REMEDIAL INVESTIGATION REPORT

CLOSED CITY OF YAKIMA LANDFILL SITE

YAKIMA, WASHINGTON

Prepared for

City of Yakima

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Remedial Investigation Report
Closed City of Yakima Landfill Site
Yakima, Washington

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EXECUTIVE SUMMARY

From January through April 2009, SLR International Corp (SLR) completed a remedial investigation (RI) at the closed City of Yakima Landfill (Yakima Landfill). The objectives of the work were to assess the potential environmental and geotechnical conditions that could require remedial action and/or affect potential future property development, and evaluate the land use development constraints associated with the structural capacities of the materials beneath the landfill area.

Extent and Thickness of Municipal Solid Waste

In 2008, Parametrix conducted a subsurface investigation at the Yakima Landfill and municipal solid waste (MSW) was encountered beneath the current southern log deck; however, the lateral extents of the waste were not well defined. To further delineate the extents of the MSW and other fill, the RI included the excavation of 56 test pits along the periphery of the estimated landfill area. MSW was observed in 36 of the test pits and the lateral extents of the waste were effectively delineated in the northern, southern, and western directions. Due to the presence of a drainage swale and a fence, test pits could not be excavated to delineate the eastern extents of the MSW; however, the eastern extent of the waste was estimated based on historical information. Based on the investigation results, the MSW extends from the north-central part of the log deck area to within 15 to 140 feet of the southern property line, and from near the eastern property line to at least 120 feet west of the log deck area. The MSW is also present in the southwestern part of the property and extends to near the western fence.

A total of 41 soil borings were drilled and sampled to delineate the vertical extents of the MSW. Based on the test pitting and drilling activities, MSW occurs at thicknesses of up to 15 feet, where present, and the average thickness is approximately 10 feet. The waste was thickest (greater than 12 feet thick) near the southwestern corner of the log deck, and along the western and southern edges of the log deck. The top of the MSW, where present, occurred at depths ranging from approximately 1.8 to 12 feet below ground surface (bgs), and the bottom of the MSW occurred at depths ranging from approximately 5 to 19.5 feet bgs. Based on the areal extent and thickness of the MSW, we estimate that a total volume of approximately 408,500 cubic yards of MSW are present in the Yakima Landfill.

Environmental Conditions

To evaluate the geochemical characteristics of the leachate from the waste material, five temporary wells were installed in soil borings advanced through the MSW, and leachate samples were collected from the wells. The leachate sample analytical results, as well as the groundwater sample analytical results (described below), were compared to the lowest groundwater screening levels based on protection of drinking water and protection of surface water (the shallow groundwater beneath the Yakima Landfill likely discharges to the Yakima River). The leachate sample analytical results showed that dissolved arsenic, dissolved manganese, dissolved iron, and dissolved sodium concentrations in at least three of the samples exceeded the groundwater screening levels. The pH concentrations in three of the samples were more acidic (lower) than the groundwater screening level range.

To assess the groundwater contaminant concentrations beneath the Yakima Landfill area, three groundwater monitoring wells (designated MW-11, MW-12, and MW-13) were installed at locations to the west and north of the landfill area, and groundwater samples were collected from the three new wells and three of the existing monitoring wells (MW-7, MW-8, and MW-9A). The groundwater sample analytical results showed that the samples from at least two of the wells contained dissolved manganese, dissolved iron, and dissolved arsenic concentrations that exceeded the groundwater screening levels, and/or pH concentrations that were more acidic than the groundwater screening level range. The sample from downgradient well MW-8 contained nitrate and sodium concentrations that exceeded the groundwater screening levels. The groundwater samples from all of the wells did not contain vinyl chloride concentrations greater than the method reporting limit (MRL); however, the MRL was slightly greater than the groundwater screening level. In 2008, groundwater samples from downgradient wells MW-7 and MW-8 contained vinyl chloride concentrations that exceeded the screening level.

Based on the leachate and groundwater sample analytical results, the primary source of the elevated dissolved manganese and dissolved iron concentrations and the acidic groundwater conditions is likely not the MSW. The primary source is located hydraulically upgradient (north-northwest) of the landfill area (likely associated with the former Boise Cascade mill operations). A source upgradient of the landfill area is also contributing to the dissolved arsenic and dissolved sodium concentrations; however, the MSW also appears to be a source of arsenic and sodium. The source of the nitrate is likely MSW in the southern part of the landfill. There is currently not enough groundwater data to identify the source of the vinyl chloride; however, vinyl chloride is commonly associated with solid waste landfills. The former Boise Cascade mill operations is also a potential source of the vinyl chloride concentrations.

In February 2009, 10 soil vapor probes (designated GP-4 through GP-13) were installed and sampled to assess the combustible gas distribution along the periphery of the MSW. A previously installed probe (GP-3) was also sampled. For this investigation, the detected combustible gas was assumed to consist entirely of methane. The greatest methane concentrations (51.6 and 58.5 percent) were detected at the soil vapor probes (GP-11 and GP-13) located in the log deck, and the concentrations appear to be primarily derived from a wood waste source. To the northwest, west, and southwest of the landfill area, the methane concentrations (15.4 to 22.6 percent) exceeded the upper explosive limit (UEL; 15 percent by volume) at probes GP-3, GP-4, GP-5, GP-10, and GP-12. MSW appears to be the primary source of the methane at GP-4, GP-5, GP-10, and GP-12. Since GP-3 and GP-10 are located less than 30 feet from the former plywood plant building, it is reasonable to assume that methane concentrations exceed the lower explosive limit (LEL; 5 percent by volume) in soils beneath at least portions of the building. To the south and northeast of the landfill area, the methane concentrations (0 to 0.1 percent) were below the LEL. In April 2009, five additional soil vapor probes (designated GP-14 through GP-18) were installed along the southwestern and western property lines to assess the methane concentrations that could be migrating off the property. The methane concentrations (0 to 0.2 percent) in GP-14 through G-18 were below the LEL. However, it is important to note that soil vapor migration can vary seasonally.

Geologic and Hydrogeologic Conditions

The subsurface materials encountered during the investigation included fill and alluvial gravel, sand, and silt. The fill materials consist of sand, silt, gravelly silt, sandy gravel, silty gravel, wood waste, and MSW. Fill materials extend to depths of as much as 24.5 feet bgs. Sandy gravel with cobbles, interpreted as native soil, is typically present below the fill materials. Locally, silty sand, silty gravel, or sandy silt occurs between the fill and sandy gravel units.

In February and April 2009, the depths to groundwater in the monitoring wells located near the Yakima Landfill ranged from 6.73 to 17.95 feet bgs. Beneath the landfill, the groundwater generally flows from the northwest to the southeast, towards the Yakima River. Groundwater flow near the eastern boundary of the landfill property appears to parallel the Yakima River channel, and the groundwater may not discharge to the river at a location near the property. Groundwater levels beneath the property may be affected by Yakima River stage.

Geotechnical Results

During the drilling activities, personnel from HWA GeoSciences, Inc. (HWA), a geotechnical engineering firm, collected soil samples for analysis of geotechnical properties. Based on geotechnical and physical testing results and field observations, HWA evaluated the structural capacities of the existing materials beneath the Yakima Landfill. In regards to settlement considerations for potential future structures at the property, the MