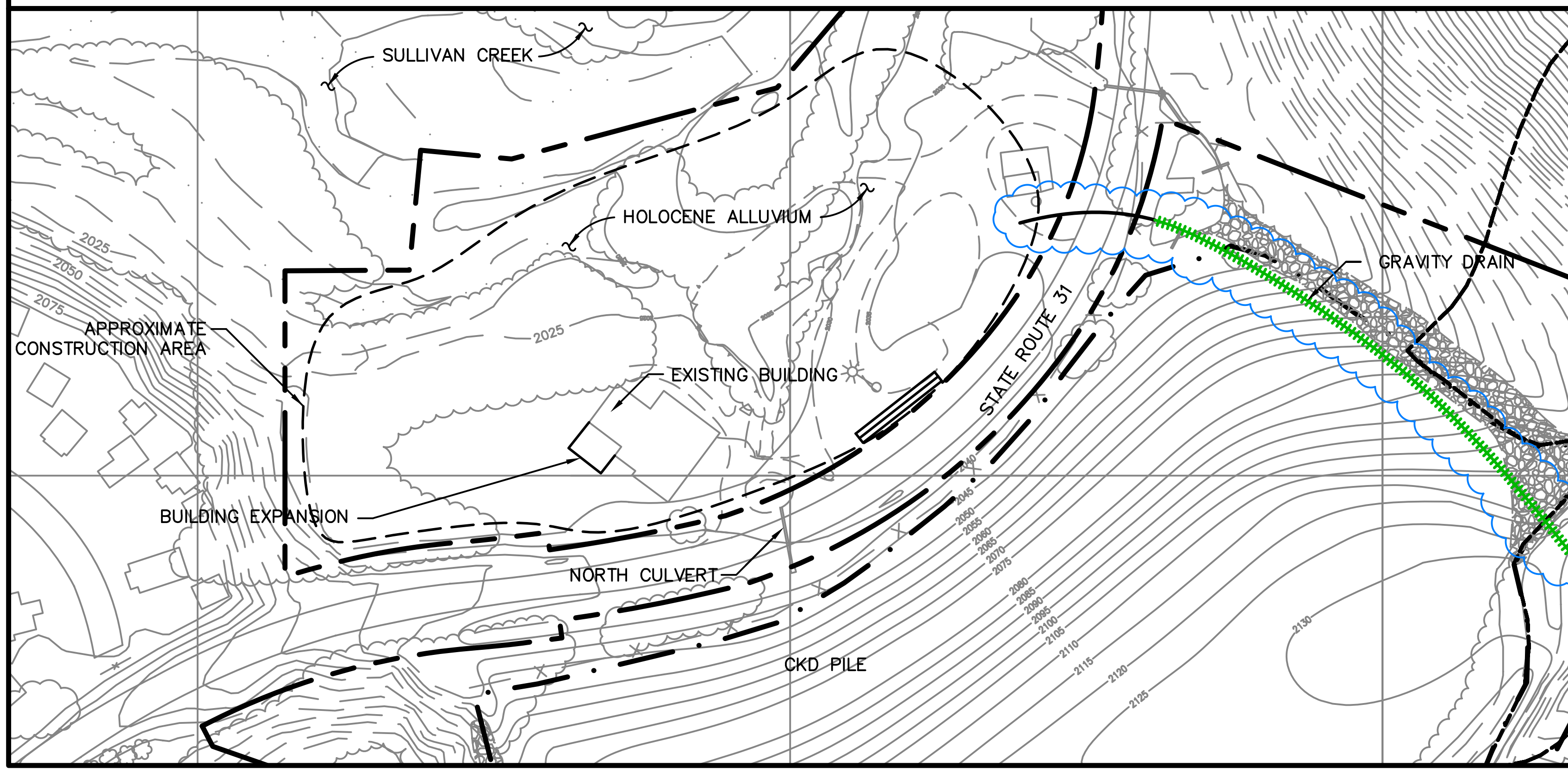
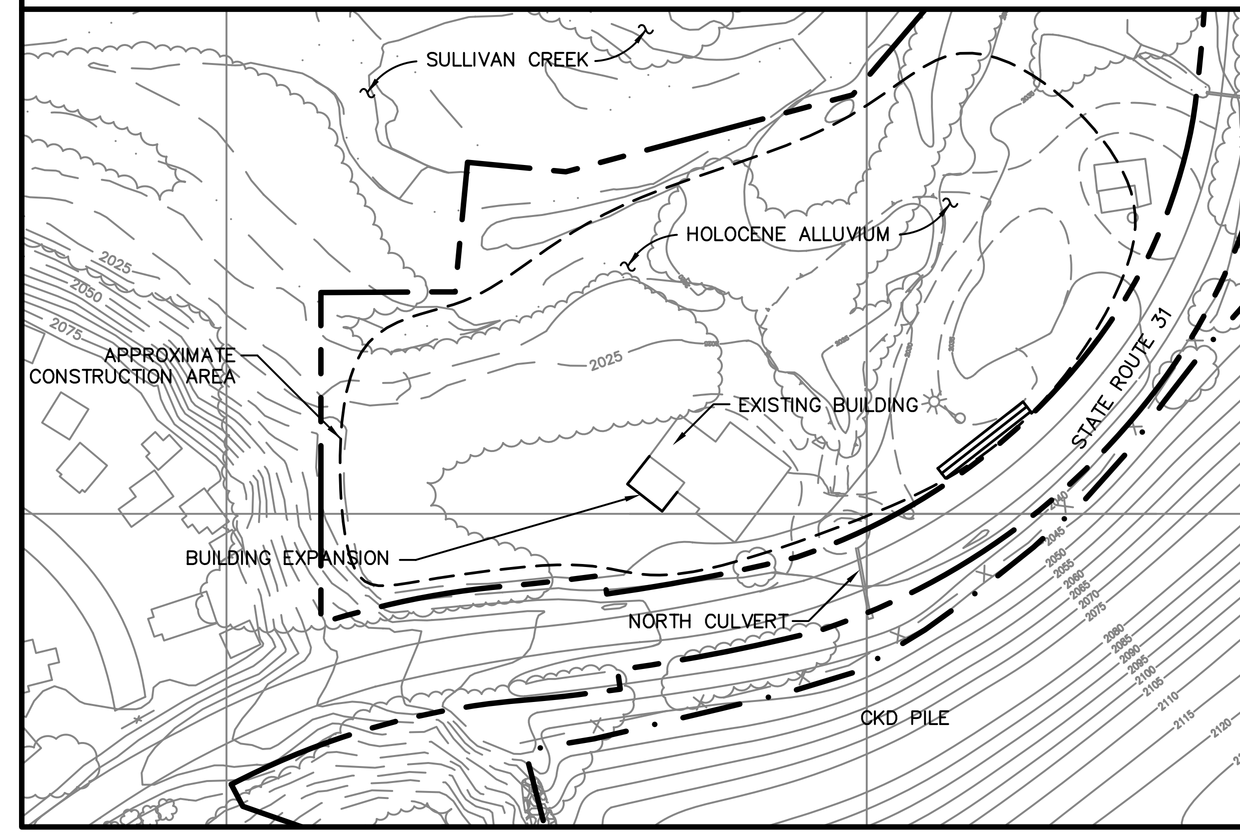
GRAVITY DRAIN



SITE PREPARATION



<u>ACTIVITIES</u>

1. INSTALL GRAVITY DRAIN
2. EVALUATE WATER FROM THE GRAVITY DRAIN
3. CLOSE THE GRAVITY DRAIN VALVE IF NEEDED

<u>ACTIVITIES</u>

1. GRADE AND GRUB CONSTRUCTION AREA.
2. INSTALL STORMWATER / SURFACE WATER CONTROLS
3. ERECT CONSTRUCTION FENCING.

LEGEND

- CLOSED CKD PILE (EXTENTS)
- PILOT SYSTEM
- PROPERTY BOUNDARY
- FOCUS OF ACTIVITY

N

0 75 150

SCALE IN FEET

GEOSYNTEC CONSULTANTS

CONCEPTUAL CONSTRUCTION SEQUENCE (2 OF 7)
LEHIGH CEMENT COMPANY CLOSED CKD PILE SITE
METALINE FALLS, WASHINGTON

FIGURE NO.	4-2
PROJECT NO.	HR0996-03
DATE:	JUNE 2006

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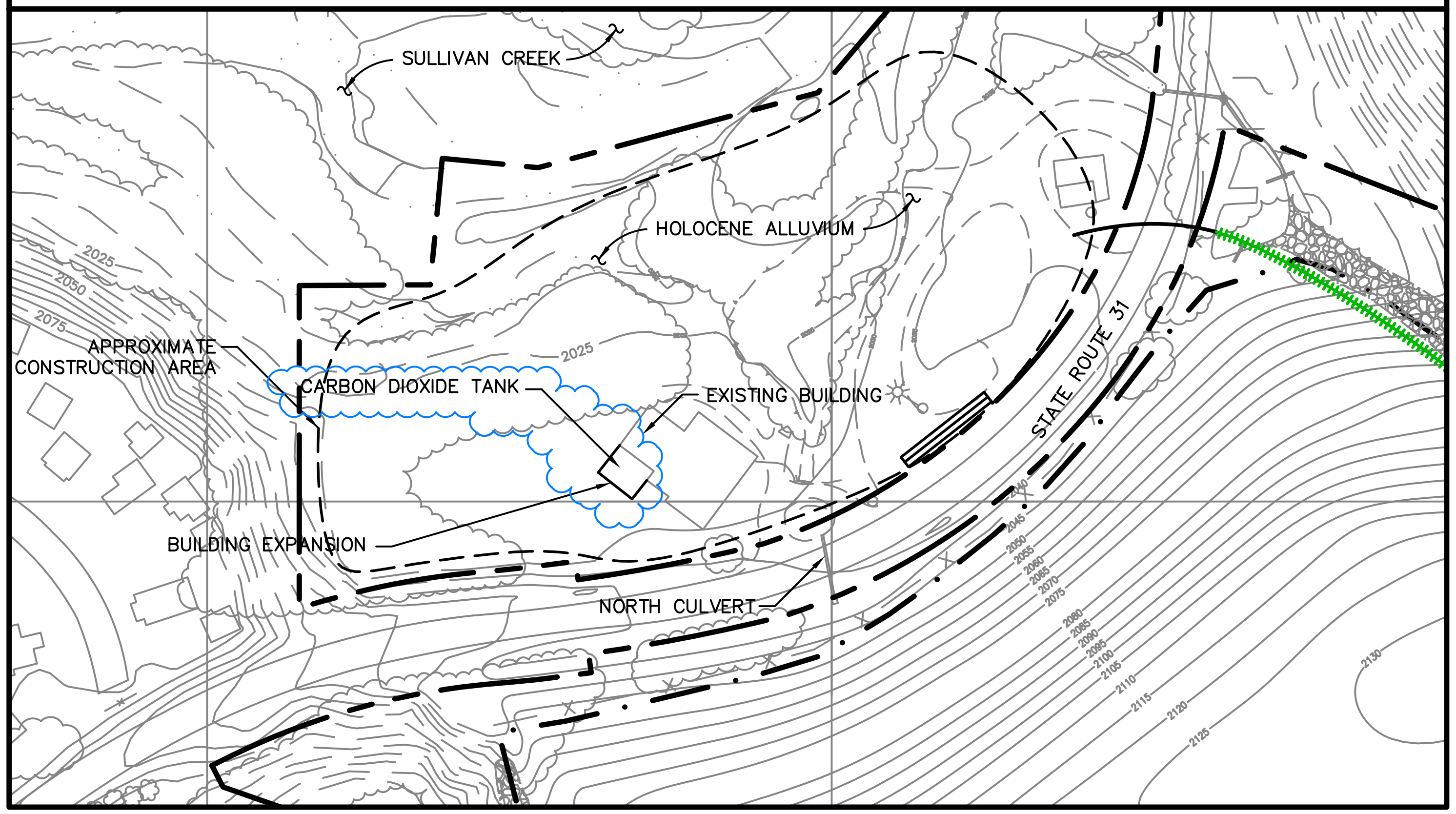
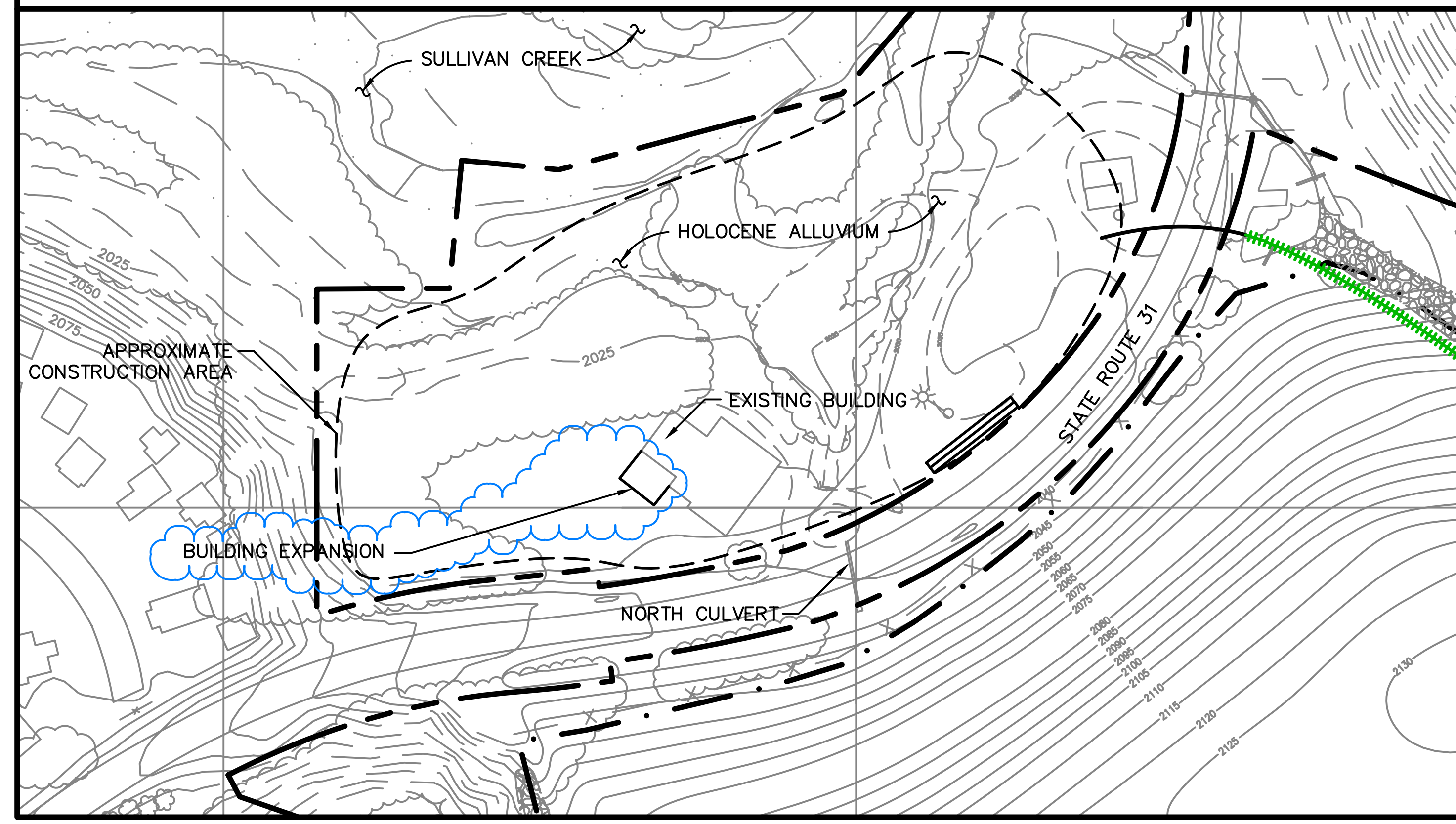
TANK INSTALLATION



ACTIVITIES

1. INSTALL CARBON DIOXIDE TANK

BUILDING EXPANSION



ACTIVITIES

1. ERECT WALLS AND ROOF AROUND CARBON DIOXIDE TANK

LEGEND

— · — · —	CLOSED CKD PILE (EXTENTS)
═══	PILOT SYSTEM
—— – – ——	PROPERTY BOUNDARY
(cloud)	FOCUS OF ACTIVITY

N

0 75 150

SCALE IN FEET

GEOSYNTEC CONSULTANTS

CONCEPTUAL CONSTRUCTION SEQUENCE (3 OF 7)

LEHIGH CEMENT COMPANY CLOSED CKD PILE SITE

METALINE FALLS, WASHINGTON

FIGURE NO.	4-3
PROJECT NO.	HR0996-03
DATE:	JUNE 2006

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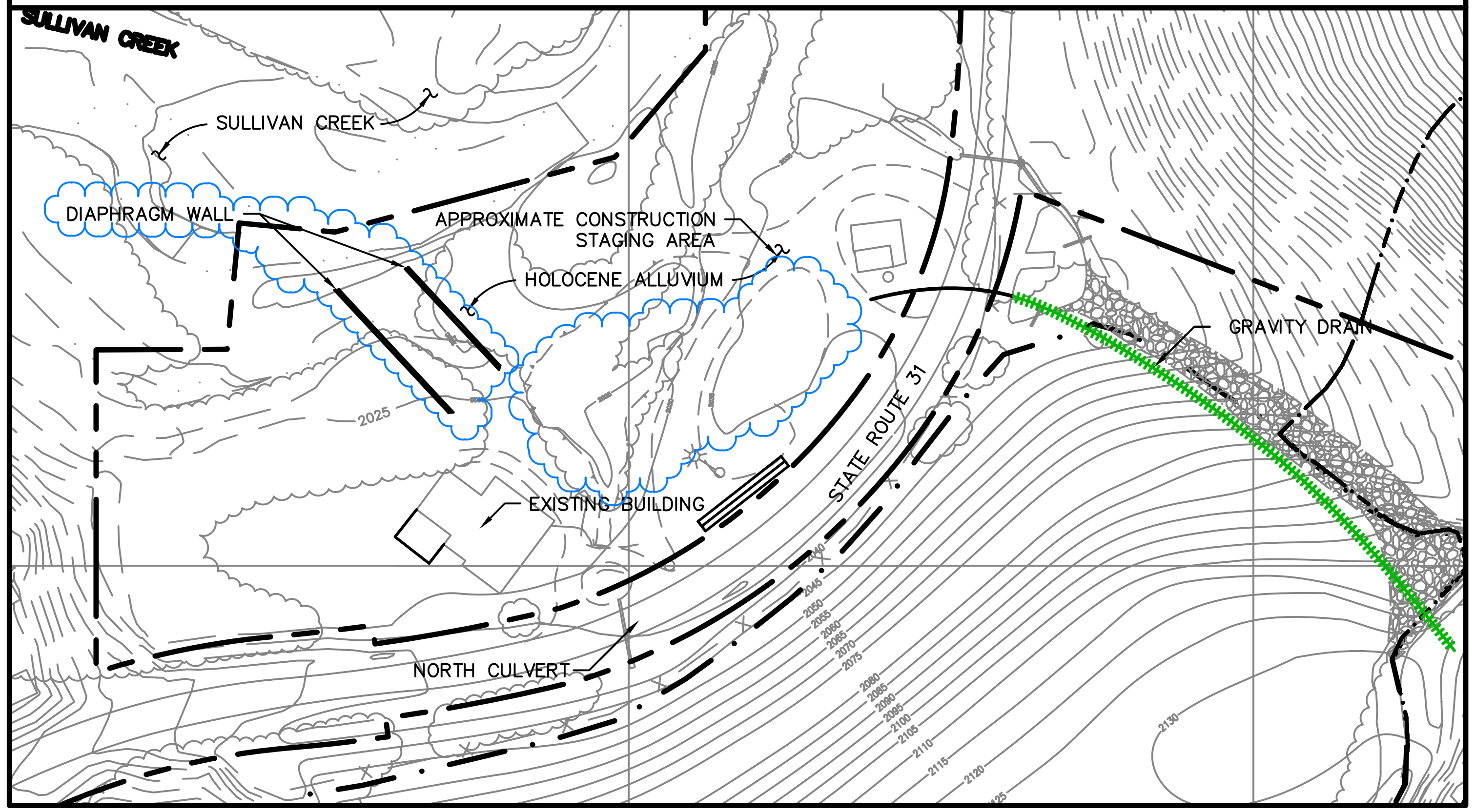
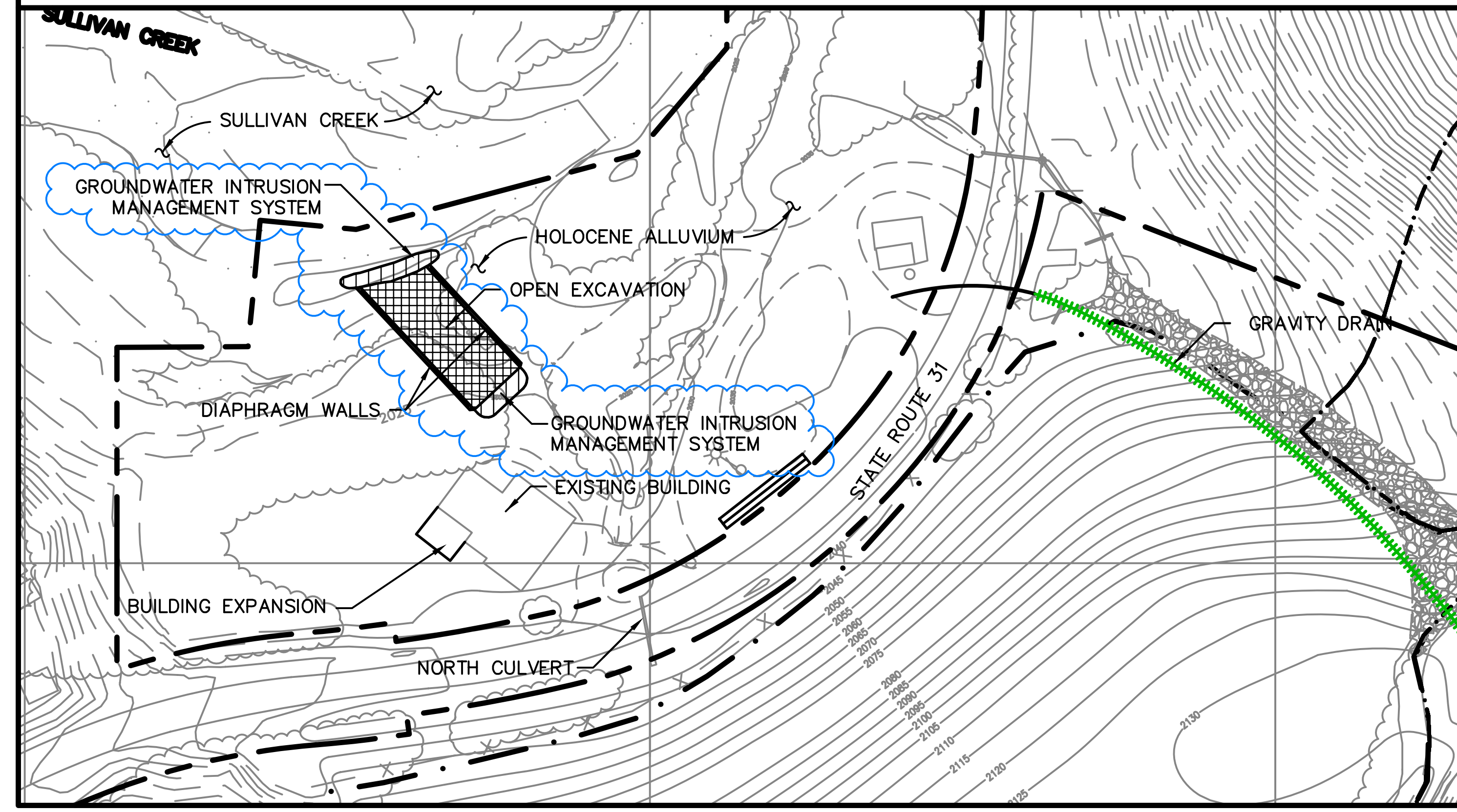
DIAPHRAGM WALLS



TREATMENT CORRIDOR



ACTIVITIES

1. BUILD WORKING PLATFORM
2. INSTALL GUIDE WALL
3. EXCAVATE TRENCH UNDER SLURRY
4. INSTALL STEEL REINFORCEMENT
5. INSTALL CEMENT MIXTURE
6. ALLOW CEMENT TO CURE

ACTIVITIES

1. INSTALL GROUNDWATER INTRUSION MANAGEMENT SYSTEM
2. PROGRESSIVELY EXCAVATE, DEWATER, AND ANCHOR DIAPHRAGM WALLS
3. APPLY GUNITE TO FLOOR OF CORRIDOR
4. INSTALL CARBON DIOXIDE COMPONENTS
5. BACKFILL CORRIDOR AS CARBON DIOXIDE COMPONENTS ARE INSTALLED

LEGEND

CLOSED CKD PILE (EXTENTS)

PILOT SYSTEM

PROPERTY BOUNDARY

FOCUS OF ACTIVITY

0 75 150
SCALE IN FEET

GEOSYNTEC CONSULTANTS

CONCEPTUAL CONSTRUCTION SEQUENCE (4 OF 7)
LEHIGH CEMENT COMPANY CLOSED CKD PILE SITE
METALINE FALLS, WASHINGTON

FIGURE NO.	4-4
PROJECT NO.	HR0996-03
DATE:	JUNE 2006

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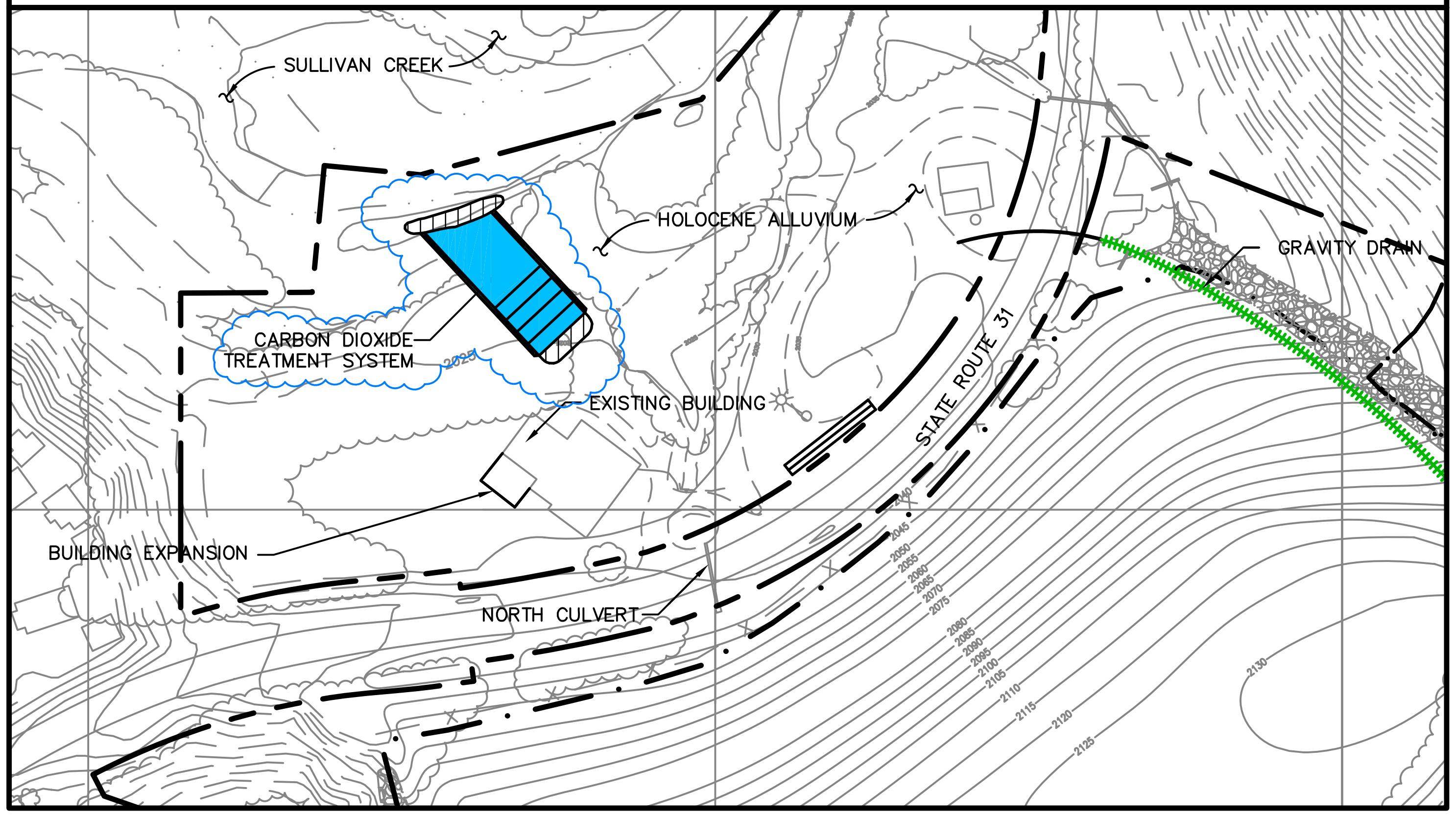
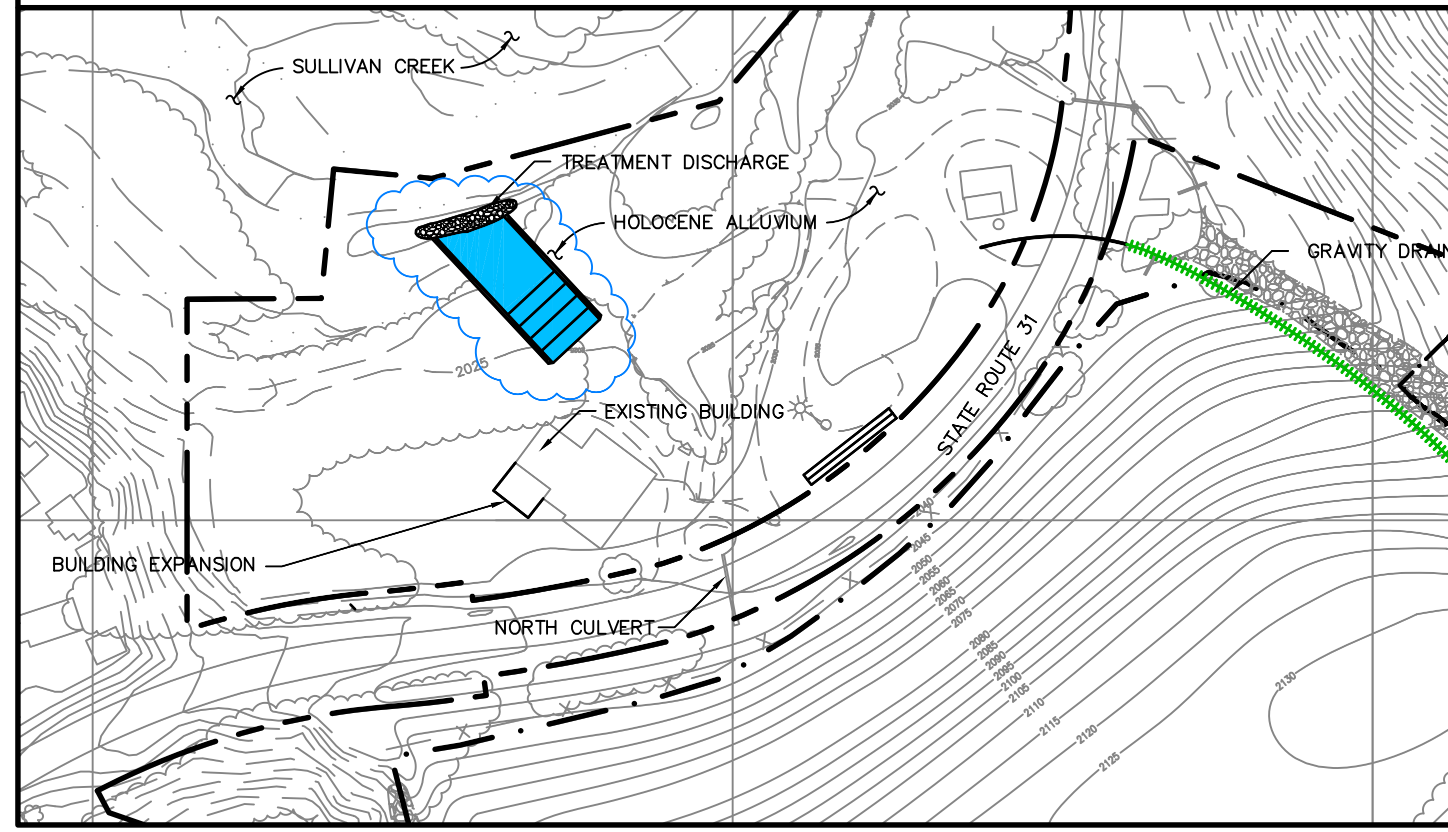
CARBON DIOXIDE TREATMENT SYSTEM



ACTIVITIES

1. INSTALL CARBON DIOXIDE CONNECTIONS

STREAMBED EROSION CONTROL - TREATED WATER DISCHARGE LOCATION



ACTIVITIES

1. PLACE SILT CURTAIN IN CREEK
2. INSTALL BIOSTRUCTURAL STREAMBANK COMPONENTS
3. DEACTIVATE/REMOVE INTRUSION WATER MANAGEMENT SYSTEM

NOTE:
TO TAKE PLACE DURING DEPARTMENT OF ECOLOGY APPROVED TIME FRAME.

LEGEND

CLOSED CKD PILE (EXTENTS)

PILOT SYSTEM

PROPERTY BOUNDARY

FOCUS OF ACTIVITY

0 75 150
SCALE IN FEET

GEOSYNTEC CONSULTANTS

CONCEPTUAL CONSTRUCTION SEQUENCE (5 OF 7)
LEHIGH CEMENT COMPANY CLOSED CKD PILE SITE
METALINE FALLS, WASHINGTON

FIGURE NO.	4-5
PROJECT NO.	HR0996-03
DATE:	JUNE 2006

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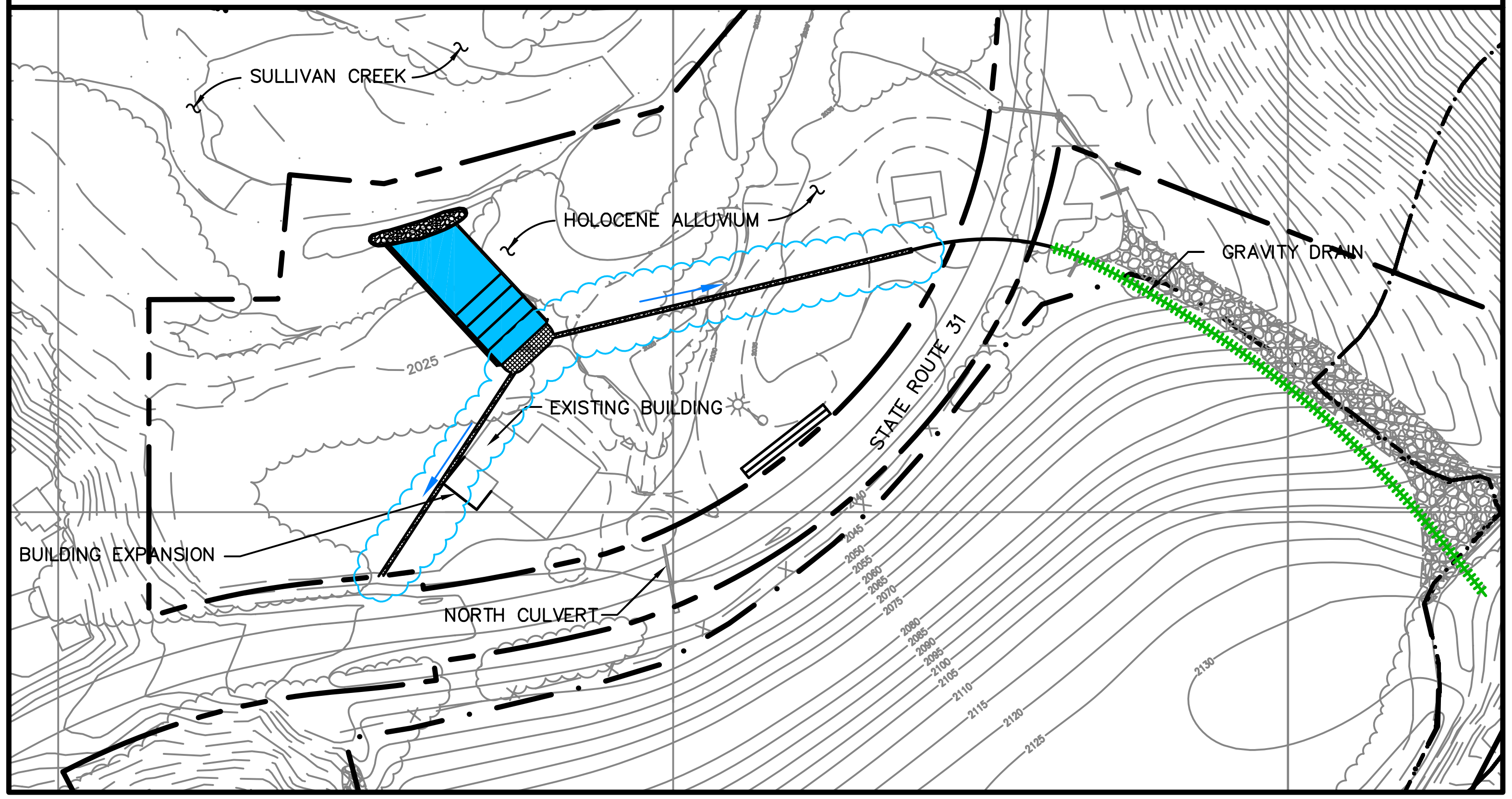
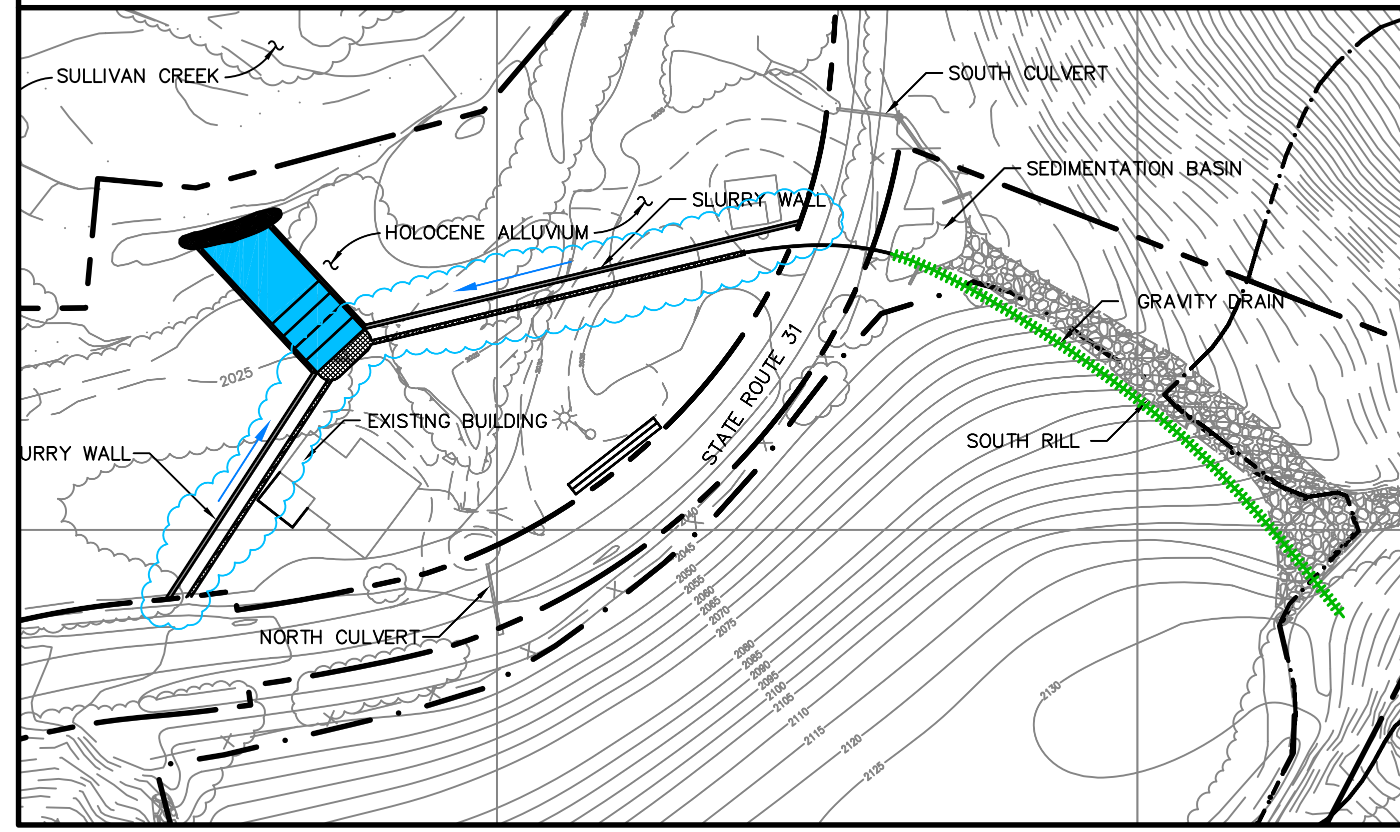
FRENCH DRAIN



GROUNDWATER BARRIER WALLS



ACTIVITIES

1. EXCAVATE TRENCH/POUR BIODEGRADABLE SLURRY
2. DISPLACE SLURRY/INSTALL GRAVEL
3. RECOVER AND DISPOSE OF EXCESS DISPLACED SLURRY
4. ADD A "BREAKER" SOLUTION TO SPEED DEGRADATION OF SLURRY

ACTIVITIES

1. EXCAVATE TRENCH/ POUR SLURRY
2. ADD SOIL-BENTONITE BACKFILL

0 75 150
SCALE IN FEET

LEGEND

CLOSED CKD PILE (EXTENTS)

PILOT SYSTEM

PROPERTY BOUNDARY

FOCUS OF ACTIVITY

NOTE:
DRAIN AND GROUNDWATER BARRIER WALLS MAY BE INSTALLED CONCURRENTLY.

GEOSYNTEC CONSULTANTS

CONCEPTUAL CONSTRUCTION SEQUENCE (6 OF 7)
LEHIGH CEMENT COMPANY CLOSED CKD PILE SITE

METALINE FALLS, WASHINGTON

FIGURE NO.	4-6
PROJECT NO.	HR0996-03
DATE:	JUNE 2006

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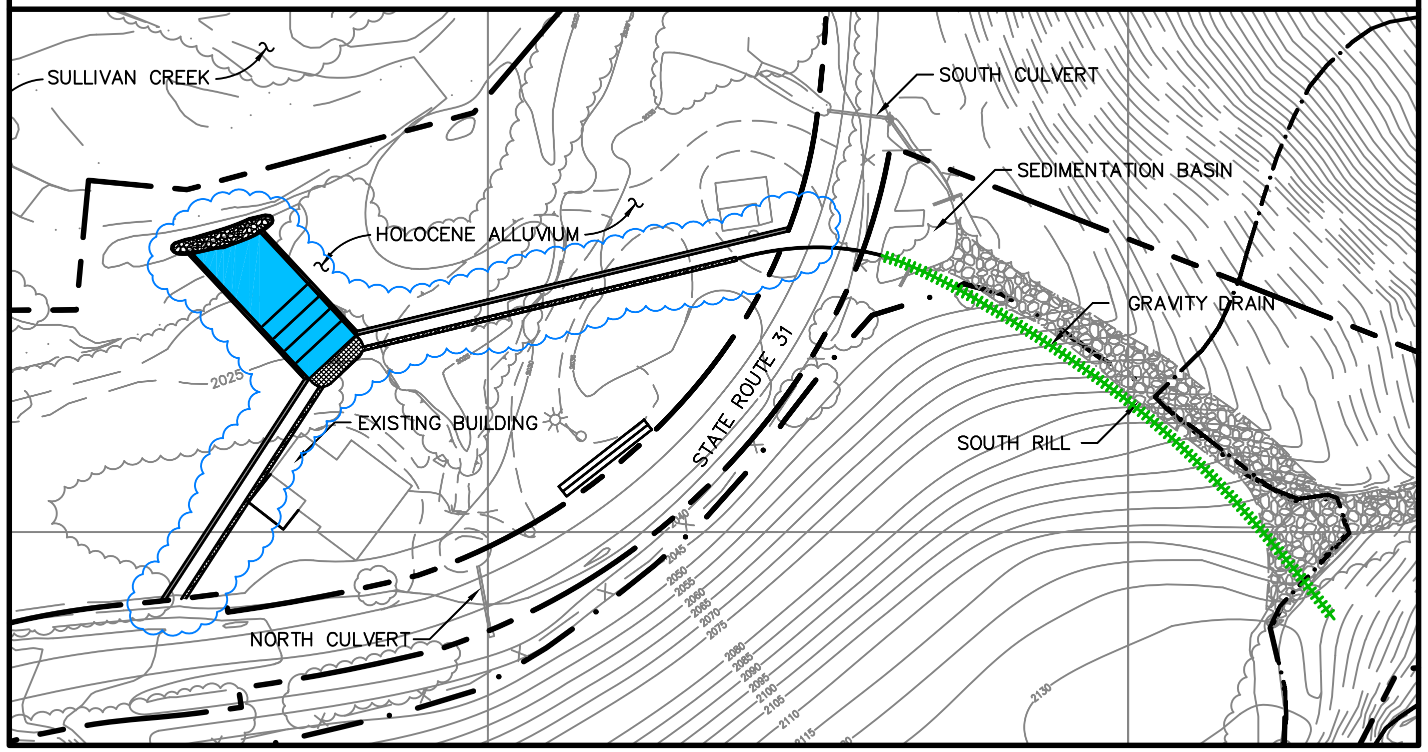
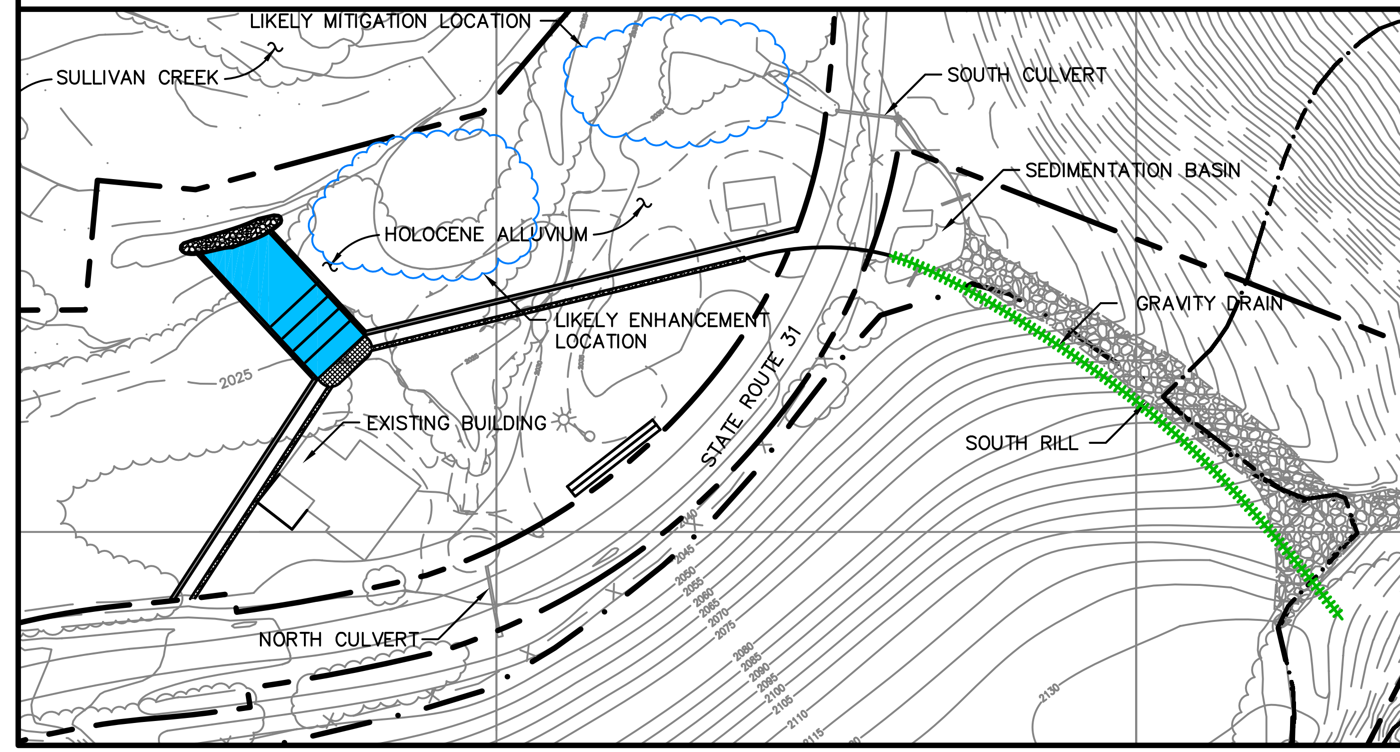
SITE CLEANUP



WETLANDS MITIGATION MEASURES



ACTIVITIES

1. CONNECT THE GRAVITY DRAIN TO THE REMAINDER OF THE GROUNDWATER REMEDY.
2. REMOVE EQUIPMENT AND DEBRIS
3. CONDUCT FINAL GRADING TO PUT SITE TO FINISH GRADE
4. RESTORE DESTROYED VEGETATION

ACTIVITIES

1. WETLANDS RESTORATION ACTIVITIES
2. RIPARIAN ENHANCEMENT ACTIVITIES

N

0 75 150

SCALE IN FEET

LEGEND

— · — · —	CLOSED CKD PILE (EXTENTS)
═══	PILOT SYSTEM
—— — — ——	PROPERTY BOUNDARY
(cloud outline)	FOCUS OF ACTIVITY

GEOSYNTEC CONSULTANTS

CONCEPTUAL CONSTRUCTION SEQUENCE (7 OF 7)
LEHIGH CEMENT COMPANY CLOSED CKD PILE SITE
METALINE FALLS, WASHINGTON

FIGURE NO.	4–7
PROJECT NO.	HR0996–03
DATE:	JUNE 2006

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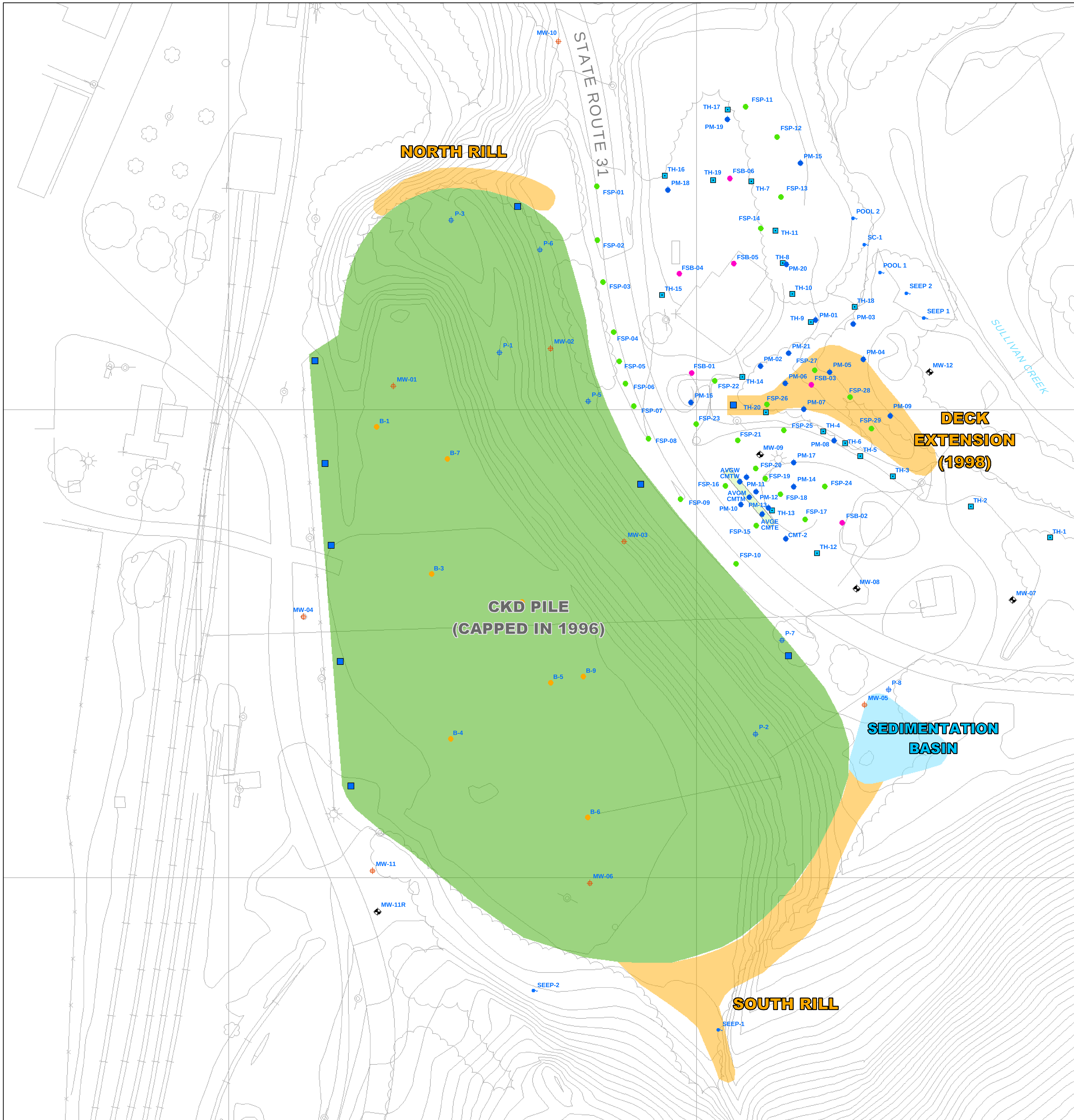


PROJECT:

LEHIGH CEMENT COMPANY
CLOSED CKD PILE SITE
METALINE FALLS, WASHINGTON

DRAFT ENGINEERING
DESIGN REPORT

TITLE:

HISTORICAL SAMPLING LOCATIONS

EXHIBIT:

A-1

LEGEND

- Groundwater Monitoring Well Network Location
- Approximate Rotasonic Boring Location (July 2003)
- Performance Monitoring Location
- Approximate Direct Push Boring Location (July 2003)
- Boring Location (Dames and Moore, 1992)
- Former Groundwater Monitoring Well (Dames and Moore 1992)
- Former Piezometer Location (Dames and Moore, 1992)
- Seep Sampling Location (1999)
- Geoprobe (1999)
- Surface Water Catch Basin
- Topographic Elevation Line
- Pilot Permeable Treatment Wall (Installed 2002)
- Closed CKD Pile and Cover
- Deck Extension
- North Rill / South Rill
- South Rill
- Sedimentation Basin

Note: Department of Ecology's summer 2004 investigation locations are not shown on this figure.

N W E S

0 30 60 120 Feet

Huntington Beach, California

Date: January 2005 | Project No: HR0196

GeoSyntec Consultants

EXHIBIT A-1
SOIL PHYSICAL PROPERTY DATA
LEHIGH CEMENT COMPANY CLOSED CKD PILE SITE
METALINE FALLS, WASHINGTON

LOCATION	DEPTH (ft)	SOIL TYPE	ATTERBERG LIMITS	GRAIN SIZE DISTRIBUTION			DRY DENSITY (pcf)	MOISTURE CONTENT (%)	POCKET PENETROMETER STRENGTH (tsf)	DIRECT SHEAR TEST		PERMEABILITY[(1)] (ft/min)	TOTAL POROSITY (%)	SPECIFIC GRAVITY	SOURCE
				GRAVEL (%)	SAND (%)	FINES (%)				NORMAL STRESS (psf)	PEAK SHEAR STRESS (psf)				
MW-4A	70	ML	LL=27, PI=5	0	35	65	-	-	-	-	-	2.09×10^{-6}	-	-	1
MW-5	4	ML	Non-plastic	0.6	34.6	64.7	-	-	-	-	-	6.12×10^{-5}	-	-	1
B-7	83	ML/SM	-	-	-	65.6	46.7	88.8	-	-	-	-	-	-	2
B-7	85.5	ML/SM	-	-	-	-	63.3	59.0	0.7	-	-	-	-	-	2
B-7	85.5	ML/SM	-	-	-	-	62	60.5	-	1000	1080	-	-	-	2
B-7	85.5	ML/SM	-	-	-	-	65.3	55.9	-	2000	1980	-	-	-	2
B-7	85.5	ML/SM	-	-	-	-	62.5	60.5	-	4000	3990	-	-	-	2
B-9	78	ML/SM	-	-	-	-	41	110	1.8	-	-	-	-	-	2
B-9	78	ML/SM	-	-	-	-	42	100.8	-	1000	900	-	-	-	2
B-9	78	ML/SM	-	-	-	-	42.1	109.3	-	2000	1580	-	-	-	2
B-9	78	ML/SM	-	-	-	-	39.1	119.9	-	4000	3150	-	-	-	2
TH-7	7-9	-	-	-	-	-	116.7	5.7	-	-	-	-	32.5	2.77	3
TH-17	5.5-6.5	-	-	-	-	-	120.4	3.7	-	-	-	-	30.4	2.77	3
TH-17	7-7.5	ML	-	-	-	-	-	-	-	-	-	-	-	-	3
TH-17	10.5-11.5	SM	-	-	-	-	-	-	-	-	-	-	-	-	3
TH-19	8.5-9.5	SM	-	-	-	-	-	-	-	-	-	-	-	-	3
TH-20	5-5.5	SC	-	-	-	-	-	-	-	-	-	-	-	-	3
TH-20	5.5-6	ML/CL	-	-	-	-	-	-	-	-	-	-	-	-	3
TH-20	4.5-5.5	-	-	-	-	-	77.8	46.5	-	-	-	-	54.5	2.74	3
TH-20	7-7.5	ML/CL	-	-	-	-	119	6.5	-	-	-	-	35.4	2.75	3

Notes:
(1) Permeability also evaluated in situ using aquifer slug and pumping tests (See table A-2).
tsf – tons per square foot
pcf – pounds per cubic foot
psf – pounds per square foot
ft/min – feet per minute
LL – Liquid limit: water content, in percent, of a soil at an arbitrary defined boundary between the liquid and plastic state (ASTM D-4318)
PI – Plasticity index: range of water content over which a soil behaves plastically (ASTM D-4318)
ML – Sandy silt
SM – Silty sand
CL – Inorganic clay
Source 1: Preliminary Site Characterization Report, Dames and Moore, 1992.
Source 2: Addendum – Preliminary Site Characetrization Report, Dames and Moore, 1993.
Source 3: Draft Final Remedial Investigation Report, GeoSyntec Consultants, 2001.

EXHIBIT A-2
HYDROGEOLOGIC DATA
LEHIGH CEMENT COMPANY CLOSED CKD PILE SITE
METALINE FALLS, WASHINGTON

MONITORING WELL NUMBER	VERTICAL HYDRAULIC CONDUCTIVITY (ft/min)	HORIZONTAL HYDRAULIC CONDUCTIVITY (ft/min)	AVERAGE HORIZONTAL HYDRAULIC CONDUCTIVITY (ft/min)	SOURCE
MW-1	Not Tested	1.30×10^{-3} to 9.50×10^{-4} (1)	1.10×10^{-3} (1)	1
MW-2	Not Tested	2.60×10^{-3} to 1.20×10^{-3} (1)	1.90×10^{-3} (1)	1
MW-3	2.00×10^{-5} (3)	2.90×10^{-1} to 3.30×10^{-2} (1)	1.60×10^{-1} (1)	1
MW-4	3.00×10^{-4} (3)	1.20×10^{-3} to 5.60×10^{-4} (1)	8.80×10^{-4} (1)	1
MW-5	Not Tested	9.00×10^{-3} (1)	9.00×10^{-3} (1)	1
MW-6	Not Tested	1.50×10^{-3} to 8.70×10^{-4} (1)	1.20×10^{-3} (1)	1
MW-7	Not Tested	1.67×10^{-2} (2)	-	2
MW-8	Not Tested	1.68×10^{-2} (2)	-	2
MW-11	Not Tested	1.10×10^{-4} (2)	-	2
PM-16	Not Tested	1.74×10^{-2} to 6.60×10^{-2} (4)	4.1×10^{-2} (4)	3

Notes:

(1) Hvorslev's Method.

(2) Determined by Bouwer and Rice Method.

(3) Mechanical Constant Head Permeability Tests

(4) Pumping Test with average pumping rate of 2.9 gallons per minute

Source 1: Preliminary Site Characterization Report, Dames and Moore, 1992.

Source 2: Addendum – Preliminary Site Characetrization Report, Dames and Moore, 1993.

Source 3: Revised Draft Feasibility Study Technical Report, GeoSyntec Consultants, 2005.

EXHIBIT A-3
GROUNDWATER ELEVATION DATA (AUGUST 2002 - MARCH 2006)
LEHIGH CEMENT COMPANY CLOSED CKD PILE SITE
METALINE FALLS, WASHINGTON

Well ID	8/30/02	9/13/02	9/20/02	11/21/02	1/10/03	3/1/03	4/20/03	5/12/03	7/31/03	8/26/03	11/18/03	4/5/04	5/31/04	7/20/04	11/3/04	3/9/05	6/6/05	12/11/05	3/15/06
PM-1	2021.30	2021.42	2021.42	2021.95	2021.87	NM	2021.90	NM	2021.31	2021.23	2021.82	2021.88	2021.60	2021.20	2022.20	2021.78	2021.42	2021.23	2021.69
PM-2	2019.85	2023.33	2023.29	2023.91	2023.91	NM	2023.94	2023.70	2023.25	2023.23	2023.76	2023.89	2023.68	2023.30	2024.10	2023.85	2023.46	2023.44	2023.81
PM-3	2014.77	2021.09	2021.06	2021.44	2021.29	NM	2021.42	NM	2021.02	2023.00	2021.06	2021.77	2021.19	2020.95	2021.46	2021.25	2021.05	2020.80	2021.12
PM-4	2021.25	2021.32	2021.31	2021.67	2021.63	NM	2021.67	NM	2021.26	2021.18	2021.69	2021.63	2021.41	2021.15	2021.92	2021.51	2021.23	2021.10	2022.65
PM-5	2018.41	2021.76	2021.95	2022.44	2022.46	NM	2022.51	NM	2021.67	2021.62	2021.99	2022.08	2022.05	2021.56	2022.70	2022.33	2021.90	2021.53	2022.13
PM-6	2018.29	2023.74	2023.72	2024.69	2025.02	NM	2024.69	2024.81	2023.90	2023.77	2025.35	2025.25	2025.04	2023.97	2024.94	2025.14	2024.39	2024.23	2025.18
PM-7	2024.14	2024.15	2024.10	2025.33	2025.26	NM	2025.70	2025.03	2024.13	2024.07	2025.74	2025.89	2025.43	2024.24	2025.95	2025.52	2024.81	2024.52	2025.78
PM-8	2024.85	2024.92	2024.85	2025.44	2025.42	NM	2025.50	2025.15	2024.68	2024.54	2025.55	2025.50	2025.05	2024.53	2025.41	2025.16	2024.73	2024.38	2025.36
PM-9	2019.68	2022.03	2022.18	2022.50	2022.62	NM	2022.73	NM	2022.04	2021.87	2022.44	2022.27	2022.18	2021.83	2022.44	2022.28	2021.99	2021.67	2022.20
PM-10	NI	NI	NI	2028.72	2028.91	NM	2028.72	2029.42	2028.18	2028.03	2029.26	2029.66	2029.07	2028.43	2028.92	2029.47	2028.95	2028.43	2029.71
PM-11	NI	NI	NI	2028.49	2028.67	NM	2028.49	2029.16	2027.94	2027.79	2028.95	2029.54	2028.83	2028.22	2028.72	2029.20	2028.72	2028.21	2029.53
PM-12	NI	NI	NI	2028.48	2028.68	NM	2028.48	2029.13	2027.95	2027.80	2028.95	2029.50	2028.82	2028.21	2028.62	2029.22	2028.72	2028.20	2029.51
PM-13	NI	NI	NI	2028.50	2028.88	NM	2028.50	2029.15	2027.96	2027.76	2028.98	2029.65	2028.86	2028.22	2028.70	2029.23	2028.75	2028.25	2028.56
PM-14	NI	NI	NI	2028.42	2028.64	NM	2029.47	2028.97	2027.86	2027.72	2028.88	2029.32	2028.76	2028.10	2028.62	2029.11	2028.60	2028.15	2029.47
PM-15	NI	NI	NI	2020.20	2020.28	NM	2020.54	NM	2019.99	2018.82	2020.23	2020.29	2020.27	2020.12	2020.45	2020.39	2020.22	2020.08	2020.45
PM-16	NI	NI	NI	NI	NI	NI	NI	NI	2026.59	2026.77	2027.55	2027.77	2024.44	2027.14	2027.57	2027.51	2027.25	NM	2027.63
PM-17	NI	NI	NI	NI	NI	NI	NI	NI	2028.36	2028.20	2029.34	2029.37	2029.23	2028.61	2029.12	2029.61	2029.11	2028.66	2029.94
PM-18	NI	NI	NI	NI	NI	NI	NI	NI	2021.14	2021.00	2021.14	2020.85	2021.23	2021.07	2021.20	2021.27	2021.21	2020.91	2021.52
PM-19	NI	NI	NI	NI	NI	NI	NI	NI	2020.18	2019.96	2020.09	2021.04	2020.27	2020.09	2020.21	2020.31	2020.18	2019.78	2020.55
PM-20	NI	NI	NI	NI	NI	NI	NI	NI	2020.46	2020.35	2020.72	2020.37	2020.78	2020.67	2020.77	2020.73	2021.78	2025.01	2020.82
PM-21	NI	NI	NI	NI	NI	NI	NI	NI	2022.18	2022.14	2023.11	2023.36	2023.11	2022.35	2023.37	2023.31	2022.82	NM	2023.58
AVGW	NI	NI	NI	NM	2028.83	NM	2029.74	2029.31	2028.10	NM	2028.69	2029.23	2029.04	NM	2028.24	2028.84	2028.79	2028.26	2029.62
AVGM	NI	NI	NI	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	2028.28	2029.06	2029.38	2028.79	2028.27	2029.64
AVGE	NI	NI	NI	NM	2028.82	NM	2029.70	2029.35	2028.09	NM	2028.65	2029.14	2029.02	NM	2031.13	2029.35	2028.79	2028.26	2029.62
MW-7R	2028.97	2028.52	2029.96	2030.43	2030.25	2030.04	2030.17	NM	2029.58	2029.45	2030.47	2030.49	2029.69	2029.53	2030.37	2030.27	2030.27	2030.73	2030.51
MW-8	2028.88	2029.23	2029.26	2029.38	2029.77	2030.26	2030.76	NM	2028.85	2028.67	2029.34	2030.61	2029.76	2028.94	2029.28	2030.07	2030.07	2028.98	2030.48
MW-9	2028.37	2028.57	2028.68	2028.64	2028.64	2028.74	2028.74	NM	2027.87	NM	2028.99	2025.70	2028.80	2028.34	2028.70	2028.74	2028.74	2028.21	2028.94
MW-11	2060.32	NM	NM	2059.86	NM	2060.89	2060.58	NM	NM	2061.15	2061.15	2061.49	2060.45	2060.99	2060.41	2059.98	2059.98	2060.03	2060.44
MW-12	2022.11	2021.44	2021.48	2022.49	2022.22	2022.32	2022.37	NM	2022.05	2021.97	2022.33	2022.31	2022.24	2021.95	2022.40	2022.28	2022.28	2021.84	2022.20

Notes:
Groundwater elevations are expressed as feet above mean sea level.
TOC - Top of Casing
NM - Not Measured
NI - Monitoring location was not yet installed

EXHIBIT A-4
GROUNDWATER ANALYTICAL DATA SUMMARY
LEHIGH CEMENT COMPANY CLOSED CKD PILE SITE
METALINE FALLS, WASHINGTON
(June 1999 to Jan 2006)

		MW-07 and MW-11 (1) Background Groundwater Range (Non-CKD-Affected)					MW-09 and PM-16 (2) CKD-Affected Groundwater					AVG-E, AVG-W, PM-11, PM-12 (3) Post-Treatment Groundwater				
PARAMETER	**UNITS**	**# Analysis**	**# Detects**	**FOD %**	**Min**	**Max**	**# Analysis**	**# Detects**	**FOD %**	**Max**		**# Analysis**	**# Detects**	**FOD %**	**Min**	**Max**
Alkalinity (expressed as CaCO3)	mg/L	34	34	100%	178	452	35	35	100%	903		44	44	100%	1020	1520
Aluminum, Total	mg/L	12	12	100%	0.731	4.25	8	8	100%	n/a		2	2	100%	0.056	0.107
Ammonia (expressed as nitrogen)	mg/L	12	8	67%	<0.01	0.03	10	10	100%	8.1		10	10	100%	0.167	1.76
Anion Sum	MEQ/L	26	26	100%	10.5	11.3	21	21	100%	75.7		24	24	100%	10.6	29.22
Arsenic, Dissolved	mg/L	79	17	22%	0.001	0.011	84	84	100%	0.479		41	20	49%	<0.001	0.0223
Arsenic, Total	mg/L	119	43	36%	<0.001	0.36	123	123	100%	0.752		49	31	63%	<0.001	0.033
BOD	mg/L	0	0	n/a	n/a	n/a	0	0	n/a	n/a		8	7	88%	<2	7
Arsenic(III)	mg/L	2	0	0%	<0.002	<0.002	2	2	100%	0.752		0	0	n/a	n/a	n/a
Arsenic(V)	mg/L	2	2	100%	0.002	0.003	2	0	0%	<0.002		0	0	n/a	n/a	n/a
Calcium, Dissolved	mg/L	8	8	100%	103	109	7	7	100%	4.13		4	4	100%	130	165
Calcium, Total	mg/L	28	28	100%	102	132	34	34	100%	5.71		32	32	100%	102	310
Cation Sum	meg/L	28	28	100%	10	10.8	24	24	100%	99.6		20	20	100%	11.1	31.55
Cation-Anion Balance	%	22	22	100%	0.37	8.49	16	16	100%	8.45		16	16	100%	<0.06	3.97
Chloride, Total	mg/L	30	30	100%	0.28	9.68	33	33	100%	63.9		32	32	100%	10.6	183
Chromium, Dissolved	mg/L	77	23	30%	0.00025	0.003	76	47	62%	<0.006		20	1	5%	<0.001	0.009
Chromium, Total	mg/L	130	65	50%	<0.001	1.08	115	90	78%	<0.025		20	10	50%	<0.0003	0.019
Chromium (III)	mg/L	0	0	n/a	n/a	n/a	1	0	0%	<0.01		2	0	0%	<0.01	<0.01
Chromium (VI)	mg/L	0	0	n/a	n/a	n/a	1	0	0%	<0.01		2	0	0%	<0.01	<0.01
CO3 (expressed as CaCO3)	mg/L	18	0	0%	<1	<1	22	22	100%	949		24	1	4%	<1	35.6
COD	mg/L	12	10	83%	10.3	52.3	8	8	100%	398		8	6	75%	21.5	49
Conductivity	µmhos/cm	7	7	100%	404	757	5	5	100%	23600		0	0	n/a	n/a	n/a
Dissolved Inorganic Carbon	mg/L	20	20	100%	100	113	24	24	100%	99		34	34	100%	111	500
Dissolved Organic Carbon	mg/L	20	20	100%	43.1	86	16	16	100%	217		0	0	n/a	n/a	n/a
Eh	mV	115	115	100%	105	307	109	109	100%	<449		46	46	100%	0.9	337
Iron (II)	mg/L	2	1	50%	0.02	0.02	2	0	0%	<0.02		0	0	n/a	n/a	n/a
Iron (III)	mg/L	2	1	50%	<0.02	0.09	2	2	100%	0.79		0	0	n/a	n/a	n/a
Fluoride	mg/L	12	2	17%	<0.01	0.12	8	8	100%	3.54		0	0	n/a	n/a	n/a
Fluoride, Total	mg/L	10	9	90%	0.1	0.15	10	9	90%	2.86		8	0	0%	<0.1	<0.1
Hardness	mg/L	0	0	n/a	n/a	n/a	0	0	n/a	n/a		4	4	100%	160	857
Bicarbonate (expressed as CaCO3)	mg/L	18	18	100%	232	450	22	0	0%	<1		24	24	100%	1020	1520
Hydroxide (expressed as CaCO3)	mg/L	6	0	0%	<1	<1	4	4	100%	2010		0	0	n/a	n/a	n/a
Iron, Dissolved	mg/L	17	1	6%	<0.02	0.023	15	15	100%	0.823		18	17	94%	<0.02	56.3
Iron, Total	mg/L	37	30	81%	<0.02	12.2	37	37	100%	6.45		20	20	100%	0.141	94.7
Lead, Dissolved	mg/L	81	2	2%	<0.001	0.002	77	20	26%	<0.06		20	2	10%	<0.001	0.038
Lead, Total	mg/L	114	35	31%	<0.001	0.64	109	54	50%	<0.06		20	12	60%	<0.003	0.055
Magnesium, Dissolved	mg/L	2	2	100%	31.2	44.6	6	0	0%	<0.04		4	4	100%	10.3	43.5
Magnesium, Total	mg/L	34	34	100%	16.1	49.3	35	20	57%	3.99		32	32	100%	10.1	49.8
Manganese, Dissolved	mg/L	16	11	69%	<0.002	0.0207	16	15	94%	0.0146		29	29	100%	0.454	7.54
Manganese, Total	mg/L	34	33	97%	0.0025	0.593	32	32	100%	0.232		29	29	100%	0.49	10.2
Nitrate (expressed as nitrogen)	mg/L	8	7	88%	<0.05	0.564	6	1	17%	0.053		12	3	25%	<0.05	0.145
Nitrite (expressed as nitrogen)	mg/L	0	0	n/a	n/a	n/a	2	0	0%	<0.5		0	0	n/a	n/a	n/a
Nitrate + Nitrite (expressed as nitrogen)	mg/L	12	12	100%	0.05	0.49	8	8	100%	0.21		0	0	n/a	n/a	n/a
pH	Stand. Units	115	115	100%	6.84	8.11	110	110	100%	12.91		46	46	100%	5.63	9.02
Phosphorus, Total	mg/L	16	12	75%	<0.05	0.353	13	13	100%	2.04		10	9	90%	<0.01	0.611
Potassium, Dissolved	mg/L	2	2	100%	2.2	8.9	5	5	100%	3830		28	28	100%	n/a	n/a
Potassium, Total	mg/L	34	34	100%	12.7	12.8	34	34	100%	958		0	0	n/a	104	848

EXHIBIT A-4
GROUNDWATER ANALYTICAL DATA SUMMARY
LEHIGH CEMENT COMPANY CLOSED CKD PILE SITE
METALINE FALLS, WASHINGTON
(June 1999 to Jan 2006)

		MW-07 and MW-11 (1) Background Groundwater Range (Non-CKD-Affected)					MW-09 and PM-16 (2) CKD-Affected Groundwater					AVG-E, AVG-W, PM-11, PM-12 (3) Post-Treatment Groundwater				
PARAMETER	**UNITS**	**# Analysis**	**# Detects**	**FOD %**	**Min**	**Max**	**# Analysis**	**# Detects**	**FOD %**	**Max**		**# Analysis**	**# Detects**	**FOD %**	**Min**	**Max**
Silica, Dissolved	mg/L	8	8	100%	11.4	25.9	7	7	100%	97		14	14	100%	10	35.6
Silica, Total	mg/L	14	14	100%	10.8	27.1	17	17	100%	95.9		12	12	100%	11.2	43.2
Silicon, Total	mg/L	6	6	100%	14.2	17	10	10	100%	100		4	4	100%	21.4	130
Silicon, Dissolved	mg/L	0	0	n/a	n/a	n/a	3	3	100%	68.3		8	8	100%	106	138
Sodium, Dissolved	mg/L	4	4	100%	3.6	6.74	7	7	100%	72.4		0	0	n/a	n/a	n/a
Sodium, Total	mg/L	32	32	100%	2.17	7.13	34	34	100%	98		28	28	100%	n/a	n/a
Spec. Cond., Total	µmhos/cm	14	14	100%			16	13	81%	9900		6	6	100%	1700	3320
Sulfate	mg/L	32	32	100%	16.5	115	35	35	100%	877		32	32	100%	12.9	662
Sulfide, Total	mg/L	32	2	6%	<0.5	0.6	34	34	100%	9.8		28	0	0%	<1	<1
Sulfite	mg/L	14	4	29%	<0.5	0.8	11	11	100%	92		0	0	n/a	n/a	n/a
TDS, measured	mg/L	20	20	100%	188	540	15	15	100%	8360		22	22	100%	1030	2270
Calculated TDS	mg/L	22	22	100%	187	618	16	16	100%	7778.3		16	16	100%	1090	1970
TOC	mg/L	0	0	n/a	n/a	n/a	0	0	n/a	n/a		10	10	100%	14.4	14.4
TSS	mg/L	0	0	n/a	n/a	n/a	0	0	n/a	n/a		8	8	100%	10	100
Temperature	C	16	16	100%	10.1	24.8	16	16	100%	9.5		0	0	n/a	n/a	n/a
Turbidity	NTU	91	91	100%	0.12	8350	76	76	100%	7.93		26	26	100%	1.13	402

Notes:
This summary includes data from after 1 June 1999, when Site groundwater conditions reached an approximate steady state following closure of the CKD Pile.
%FOD: Frequency of Detection (%)
BOD: Biological Oxygen Demand
CaCO3: Calcium Carbonate
COD: Chemical Oxygen Demand
CO3: Carbonate
Eh: Redox Potential
HCO3: Bicarbonate
TDS: Total Dissolved Solids
TOC: Total Organic Carbon
TSS: Total Suspended Solids
NTU: Nephelometric Turbidity Units

EXHIBIT A-5
SUMMARY OF SOIL INORGANIC CHEMISTRY DATA
LEHIGH CEMENT COMPANY CLOSED CKD PILE SITE
METALINE FALLS, WASHINGTON

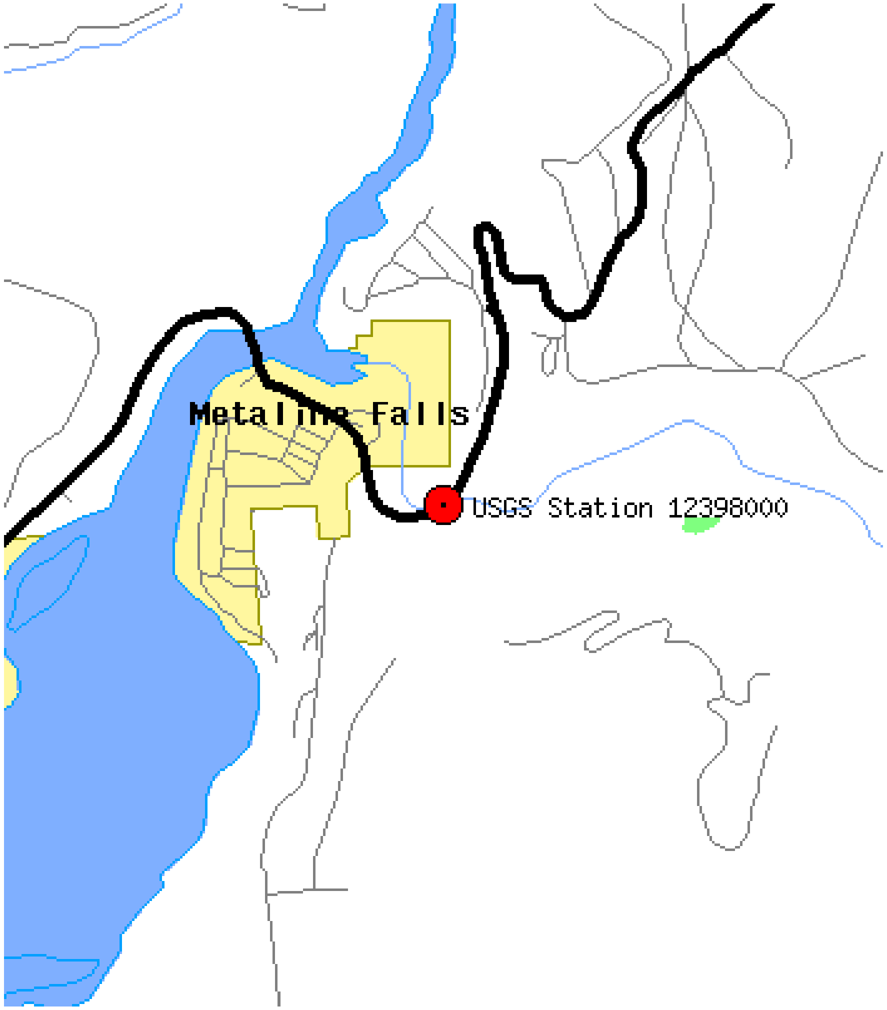
Sample Name	Sample Location	Sample Depth (ft)	Sample Date	Antimony	Arsenic	Barium	Beryllium	Cadmium	Calcium	Chromium	Cobalt	Copper	Iron	Lead	Magnesium	Manganese	Mercury	Molybdenum	Nickel	pH	Potassium	Selenium	Sodium	Sulfide, Total	Silver	Thallium	Vanadium	Zinc
B1-59	B-1	59	01-Jan-92	<5	5.89	NA	0.30	0.40	NA	29.7	NA	42.7	NA	27.1	NA	NA	NA	NA	28	NA	NA	<5	NA	NA	NA	7	NA	160
B3-75.5	B-3	75.5	01-Jan-92	6	3.00	NA	0.20	<0.2	NA	15.2	NA	11.1	NA	11.8	NA	NA	NA	NA	20	NA	NA	<5	NA	NA	NA	9	NA	44.3
B4-69.5	B-4	69.5	01-Jan-92	<6	2.70	NA	0.20	0.70	NA	29.3	NA	30.9	NA	10.5	NA	NA	NA	NA	24	NA	NA	<6	NA	NA	NA	11	NA	80.7
B5-78	B-5	78	01-Jan-92	<6	2.80	NA	0.30	0.60	NA	27.5	NA	29.9	NA	25.8	NA	NA	NA	NA	21	NA	NA	<6	NA	NA	NA	<6	NA	94.8
B6-45	B-6	45	01-Jan-92	<6	5.16	NA	0.30	0.60	NA	31.0	NA	24.6	NA	16.3	NA	NA	NA	NA	23	NA	NA	6	NA	NA	NA	10	NA	98.1
FSP-06-5	FSP-6	5	15-Jul-03	NA	4.46	NA	NA	NA	NA	NA	NA	NA	18,900	NA	NA	470	NA	NA	NA	NA	NA	NA	NA	<0.01	NA	NA	NA	NA
FSP-18-12	FSP-18	12	17-Jul-03	NA	3.00	NA	NA	NA	NA	NA	NA	NA	17,800	NA	NA	353	NA	NA	NA	NA	NA	NA	NA	<0.01	NA	NA	NA	NA
FSP-19-8	FSP-19	8	17-Jul-03	NA	4.36	NA	NA	NA	NA	NA	NA	NA	20,100	NA	NA	419	NA	NA	NA	NA	NA	NA	NA	<0.01	NA	NA	NA	NA
MW-1-74	MW-1	74	01-Jan-92	<33	3.00	NA	<1	<1	NA	131.0	NA	27.0	NA	78.1	NA	NA	NA	NA	18	NA	NA	<33	NA	NA	NA	<33	NA	1430
MW-2-9.5	MW-2	9.5	01-Jan-92	<6	3.20	NA	0.30	0.40	NA	26.4	NA	18.2	NA	71.7	NA	NA	NA	NA	21	NA	NA	<6	NA	NA	NA	7	NA	223
MW-3-9.5	MW-3	9.5	01-Jan-92	<6	2.90	NA	0.30	0.60	NA	24.9	NA	36.9	NA	16.6	NA	NA	NA	NA	21	NA	NA	<6	NA	NA	NA	<7	NA	76.3
MW-4-15	MW-4	15	01-Jan-92	<5	2.70	NA	0.30	<0.2	NA	27.2	NA	27.4	NA	10.1	NA	NA	NA	NA	22	9	NA	<5	NA	NA	NA	<5	NA	67.3
MW-4-25	MW-4	25	01-Jan-92	<5	3.60	NA	0.20	0.60	NA	25.6	NA	24.8	NA	8.8	NA	NA	NA	NA	21	NA	NA	<5	NA	NA	NA	11	NA	64.3
MW-4-55	MW-4	55	01-Jan-92	<5	4.30	NA	0.20	0.40	NA	24.2	NA	22.8	NA	7.1	NA	NA	NA	NA	18	NA	NA	<5	NA	NA	NA	6	NA	55.5
MW-5-2.5	MW-5	2.5	01-Jan-92	<6	4.50	NA	0.20	0.40	NA	20.5	NA	18.2	NA	11.6	NA	NA	NA	NA	17	NA	NA	<6	NA	NA	NA	<6	NA	71.9
MW-6-39.5	MW-6	39.5	01-Jan-92	<6	4.90	NA	0.40	0.60	NA	27.7	NA	21.7	NA	1.2	NA	NA	NA	NA	21	NA	NA	<6	NA	NA	NA	<6	NA	95
MWX-4-15	MW-4	15	01-Jan-92	<5	2.40	NA	0.20	0.30	NA	25.9	NA	27.8	NA	10.0	NA	NA	NA	NA	23	NA	NA	<5	NA	NA	NA	15	NA	70.5
SS-13	Background (South of MW-11)	Surface	01-Jan-92	NA	5.30	NA	0.30	0.70	NA	27.7	NA	31.6	NA	59.0	NA	NA	NA	NA	23	8.2	NA	NA	NA	NA	NA	12	NA	127
SS-14	Background (South of MW-11)	Surface	01-Jan-92	NA	5.10	NA	<1	5.00	NA	32.0	NA	40.0	NA	96.3	NA	NA	NA	NA	21	7.7	NA	NA	NA	NA	NA	38	NA	3650
B-1(2'-3')	TH-1	2 - 3	13-Sep-00	<0.75	2.23	70.5	<0.25	1.29	52,200	14.7	5.1	27.2	10,200	89.8	12,200	388	<0.0835	0.763	11.5	9.45	3,540	2.96	668	NA	<0.25	<0.75	19.5	411
B-1(4'-5')	TH-1	4 - 5	13-Sep-00	<0.75	<0.75	50	<0.25	<0.50	13,100	13.0	6.3	15.5	11,800	5.5	6,480	263	<0.0835	0.572	12.8	10.76	2,160	1.56	159	NA	<0.25	<0.75	21.8	45.3
B-1(6')	TH-1	6	13-Sep-00	<0.75	13.80	36.6	0.26	<0.50	2,720	2.1	2.24	15.2	2,640	2.6	702	23.7	<0.0835	<0.25	6.23	NA	651	<0.75	321	NA	<0.25	<0.75	1.58	17.8

Notes:
Concentrations expressed in milligrams per kilogram
NA - Not Analyzed
"<" indicates that the analytes was not detected at or above the given reporting limit

EXHIBIT A-6
SUMMARY OF SOIL ORGANIC CHEMISTRY DATA
LEHIGH CEMENT COMPANY CLOSED CKD PILE SITE
METALINE FALLS, WASHINGTON

Sample Name	Sample Location	Sample Depth (ft)	Sample Date	1,1,1-Trichloroethane	2-Butanone	2-Methylnaphthalene	Acenapthene	Acetone	Anthracene	Benzo(a)anthracene	Bis(2-ethylhexyl)phthala	Chrysene	Dibenxofuran	Di-n-butylphthalate	Ethylbenzene	Fluoranthene	Methylene Chloride	Napthalene	Phenanthrene	Pyrene	Tetrachloroethene	Toluene	Total Xylenes
MW-4-15	MW-4	15	01-Jan-92	<0.0012	<0.0057	<0.075	<0.075	<0.0057	<0.075	<0.075	<0.075	<0.075	<0.075	<0.075	<0.0012	<0.075	<0.0023	<0.075	<0.075	<0.075	<0.0012	<0.0012	<0.0023
MWX-4-15	MW-4	15	01-Jan-92	<0.0011	<0.0057	<0.073	<0.073	<0.0057	<0.073	<0.073	<0.073	<0.073	<0.073	<0.073	<0.0011	<0.073	<0.0023	<0.073	<0.073	<0.073	<0.0011	<0.0011	<0.0023

Notes:
Concentrations expressed in milligrams per kilogram
NA - Not Analyzed
"<" indicates that the analytes was not detected at or above the given reporting limit



Note: This map was downloaded from the United States Geological Survey's records database for Station 12398000.

GEOSYNTEC CONSULTANTS

USGS STATION 12398000 LOCATION LEHIGH CEMENT COMPANY CLOSED CKD PILE SITE METALINE FALLS, WASHINGTON	EXHIBIT A-7
	PROJECT NO.: NPDES-ER
	DATE: MARCH 2006

2004 Water Year

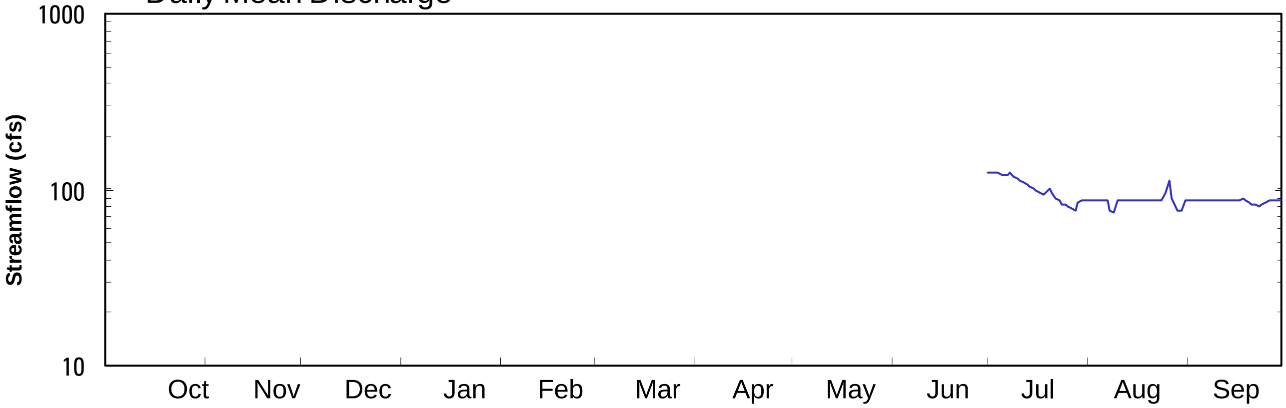
Pend Oreille River Basin

12398000 SULLIVAN CREEK AT METALINE FALLS, WA

Latitude: 48°51'37" Longitude: 117°21'47" Hydrologic Unit Code: 17010216

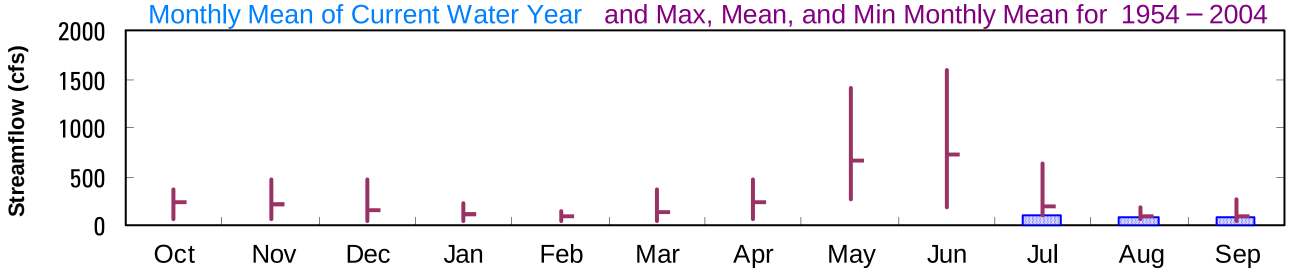
Pend Oreille County Drainage Area: 142 mi^2

Daily Mean Discharge

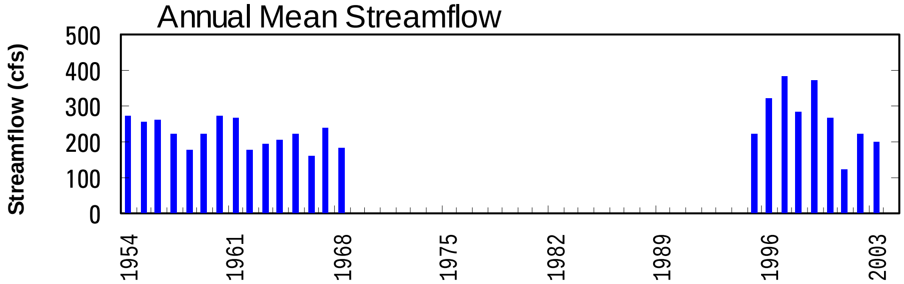


Monthly Statistics

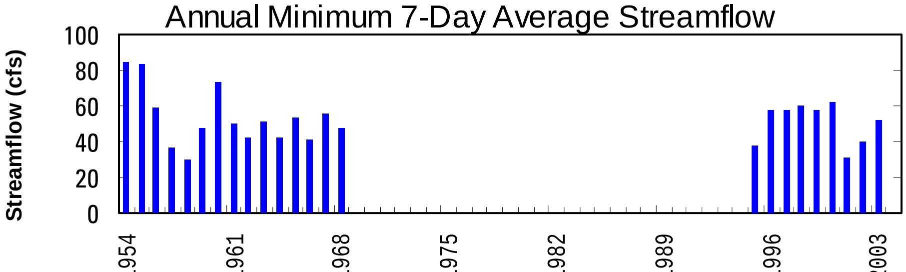
Monthly Mean of Current Water Year and Max, Mean, and Min Monthly Mean for 1954 – 2004



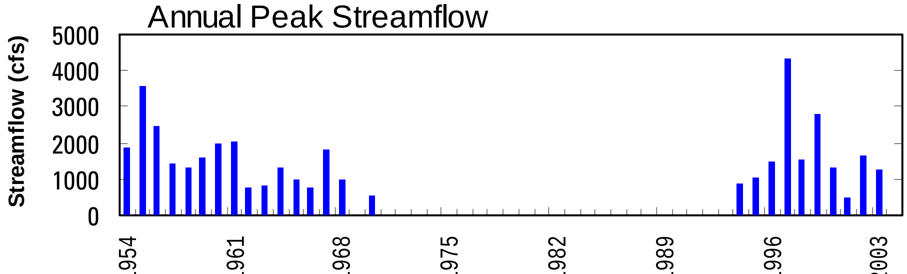
Annual Mean Streamflow



Annual Minimum 7-Day Average Streamflow



Annual Peak Streamflow



12398000 SULLIVAN CREEK AT METALINE FALLS, WA

LOCATION.--Lat 48°51'37", long 117°21'47", in SW$\frac{1}{4}$SW$\frac{1}{4}$, sec.22, T.39 N., R.43 E., Pend Oreille County, Hydrologic Unit 17010216, on left pier of State highway bridge, 0.5 mi upstream from mouth, 0.5 mi east of Metaline Falls, and at mile 0.5.

DRAINAGE AREA.--142 mi^2.

PERIOD OF RECORD.--October 1953 to November 1968, April 1994 to September 2003, July to September 2004.

GAGE.--Water-stage recorder. Elevation of gage is 2,050 ft above NGVD of 1929, from topographic map. Aug. 24, 1956, to November 1968, water-stage recorder 100 ft downstream, at different datum. Prior to Aug. 24, 1956, staff gage at site 20 ft upstream at different datum.

REMARKS.--No estimated daily discharges. Records fair except for those above 1,000 ft^3/s, which are poor. Some regulation by storage in Sullivan Lake. Small diversions upstream from station for municipal water supply.

AVERAGE DISCHARGE.--24 years (water years 1954-68, 1995-2003), 239 ft^3/s, 172,800 acre-ft/yr.

EXTREMES FOR PERIOD OF RECORD.--Maximum discharge observed, 4,350 ft^3/s, June 1, 1997, gage height, 4.38 ft; minimum discharge, 7.3 ft^3/s, Jan. 1, 1958, result of freezeup; minimum daily discharge, 27 ft^3/s, Jan. 1, 1958.

EXTREMES FOR CURRENT YEAR.--Maximum discharge for the period July to September, 132 ft^3/s, July 3, gage height, 0.41 ft; minimum discharge, 71 ft^3/s, Aug. 9.

DISCHARGE, CUBIC FEET PER SECOND
WATER YEAR OCTOBER 2003 TO SEPTEMBER 2004
DAILY MEAN VALUES

DAY	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1	---	---	---	---	---	---	---	---	---	126	87	87
2	---	---	---	---	---	---	---	---	---	124	87	87
3	---	---	---	---	---	---	---	---	---	124	87	87
4	---	---	---	---	---	---	---	---	---	126	87	87
5	---	---	---	---	---	---	---	---	---	123	87	87
6	---	---	---	---	---	---	---	---	---	120	87	87
7	---	---	---	---	---	---	---	---	---	123	87	87
8	---	---	---	---	---	---	---	---	---	124	76	87
9	---	---	---	---	---	---	---	---	---	118	75	87
10	---	---	---	---	---	---	---	---	---	115	86	87
11	---	---	---	---	---	---	---	---	---	111	87	87
12	---	---	---	---	---	---	---	---	---	109	87	87
13	---	---	---	---	---	---	---	---	---	106	87	86
14	---	---	---	---	---	---	---	---	---	104	87	86
15	---	---	---	---	---	---	---	---	---	101	87	87
16	---	---	---	---	---	---	---	---	---	98	87	87
17	---	---	---	---	---	---	---	---	---	96	87	87
18	---	---	---	---	---	---	---	---	---	94	87	89
19	---	---	---	---	---	---	---	---	---	96	87	87
20	---	---	---	---	---	---	---	---	---	101	87	84
21	---	---	---	---	---	---	---	---	---	96	87	82
22	---	---	---	---	---	---	---	---	---	90	87	82
23	---	---	---	---	---	---	---	---	---	87	87	81
24	---	---	---	---	---	---	---	---	---	83	87	82
25	---	---	---	---	---	---	---	---	---	82	95	85
26	---	---	---	---	---	---	---	---	---	80	111	86
27	---	---	---	---	---	---	---	---	---	78	90	87
28	---	---	---	---	---	---	---	---	---	77	81	87
29	---	---	---	---	---	---	---	---	---	84	77	87
30	---	---	---	---	---	---	---	---	---	87	77	86
31	---	---	---	---	---	---	---	---	---	86	87	---
TOTAL	---	---	---	---	---	---	---	---	---	3,169	2,682	2,582
MEAN	---	---	---	---	---	---	---	---	---	102	86.5	86.1
MAX	---	---	---	---	---	---	---	---	---	126	111	89
MIN	---	---	---	---	---	---	---	---	---	77	75	81
AC-FT	---	---	---	---	---	---	---	---	---	6,290	5,320	5,120
CFSM	---	---	---	---	---	---	---	---	---	0.72	0.61	0.61
IN.	---	---	---	---	---	---	---	---	---	0.83	0.70	0.68

STATISTICS OF MONTHLY MEAN DATA FOR WATER YEARS 1954 - 2004, BY WATER YEAR (WY)

	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
MEAN	228	213	144	93.1	79.5	115	218	663	714	190	85.8	86.1
MAX	370	460	465	230	147	360	463	1,398	1,590	630	183	262
(WY)	(1967)	(1996)	(1960)	(1957)	(1959)	(1959)	(1956)	(1997)	(1999)	(1999)	(1999)	(1957)
MIN	55.4	52.7	44.6	40.8	35.6	42.2	65.9	266	189	92.5	54.3	43.0
(WY)	(1959)	(1957)	(1958)	(1958)	(2001)	(2001)	(2001)	(2001)	(2001)	(2001)	(2001)	(2001)

12398000 SULLIVAN CREEK AT METALINE FALLS, WA—Continued

SUMMARY STATISTICS	WATER YEARS 1954 - 2004	
ANNUAL MEAN	239	
HIGHEST ANNUAL MEAN	386	1997
LOWEST ANNUAL MEAN	121	2001
HIGHEST DAILY MEAN	4,020	Jun 1, 1997
LOWEST DAILY MEAN	27	Jan 1, 1958
ANNUAL SEVEN-DAY MINIMUM	30	Dec 31, 1957
ANNUAL RUNOFF (AC-FT)	172,800	
ANNUAL RUNOFF (CFSM)	1.68	
ANNUAL RUNOFF (INCHES)	22.82	
10 PERCENT EXCEEDS	549	
50 PERCENT EXCEEDS	114	
90 PERCENT EXCEEDS	56	

12398000 SULLIVAN CREEK AT METALINE FALLS, WA

LOCATION.--Lat 48°51'37", long 117°21'47", in SW 1/4 SW 1/4 sec.22, T.39 N., R.43 E., Pend Oreille County, Hydrologic Unit 17010216, on left pier of State highway bridge, 0.5 mi upstream from mouth, 0.5 mi east of Metaline Falls and at mile 0.5.

DRAINAGE AREA.--142 mi^2.

PERIOD OF RECORD.--October 1953 to November 1968, April 1994 to current year.

GAGE.--Water-stage recorder. Elevation of gage is 2,050 ft above NGVD of 1929, from topographic map. Aug. 24, 1956, to November 1968, water-stage recorder 100 ft downstream, at different datum. Prior to Aug. 24, 1956, staff gage at site 20 ft upstream at different datum.

REMARKS.--No estimated daily discharges. Records fair except for those above 1,000 ft^3/s, which are poor. Some regulation by storage in Sullivan Lake. Small diversions upstream from station for municipal water supply.

AVERAGE DISCHARGE.--24 years (water years 1954-68, 1995-2003), 239 ft^3/s, 172,800 acre-ft/yr.

EXTREMES FOR PERIOD OF RECORD.--Maximum discharge observed, 4,350 ft^3/s June 1, 1997, gage height, 4.38 ft; minimum discharge, 7.3 ft^3/s Jan. 1, 1958, result of freezeup; minimum daily discharge, 27 ft^3/s Jan. 1, 1958.

EXTREMES FOR CURRENT YEAR.--Maximum discharge, 1,250 ft^3/s May 31, gage height, 2.23 ft, minimum discharge, 50 ft^3/s Dec. 9, Jan. 10, and Sept. 30.

DISCHARGE, CUBIC FEET PER SECOND
WATER YEAR OCTOBER 2002 TO SEPTEMBER 2003
DAILY MEAN VALUES

DAY	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1	125	333	61	63	82	66	223	329	1,030	199	72	56
2	309	326	59	67	81	66	160	346	873	157	71	55
3	348	316	59	75	80	64	157	364	746	139	71	55
4	368	303	57	71	77	62	153	376	636	128	71	54
5	363	304	56	72	72	63	148	374	626	124	70	54
6	358	312	55	68	68	61	142	360	670	120	69	54
7	352	314	54	63	76	59	137	333	680	117	71	54
8	364	314	53	61	76	58	134	310	673	115	73	61
9	378	301	52	59	73	60	139	301	676	112	69	72
10	372	280	53	53	72	60	147	294	664	109	67	61
11	367	263	54	58	69	60	163	296	628	106	66	58
12	363	262	54	65	68	65	197	315	590	104	65	59
13	357	255	60	64	69	120	214	335	567	102	64	57
14	351	235	74	63	71	149	243	389	542	100	63	56
15	357	212	135	60	70	149	257	446	512	97	63	55
16	376	191	120	58	75	191	254	431	484	95	63	56
17	369	165	110	56	75	208	254	398	462	92	64	59
18	374	143	97	56	73	204	252	366	443	90	62	57
19	380	138	87	56	71	202	240	330	425	88	61	56
20	375	125	81	57	73	200	232	306	400	86	60	55
21	368	116	76	55	74	203	242	290	394	84	59	55
22	360	108	76	56	72	266	279	291	386	83	59	54
23	359	100	73	57	64	326	321	334	387	82	60	54
24	363	88	70	57	58	324	359	456	358	80	59	53
25	356	79	68	57	63	307	421	874	342	79	58	53
26	345	76	68	72	67	300	420	1,040	315	78	57	52
27	337	71	67	92	68	287	394	911	295	77	57	52
28	344	67	65	84	67	270	363	912	280	76	57	52
29	343	66	65	77	---	253	348	1,010	269	75	57	52
30	324	63	62	77	---	243	329	938	245	74	56	51
31	323	---	65	80	---	247	---	983	---	73	56	---
TOTAL	10,828	5,926	2,186	2,009	2,004	5,193	7,322	15,038	15,598	3,141	1,970	1,672
MEAN	349	198	70.5	64.8	71.6	168	244	485	520	101	63.5	55.7
MAX	380	333	135	92	82	326	421	1,040	1,030	199	73	72
MIN	125	63	52	53	58	58	134	290	245	73	56	51
AC-FT	21,480	11,750	4,340	3,980	3,970	10,300	14,520	29,830	30,940	6,230	3,910	3,320

STATISTICS OF MONTHLY MEAN DATA FOR WATER YEARS 1954 - 2003, BY WATER YEAR (WY)

	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
MEAN	228	213	144	93.1	79.5	115	218	663	714	193	85.7	86.1
MAX	370	460	465	230	147	360	463	1,398	1,590	630	183	262
(WY)	(1967)	(1996)	(1960)	(1957)	(1959)	(1959)	(1956)	(1997)	(1999)	(1999)	(1999)	(1957)
MIN	55.4	52.7	44.6	40.8	35.6	42.2	65.9	266	189	92.5	54.3	43.0
(WY)	(1959)	(1957)	(1958)	(1958)	(2001)	(2001)	(2001)	(2001)	(2001)	(2001)	(2001)	(2001)

SUMMARY STATISTICS	FOR 2002 CALENDAR YEAR		FOR 2003 WATER YEAR		WATER YEARS 1954 - 2003	
ANNUAL TOTAL	85,497		72,887			
	234		200		239	
HIGHEST ANNUAL MEAN						
LOWEST ANNUAL MEAN						
HIGHEST DAILY MEAN	1,410	May 29	1,040	May 26	4,020	Jun 1, 1997
LOWEST DAILY MEAN	52	Jan 1	51	Sep 30	27	Jan 1, 1958
ANNUAL SEVEN-DAY MINIMUM	54	Dec 6	52	Sep 24	30	Dec 31, 1957
ANNUAL RUNOFF (AC-FT)	169,600		144,600		172,800	
10 PERCENT EXCEEDS	534		388		549	
50 PERCENT EXCEEDS	102		97		114	
90 PERCENT EXCEEDS	61		56		56	

12398000 SULLIVAN CREEK AT METALINE FALLS, WA

LOCATION.--Lat 48°51'37", long 117°21'47", in SW $^{1}/_{4}$ SW $^{1}/_{4}$ sec.22, T.39 N., R.43 E., Pend Oreille County, Hydrologic Unit 17010216, on left pier of State highway bridge, 0.5 mi upstream from mouth, 0.5 mi east of Metaline Falls and at mile 0.5.

DRAINAGE AREA.--142 mi^2.

PERIOD OF RECORD.--October 1953 to November 1968, April 1994 to current year.

GAGE.--Water-stage recorder. Elevation of gage is 2,050 ft above NGVD of 1929, from topographic map. Aug. 24, 1956, to November 1968, water-stage recorder 100 ft downstream, at different datum. Prior to Aug. 24, 1956, staff gage at site 20 ft upstream at different datum.

REMARKS.--Records fair except for those above 1,000 ft^3/s, which are poor. Some regulation by storage in Sullivan Lake. Small diversions upstream from station for municipal water supply.

AVERAGE DISCHARGE.--23 years (water years 1954-68, 1995-2002), 240 ft^3/s, 174,000 acre-ft/yr.

EXTREMES FOR PERIOD OF RECORD.--Maximum discharge observed, 4,350 ft^3/s June 1, 1997, gage height, 4.38 ft; minimum discharge, 7.3 ft^3/s Jan. 1, 1958, result of freezeup; minimum daily discharge, 27 ft^3/s Jan. 1, 1958.

EXTREMES FOR CURRENT YEAR.--Maximum discharge, 1,670 ft^3/s May 28, gage height, 2.21 ft, minimum discharge, 39 ft^3/s Oct. 4, 5 and 7.

DISCHARGE, CUBIC FEET PER SECOND, WATER YEAR OCTOBER 2001 TO SEPTEMBER 2002
DAILY MEAN VALUES

DAY	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1	41	256	178	52	85	86	93	302	1240	310	92	67
2	41	248	159	57	84	83	90	360	1170	287	91	65
3	40	246	148	59	81	86	87	424	1190	263	89	69
4	40	243	137	57	80	86	88	430	1140	238	87	67
5	39	262	128	55	79	86	91	404	1160	225	86	64
6	39	286	124	57	79	83	100	372	1200	212	85	64
7	39	283	119	75	81	81	112	331	1100	201	84	63
8	40	296	110	171	81	79	110	300	988	271	82	62
9	41	299	104	156	78	82	107	278	883	278	81	62
10	42	295	94	140	78	87	119	261	739	244	80	61
11	46	291	93	135	78	89	128	251	694	232	79	61
12	45	287	85	137	69	90	151	252	728	218	77	60
13	45	293	91	135	75	87	227	277	793	208	76	59
14	47	324	95	128	72	85	481	361	894	202	75	59
15	45	357	83	111	70	86	520	380	924	191	75	59
16	43	380	86	107	72	87	418	375	913	174	73	59
17	43	385	96	109	74	84	347	393	834	167	72	61
18	42	368	79	101	72	82	310	439	831	161	71	64
19	42	359	79	108	72	84	284	514	826	152	70	61
20	42	353	74	110	72	83	267	836	711	142	70	59
21	43	346	73	109	71	76	265	988	656	138	70	59
22	72	342	70	102	81	83	285	1090	607	131	69	59
23	141	327	61	98	102	83	275	943	602	112	69	59
24	169	312	64	99	94	83	259	750	554	112	68	58
25	204	296	61	93	74	84	250	649	486	109	68	57
26	223	286	53	89	81	86	239	639	437	106	68	58
27	223	273	53	84	86	87	225	736	399	103	68	58
28	225	248	60	78	87	88	217	1150	372	100	67	57
29	224	222	63	70	---	87	220	1410	391	98	68	58
30	233	196	61	81	---	87	247	1340	343	97	71	64
31	249	---	59	85	---	90	---	1260	---	95	68	---
TOTAL	2848	8959	2840	3048	2208	2630	6612	18495	23805	5577	2349	1833
MEAN	91.87	298.6	91.61	98.32	78.86	84.84	220.4	596.6	793.5	179.9	75.77	61.10
MAX	249	385	178	171	102	90	520	1410	1240	310	92	69
MIN	39	196	53	52	69	76	87	251	343	95	67	57
AC-FT	5650	17770	5630	6050	4380	5220	13110	36680	47220	11060	4660	3640

STATISTICS OF MONTHLY MEAN DATA FOR WATER YEARS 1954 - 2002, BY WATER YEAR (WY)

	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
MEAN	223.2	213.5	147.3	94.37	79.86	112.3	216.5	670.1	721.6	197.0	86.65	87.39
MAX	370	460	465	230	147	360	463	1398	1590	630	183	262
(WY)	1967	1996	1960	1957	1959	1959	1956	1997	1999	1999	1999	1957
MIN	55.4	52.7	44.6	40.8	35.6	42.2	65.9	266	189	92.5	54.3	43.0
(WY)	1959	1957	1958	1958	2001	2001	2001	2001	2001	2001	2001	2001

SUMMARY STATISTICS	FOR 2001 CALENDAR YEAR		FOR 2002 WATER YEAR		WATER YEARS 1954 - 2002	
ANNUAL TOTAL	40053		81204			
ANNUAL MEAN	109.7		222.5		240.2	
HIGHEST ANNUAL MEAN					386	1997
LOWEST ANNUAL MEAN					121	2001
HIGHEST DAILY MEAN	449	May 25	1410	May 29	4020	Jun 1 1997
LOWEST DAILY MEAN	30	Feb 7	39	Oct 5	27	Jan 1 1958
ANNUAL SEVEN-DAY MINIMUM	31	Feb 5	40	Oct 2	30	Dec 31 1957
ANNUAL RUNOFF (AC-FT)	79450		161100		174000	
10 PERCENT EXCEEDS	273		534		557	
50 PERCENT EXCEEDS	57		96		115	
90 PERCENT EXCEEDS	38		59		56	

12398000 SULLIVAN CREEK AT METALINE FALLS, WA

LOCATION.--Lat 48°51'37", long 117°21'47", in SW $^{1}/_{4}$ SW $^{1}/_{4}$ sec.22, T.39 N., R.43 E., Pend Oreille County, Hydrologic Unit 17010216, on left pier of State highway bridge, 0.5 mi upstream from mouth, 0.5 mi east of Metaline Falls and at mile 0.5.

DRAINAGE AREA.--142 mi^2.

PERIOD OF RECORD.--October 1953 to November 1968, April 1994 to current year.

GAGE.--Water-stage recorder. Elevation of gage is 2,050 ft above sea level, from topographic map. Aug. 24, 1956, to November 1968, water-stage recorder 100 ft downstream, at different datum. Prior to Aug. 24, 1956, staff gage at site 20 ft upstream at different datum.

REMARKS.--Records fair except for those above 1,000 ft^3/s, which are poor. Some regulation by storage in Sullivan Lake. Small diversions upstream from station for municipal water supply.

AVERAGE DISCHARGE.--22 years (water years 1954-68, 1995-2001), 241 ft^3/s, 174,600 acre-ft/yr.

EXTREMES FOR PERIOD OF RECORD.--Maximum discharge observed, 4,350 ft^3/s June 1, 1997, gage height, 4.38 ft; minimum discharge, 7.3 ft^3/s Jan. 1, 1958, result of freezeup; minimum daily discharge, 27 ft^3/s Jan. 1, 1958.

EXTREMES FOR CURRENT YEAR.--Maximum discharge, 501 ft^3/s May 24, gage height, 1.63 ft, minimum daily discharge, 30 ft^3/s Feb. 7-10.

DISCHARGE, CUBIC FEET PER SECOND, WATER YEAR OCTOBER 2000 TO SEPTEMBER 2001
DAILY MEAN VALUES

DAY	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1	67	284	159	58	e35	37	45	158	238	129	71	46
2	73	279	155	57	e35	39	45	140	237	125	68	45
3	152	276	151	57	e34	38	45	131	214	120	66	45
4	223	276	147	56	e33	37	42	131	205	116	65	45
5	263	272	142	57	e33	38	42	144	201	113	65	45
6	264	264	142	56	e32	38	44	139	193	109	63	44
7	261	259	138	51	e30	38	43	139	187	107	61	44
8	257	256	134	51	e30	39	44	149	181	105	60	44
9	254	250	130	e52	e30	42	44	171	190	100	58	43
10	289	242	126	e50	e30	41	47	183	193	97	57	43
11	343	233	114	e48	e32	39	45	193	188	94	56	43
12	352	239	111	e47	e34	39	43	224	210	92	54	43
13	351	233	109	e46	e38	40	44	316	202	90	54	42
14	347	226	101	e44	e42	41	44	371	242	88	53	42
15	342	221	98	e43	39	39	43	383	245	86	52	42
16	341	219	91	e40	38	39	44	376	227	86	51	42
17	346	213	90	e36	38	39	46	332	214	88	50	42
18	339	210	85	e37	39	40	51	295	201	85	50	42
19	336	206	81	e38	38	46	55	274	192	83	49	41
20	334	199	74	e38	38	45	54	255	181	81	49	41
21	349	196	72	e38	38	42	54	242	170	85	49	41
22	332	192	72	e38	38	41	54	257	162	88	49	42
23	325	187	70	e38	38	41	56	325	154	83	51	41
24	320	189	70	e38	38	41	57	422	150	79	52	41
25	315	183	68	e38	38	46	68	449	170	78	49	40
26	310	180	65	e37	36	63	95	419	154	75	48	47
27	307	177	64	e35	37	55	114	391	148	72	48	47
28	306	169	62	e34	37	50	191	381	146	76	47	43
29	303	167	60	e35	---	46	205	330	139	86	47	42
30	296	163	58	e35	---	43	174	280	135	77	46	41
31	290	---	58	e35	---	45	---	252	---	73	46	---
TOTAL	8987	6660	3097	1363	998	1307	1978	8252	5669	2866	1684	1289
MEAN	290	222	99.9	44.0	35.6	42.2	65.9	266	189	92.5	54.3	43.0
MAX	352	284	159	58	42	63	205	449	245	129	71	47
MIN	67	163	58	34	30	37	42	131	135	72	46	40
AC-FT	17830	13210	6140	2700	1980	2590	3920	16370	11240	5680	3340	2560

STATISTICS OF MONTHLY MEAN DATA FOR WATER YEARS 1954 - 2001, BY WATER YEAR (WY)

	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
MEAN	229	210	150	94.2	79.9	114	216	673	718	198	87.1	88.5
MAX	370	460	465	230	147	360	463	1398	1590	630	183	262
(WY)	1967	1996	1960	1957	1959	1959	1956	1997	1999	1999	1999	1957
MIN	55.4	52.7	44.6	40.8	35.6	42.2	65.9	266	189	92.5	54.3	43.0
(WY)	1959	1957	1958	1958	2001	2001	2001	2001	2001	2001	2001	2001

SUMMARY STATISTICS	FOR 2000 CALENDAR YEAR		FOR 2001 WATER YEAR		WATER YEARS 1954 - 2001	
ANNUAL TOTAL	94431		44150			
ANNUAL MEAN	258		121		241	
HIGHEST ANNUAL MEAN					386	1997
LOWEST ANNUAL MEAN					121	2001
HIGHEST DAILY MEAN	1260	Jun 7	449	May 25	4020	Jun 1 1997
LOWEST DAILY MEAN	58	Dec 30	30	Feb 7	27	Jan 1 1958
ANNUAL SEVEN-DAY MINIMUM	62	Sep 24	31	Feb 5	30	Dec 31 1957
ANNUAL RUNOFF (AC-FT)	187300		87570		174600	
10 PERCENT EXCEEDS	672		282		555	
50 PERCENT EXCEEDS	122		68		115	
90 PERCENT EXCEEDS	69		38		56	

e Estimated

12398000 SULLIVAN CREEK AT METALINE FALLS, WA

LOCATION.--Lat 48°51'37", long 117°21'47", in SW $^1/_4$ SW $^1/_4$ sec.22, T.39 N., R.43 E., Pend Oreille County, Hydrologic Unit 17010216, on left pier of State highway bridge, 0.5 mi upstream from mouth, 0.5 mi east of Metaline Falls and at mile 0.5.

DRAINAGE AREA.--142 mi^2.

PERIOD OF RECORD.--October 1953 to November 1968, April 1994 to current year.

GAGE.--Water-stage recorder. Elevation of gage is 2,050 ft above sea level, from topographic map. Aug. 24, 1956, to November 1968, water-stage recorder 100 ft downstream, at different datum. Prior to Aug. 24, 1956, staff gage at site 20 ft upstream at different datum.

REMARKS.--No estimated daily discharges. Records fair except for those above 1,000 ft^3/s, which are poor. Some regulation by storage in Sullivan Lake. Small diversions upstream from station for municipal water supply.

AVERAGE DISCHARGE.--21 years (water years 1954-68, 1995-2000), 247 ft^3/s, 178,800 acre-ft/yr.

EXTREMES FOR PERIOD OF RECORD.--Maximum discharge observed, 4,350 ft^3/s June 1, 1997, gage height, 4.38 ft; minimum discharge, 7.3 ft^3/s Jan. 1, 1958, result of freezeup; minimum daily discharge, 27 ft^3/s Jan. 1, 1958.

EXTREMES FOR CURRENT YEAR.--Maximum discharge, 1,340 ft^3/s June 7, gage height, 2.15 ft, maximum gage height, 2.17 ft May 22; minimum discharge, 55 ft^3/s Jan. 31.

DISCHARGE, CUBIC FEET PER SECOND, WATER YEAR OCTOBER 1999 TO SEPTEMBER 2000
DAILY MEAN VALUES

DAY	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1	401	253	213	88	78	84	121	582	741	388	103	66
2	397	246	227	87	75	83	140	652	784	373	100	69
3	391	240	233	84	72	85	154	761	808	339	99	80
4	387	234	212	88	70	104	178	809	888	300	98	74
5	382	228	211	86	71	110	204	724	1060	278	96	71
6	371	227	206	83	70	109	203	657	1210	255	94	69
7	367	225	194	84	70	108	184	605	1260	238	93	67
8	372	218	175	85	77	105	174	572	1240	208	91	72
9	386	215	167	84	84	104	178	565	1250	209	90	85
10	361	231	155	75	77	103	203	556	1150	219	88	82
11	354	243	148	78	74	105	241	514	1060	198	86	76
12	355	309	143	78	75	105	286	483	1030	182	85	71
13	343	407	136	78	73	103	332	468	1110	166	84	69
14	337	380	125	79	72	108	368	461	1060	160	82	67
15	333	349	128	77	75	105	380	462	1060	156	80	65
16	325	323	129	77	72	106	404	499	955	151	79	65
17	320	312	125	75	64	105	409	577	862	146	78	64
18	314	295	127	68	69	105	415	713	826	142	77	63
19	310	282	116	66	72	108	424	795	765	139	75	63
20	304	276	108	67	69	103	466	844	648	134	77	62
21	299	262	108	80	79	105	497	961	606	129	75	73
22	294	247	106	80	79	105	546	1120	582	127	73	70
23	287	241	106	75	87	117	573	1110	556	124	71	64
24	283	237	101	67	84	115	534	1000	547	122	70	63
25	280	231	94	69	80	115	495	926	520	118	70	63
26	282	222	89	77	80	115	463	835	488	115	69	62
27	269	212	93	73	82	113	443	789	464	113	69	61
28	278	207	92	71	83	113	593	786	441	111	68	61
29	279	202	86	70	83	116	613	748	422	108	68	60
30	268	219	82	66	---	115	586	708	400	106	68	63
31	263	---	85	65	---	116	---	714	---	105	67	---
TOTAL	10192	7773	4320	2380	2196	3293	10807	21996	24793	5659	2523	2040
MEAN	329	259	139	76.8	75.7	106	360	710	826	183	81.4	68.0
MAX	401	407	233	88	87	117	613	1120	1260	388	103	85
MIN	263	202	82	65	64	83	121	461	400	105	67	60
AC-FT	20220	15420	8570	4720	4360	6530	21440	43630	49180	11220	5000	4050

STATISTICS OF MONTHLY MEAN DATA FOR WATER YEARS 1954 - 2000, BY WATER YEAR (WY)

	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
MEAN	226	209	152	96.6	82.0	117	224	692	743	203	88.6	90.6
MAX	370	460	465	230	147	360	463	1398	1590	630	183	262
(WY)	1967	1996	1960	1957	1959	1959	1956	1997	1999	1999	1999	1957
MIN	55.4	52.7	44.6	40.8	46.2	43.8	95.0	267	285	108	61.0	49.8
(WY)	1959	1957	1958	1958	1964	1964	1968	1955	1958	1994	1958	1995

SUMMARY STATISTICS	FOR 1999 CALENDAR YEAR		FOR 2000 WATER YEAR		WATER YEARS 1954 - 2000	
ANNUAL TOTAL	137786		97972			
ANNUAL MEAN	377		268		247	
HIGHEST ANNUAL MEAN					386	1997
LOWEST ANNUAL MEAN					161	1966
HIGHEST DAILY MEAN	2570	Jun 17	1260	Jun 7	4020	Jun 1 1997
LOWEST DAILY MEAN	69	Feb 20	60	Sep 29	27	Jan 1 1958
ANNUAL SEVEN-DAY MINIMUM	71	Feb 15	62	Sep 24	30	Dec 31 1957
ANNUAL RUNOFF (AC-FT)	273300		194300		178800	
10 PERCENT EXCEEDS	1160		672		575	
50 PERCENT EXCEEDS	207		135		117	
90 PERCENT EXCEEDS	80		70		58	

EXHIBIT A-8
MONTHLY MEAN SULLIVAN CREEK FLOW DATA
LEHIGH CEMENT COMPANY CLOSED CKD PILE SITE
METALINE FALLS, WASHINGTON

YEAR	Monthly mean streamflow (cubic feet per second)											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1953										109	105	107
1954	102	96	111	165	986	937	343	107	97.9	97	115	112
1955	107	109	108	144	267	1,404	394	115	95.1	95	90	100
1956	140	100	138	463	1,071	564	231	79.4	60.2	58.9	52.7	223
1957	230	65.5	63.9	183	885	391	138	80.9	262	271	79.8	44.6
1958	40.8	75.8	124	191	779	285	125	61	54.9	55.4	56.6	53.4
1959	64.1	147	360	254	481	865	142	78.9	94.9	126	118	465
1960	205	99.3	128	290	617	821	203	89.8	79.2	365	235	84.5
1961	58	57.8	57.9	143	931	987	129	83.5	72.3	164	57.1	284
1962	177	55.5	45.6	216	388	430	152	79.2	63.3	330	302	145
1963	87.5	97.4	69.5	128	484	366	167	80.6	62.8	334	233	84.5
1964	57.5	46.2	43.8	104	473	747	166	82.7	75.9	276	295	103
1965	64.4	56.2	64	202	531	618	134	91.9	206	323	152	67.7
1966	52.3	47.2	57.6	178	462	322	142	65.7	58	370	244	114
1967	85.6	84.2	88.5	132	462	979	163	73.5	58	336	254	74.1
1968	51.5	60.7	113	95	446	467	122	83.2	77.6			
1994					531	357	108	61.5	53.6	228	304	58.4
1995	48	70.9	191	179	690	628	134	69.7	49.8	187	460	401
1996	120	142	161	404	814	858	195	83.7	63.1	184	262	177
1997	88.3	68	156	313	1,398	1,392	307	124	147	310	378	214
1998	91.3	91.4	148	320	1,055	499	147	93.8	64.1	201	341	144
1999	81.2	75.6	119	230	759	1,590	630	183	129	329	259	139
2000	76.8	75.7	106	360	710	826	183	81.4	68	290	222	99.9
2001	44	35.6	42.2	65.9	266	189	92.5	54.3	43	91.9	299	91.6
2002	98.3	78.9	84.8	220	597	794	180	75.8	61.1	349	198	70.5
2003	64.8	71.6	168	244	485	520	101	63.5	55.7			
2004							102	86.5	86.1			
Mean of monthly streamflows	93.1	79.5	115	218	663	713	190	85.8	86.1	228	213	144

Source:
Records from United States Geological Survey, Station 12398000

EXHIBIT A-9
ANNUAL MEAN SULLIVAN CREEK FLOW DATA
LEHIGH CEMENT COMPANY CLOSED CKD PILE SITE
METALINE FALLS, WASHINGTON

YEAR	ANNUAL MEAN SULLIVAN CREEK FLOW (cubic feet per second)
1954	273
1955	252
1956	266
1957	226
1958	159
1959	267
1960	268
1961	253
1962	199
1963	183
1964	206
1965	209
1966	177
1967	232
1995	260
1996	288
1997	409
1998	267
1999	377
2000	258
2001	110
2002	234

Source:
Records from United States Geological Survey, Station 12398000

ESTIMATED GROUNDWATER FLOW CAPTURED BY THE FUNNEL-AND-GATE SYSTEM LEHIGH CEMENT COMPANY CLOSED CKD PILE METALINE FALLS, WASHINGTON

Objective

The preliminary calculations described in this document are intended to estimate flowrate of groundwater that will be captured by the funnel-and-gate system, which is part of the Remedy. The approximated flowrate of groundwater captured by the Remedy can be estimated as the groundwater intercepted by the groundwater barriers walls and French drain.

Calculation Approach

The approach used for calculating the groundwater flow to the Remedy included:

- Evaluate historical groundwater potentiometric surface maps to develop an understanding of the groundwater flow direction and gradient. The November 2004 data, which are representative of Site conditions, were used in this analysis;

- Evaluate the locations of nearby groundwater wells and boreholes with groundwater surface elevation data (November 2004) and aquitard elevation data (from borehole logs) that can be used to estimate groundwater flow;

- Generate two cross-sections based on the information from the first two bullets that are approximately perpendicular to groundwater flow (see Attachment 1). Two cross-sections were used to calculate separate flowrates for comparison purposes; and

- Apply Darcy's law for steady flow along a flow line (i.e., through the two cross-sections described in the previous bullet). This flow line represents an estimate of the groundwater that will be captured by the funnel-and-gate system for treatment by the Remedy.

<u>Analysis</u>

Cross-sections 1 and 2 are shown on Attachment 1. Approximate characteristics of the two cross sections are:

Length, L_{total} = 750 ft
Nearby groundwater gradient, i = 0.036 ft/ft

Each of the two cross-sections was drawn in the immediate vicinity of five existing groundwater wells. The cross-sections were extended to the approximate lateral extant of the zone that will be captured by the funnel-and-gate system of the Remedy. Sectional end points were assigned. The distance between the groundwater surface elevation and aquitard elevation at each location was taken to be representative of the saturated thickness of the aquifer. The saturated thicknesses were used in combination with the lengths of the cross-section to estimate the approximate flow area for each cross-section. The flow area, cross-section length, and gradient were used to estimate the flowrate according to Darcy's law, Equation 1.

$$Q = K \cdot A \cdot i \qquad (1)$$

Where:
Q = Groundwater volumetric flowrate
K = horizontal hydraulic conductivity
A = area normal to groundwater flow (flow area)
i = nearby groundwater gradient

Flow areas were calculated using available lithologic information from borings that were installed approximately along the cross-section alignment. The total cross-section flow area was calculated by adding the flow areas between consecutive borings along the cross-section. The flow area was calculated between consecutive data points using a trapezoidal area equation (Equation 2).

$$A_{ij} = \frac{l}{2}(h_i + h_j) \tag{2}$$

Where:
A_{ij} = flow area between consecutive data points
l = distance between consecutive data points
h_i = saturated thickness at i
h_j = saturated thickness at j

The tables below summarize the calculation procedure.

<u>Cross-section 1</u>:

Point	Water Level (ft AMSL)	Aquitard Elevation (ft AMSL)	h_i (ft)	l (ft)	A_{ij} (ft^2)
End			7.40		
MW8	2029.28	2019.80	9.48	100	845
PM14	2028.62	2017.57	11.05	130	1335
MW9	2028.70	2015.34	13.36	70	855
PM2	2024.10	2021.45	2.65	100	800
PM18	2021.20	2013.82	7.38	210	1050
End			13.00	140	1430
				Total (A_1)	**6315**

<u>Cross-section 2</u>:

Point	Water Level (ft AMSL)	Aquitard Elevation (ft AMSL)	h_i (ft)	l (ft)	A_{ij} (ft^2)
End			15.70		
MW7	2030.37	2016.19	14.18	40	600
PM8	2025.41	2020.45	4.96	250	2390
PM6	2024.84	2020.74	4.10	100	455
PM20	2020.77	2017.09	3.68	140	545
PM19	2020.21	2009.13	11.08	180	1330
End			12.72	40	480
				Total (A_2)	**5800**

Existing horizontal hydraulic conductivity values from the immediate vicinity of cross-sections 1 and 2 are summarized below.

$K_{PM\text{-}16} = 1.74 \times 10^{-2}$ ft/ min to 6.60×10^{-2} ft / min [GeoSyntec, 2005]

$K_{MW-7} = 1.67 \times 10^{-2}$ ft/ min [Dames and Moore, 1993]
$K_{MW-8} = 1.68 \times 10^{-2}$ ft/ min [Dames and Moore, 1993]

Results

Using Equation 1, the ranges of estimated groundwater flow through Section 1 and Section 2 were calculated according to the procedures described in this document. The results are summarized in tables below.

Cross-Section 1 (A = 6,315 ft^2)

Range	K (ft/min)	Q (ft^3/min)	Q (gal/min)	Q (ft^3/s)
High	6.60×10^{-2}	15	110	0.25
Low	1.67×10^{-2}	3.9	28	0.07

Cross-Section 2: (A = 5,800 ft^2)

Range	K (ft/min)	Q (ft^3/min)	Q (gal/min)	Q (ft^3/s)
High	6.60×10^{-2}	14	100	0.23
Low	1.67×10^{-2}	3.5	26	0.06

Thus, according to the preliminary calculations shown in this document, the estimated groundwater flowrate that will be captured by the funnel-and-gate system is between 3.5 and 15 cubic feet per minute.

Limitations and Assumptions

The approach presented in this document is an estimation procedure to calculate the groundwater flow that will be intercepted by the Remedy funnel-and-gate system. The assumptions and limitations associated with the estimation procedure include:

- Horizontal hydraulic conductivity is uniform throughout the entire cross-section. The horizontal hydraulic conductivities used in this analysis were selected from groundwater wells in the vicinity of the cross-sections (see Appendix A of the Engineering Design Report). Additionally, boring logs indicate that subsurface materials are similar throughout the cross-sectional alignment, consisting of interbedded silty gravels, poorly-graded gravels, and sandy silts;

- The flow areas between consecutive data points were calculated assuming that the flow areas are trapezoidal. This implies that the slope of the groundwater surface elevations and aquitard elevations between data points is linear;

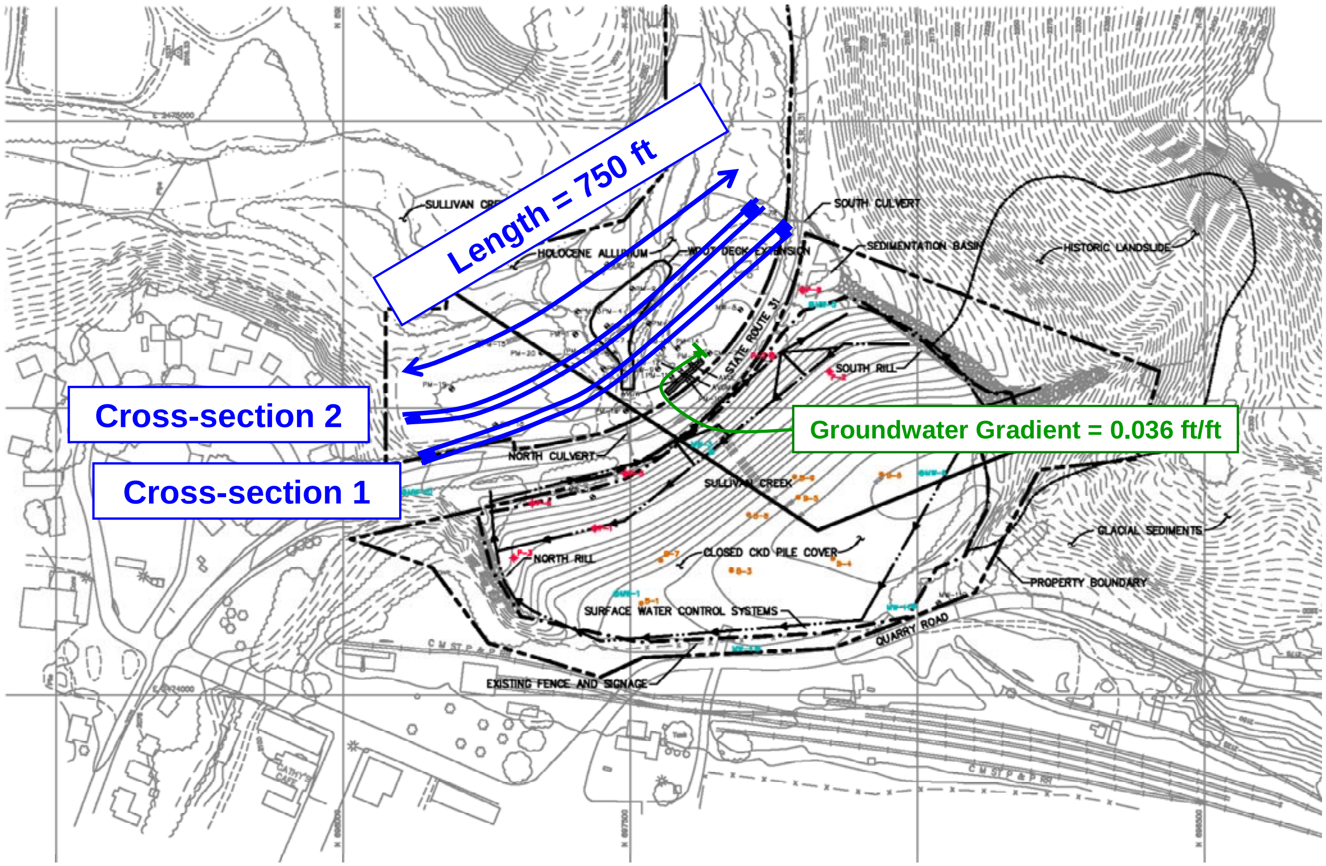
- Water flowing through the cross-sections will be intercepted by the French drain and groundwater cut off walls, and that no flow will bypass the funnel-and-gate system;

- The analysis used here assumes that groundwater conditions (e.g., gradient, groundwater table elevation, etc.) will not be affected by the Remedy. A more sophisticated analysis using a dynamic model may be used in future calculations to refine the estimated groundwater flowrate that will be captured by the funnel-and-gate system; and

- The methodology described in this document is an estimation of the hydraulic conditions at the Site based on existing data. The groundwater surface elevations used herein are from one point in time and likely fluctuate due to factors such as seasonality, infiltration, and year-to-year variability. The results presented here are useful for evaluating basic feasibility considerations and Remedy sizing calculations.

APPENDIX B, ATTACHMENT 1

ESTIMATED GROUNDWATER FLOW CAPTURED BY THE FUNNEL-AND-GATE SYSTEM
LEHIGH CEMENT COMPANY CLOSED CKD PILE
METALINE FALLS, WASHINGTON



PRELIMINARY ESTIMATED CARBON DIOXIDE TREATMENT NEEDS LEHIGH CEMENT COMPANY CLOSED CKD PILE SITE METALINE FALLS, WASHINGTON

Objective

The preliminary calculations described in this document estimate the carbon dioxide treatment dosage that will be used to neutralize the groundwater captured by the Groundwater Remedy.

Calculation Approach

The approach used to calculate the carbon dioxide dosage and delivery requirements for the Remedy included:

- Evaluate a recent groundwater pH contour map (November 2004) to evaluate the spatial distribution of groundwater pH concentrations in the immediate vicinity of the Remedy;

- Generate a cross-section that is approximately perpendicular to groundwater flow (cross-section 1 from *Estimated Groundwater Seepage Flow* preliminary calculations);

- Estimate the saturated thickness of the aquifer along the length of this cross-section by evaluating the data from the locations of nearby groundwater wells and boreholes. The groundwater surface elevation data (November 2004) and aquitard elevation data (from borehole logs) were used to estimate the saturated thicknesses;

- Calculate cross-sectional flow areas using the estimated saturated thickness results and the length of the cross-section. Combine the cross-sectional flow area (i.e. saturated thickness) with the corresponding pH concentration to calculate a weighted average of flow at each particular pH interval, and repeat this along the length of the cross-section; and

- Approximate with geochemical modeling (Geochemist's Workbench) the range of carbon dioxide dosages to treat groundwater of various pH. Use the range of carbon dioxide dosages to estimate the mass of carbon dioxide to treat each pH interval. The sum of the individual dosages represents an approximate carbon dioxide dosage that will treat the groundwater captured by the Remedy.

Analysis – Carbon Dioxide Treatment Needs

The table below summarizes the calculation procedure for estimating the carbon dioxide dosage requirements (see Attachment 1):

Area interval ID	**pH**	**Length of cross-section at given pH (ft)**	**Slope of Saturated Thickness (ft/ft)**	**Saturated thickness at start of given pH interval (ft)**	**Saturated thickness at end of given pH interval (ft)**	**Area at given pH (ft^2)**
End-MW8	8	100	0.021	7.40	9.48	**845**
MW8-MW14	8	70	0.012	9.48	10.33	**693**
MW8-MW14	9	60	0.012	10.33	11.05	**641**
PM14-MW9	9	60	0.033	11.05	13.03	**722**
PM14-MW9	11	10	0.033	13.03	13.36	**132**
MW9-PM2	11	90	-0.107	13.36	3.72	**769**
MW9-PM2	9	10	-0.107	3.72	2.65	**32**
PM2-PM18	9	20	0.023	2.65	3.10	**58**
PM2-PM18	8	60	0.023	3.10	4.45	**227**
PM2-PM18	9	90	0.023	4.45	6.48	**492**
PM2-PM18	11	40	0.023	6.48	7.38	**277**
PM18-End	11	80	0.040	7.38	10.59	**719**
PM18-End	13	60	0.040	10.59	13.00	**708**
					TOTAL	**6,315**

The cross-sectional flow areas at each given pH were added to estimate the pH interval flow areas shown in the table below:

pH	Area (ft^2)	Percentage of total flow area (%)
13	708	11.2%
11	1897	30.0%
9	1945	30.8%
8	1765	28.0%

The ranges of estimated groundwater flow calculated according to the procedures described in the *Estimated Groundwater Seepage Flow* preliminary calculations are summarized in table below:

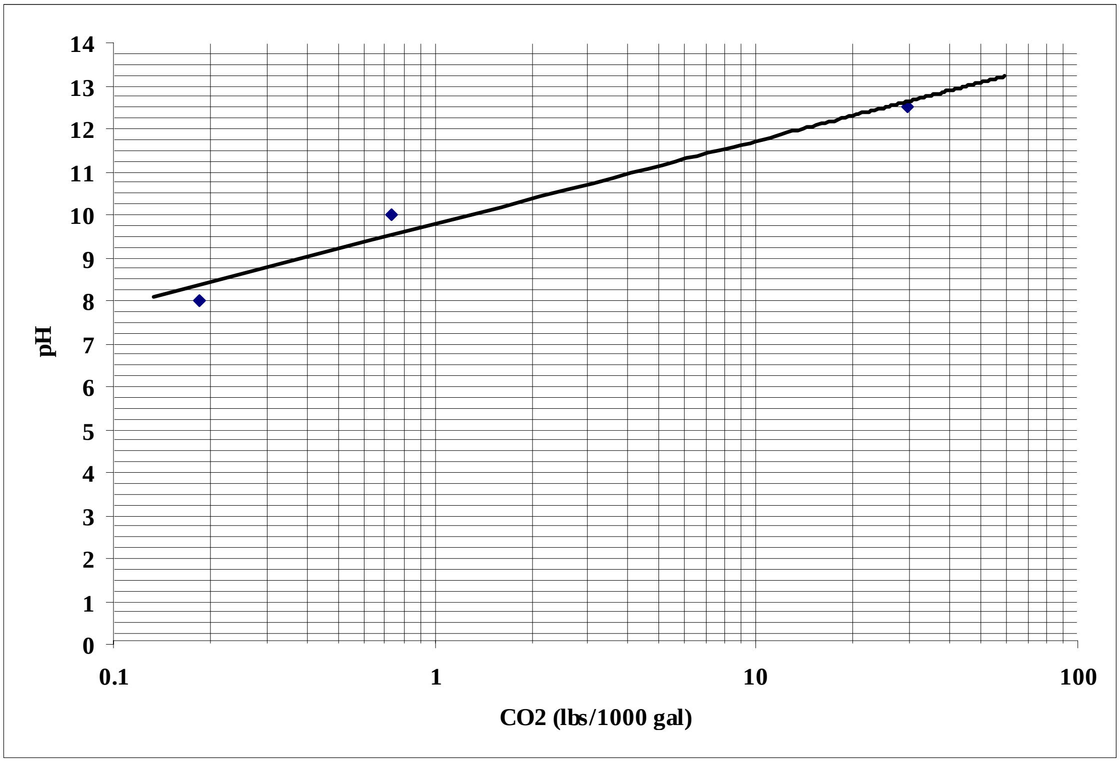
Range	K (ft/min)	Q (ft^3/min)
High	6.60×10^{-2}	15
Low	1.67×10^{-2}	3.9

Using the percentage distribution of pH according to total cross-sectional flow area, the total estimated groundwater at each pH interval can be calculated and is shown below:

Range	K (ft/min)	Q_{pH13} (ft^3/min)	Q_{pH11} (ft^3/min)	Q_{pH9}(ft^3/min)	Q_{pH8} (ft^3/min)
High	6.60×10^{-2}	1.7	4.5	4.6	4.2
Low	1.67×10^{-2}	0.44	1.17	1.20	1.09

The Geochemist's Workbench geochemical modeling package was used to estimate the mass of carbon dioxide needed to treat Site groundwater from a given pH to below pH of 7.5, which would meet the pH cleanup level for the Site (pH between 6.5 and 8.5). The carbon dioxide mass results are shown on the table below and the subsequent figure:

Site groundwater pH	**8**	**10**	**12.5**
Carbon Dioxide Dosage (lb/1000 gal)	0.18	0.74	29



From this graph, carbon dioxide loading rates (per 1000 gal of groundwater) can be estimated for specific pH values (note: some data points require interpolation or extrapolation). Based on the information shown in the graph, the carbon dioxide dosages for the pH intervals considered previously are summarized in the following table:

Site groundwater pH	**pH 13**	**pH 11**	**pH 9**	**pH 8**
lbs CO_2/1000 gal H_2O	44	4	0.4	0.2
lbs CO_2/ft^3 H_2O	0.3	0.03	0.003	0.001

Results – Carbon Dioxide Treatment Needs

The estimated carbon dioxide dosages for each pH interval were added together to calculate a total estimated carbon dioxide dosage to treat the groundwater captured by the Remedy. This calculation was performed using the anticipated high and low range of total flow captured by the Remedy and is shown in the following tables:

Individual dosage requirements according to pH interval:

		pH 13	pH 11	pH 9	pH 8
Range	**K (ft/min)**	**M_{co2}(lb/min)**	**M_{co2}(lb/min)**	**M_{co2}(lb/min)**	**M_{co2}(lb/min)**
High	6.60×10^{-2}	0.55	0.135	0.013	0.006
Low	1.67×10^{-2}	0.14	0.035	0.003	0.001

Total dosage requirements:

		TOTAL		
Range	**K (ft/min)**	**M_{co2}(lb/min)**	**M_{co2}(lb/hr)**	**M_{co2}(lb/day)**
High	6.60×10^{-2}	**0.70**	**42**	**1000**
Low	1.67×10^{-2}	**0.18**	**11**	**260**

Thus, according to the preliminary calculations shown in this document, the estimated carbon dioxide dosage that will be needed to treat the water captured by the Groundwater Remedy is between approximately 260 and 1,000 pounds per day.

The pilot system carbon dioxide usage rate has varied from approximately 30 lbs/day to 100 lbs/day during normal operation. The pilot system treats a segment of the CKD-affected groundwater that is approximately 80 ft wide. The preliminary estimated carbon dioxide treatment dosages calculated here are similar to the actual pilot system operating data. The mass carbon dioxide usage rates calculated here are likely underestimates, as they estimate the amount of carbon dioxide that will neutralize a given pH and therefore do not account for treatment system inefficiencies.

Limitations and Assumptions

The approach presented in this document is an estimation procedure to calculate the carbon dioxide required to treat the affected groundwater at the Lehigh Cement Company Closed CKD Pile Site. The estimation procedures are subject to several limitations and assumptions, including:

- The limitations and assumptions presented in the *Estimated Groundwater Seepage Flow* document;

- The carbon dioxide treatment needs approximated using Geochemists Workbench are a relatively accurate approximation of the actual carbon dioxide treatment needs; and

- The methodology described in this document is an estimation of the treatment needs for the Site groundwater based on existing data. The results presented here are useful for evaluating basic feasibility considerations and Groundwater Remedy sizing calculations.

APPENDIX C, ATTACHMENT 1

ESTIMATED GROUNDWATER pH INTERVALS
LEHIGH CEMENT COMPANY CLOSED CKD PILE
METALINE FALLS, WASHINGTON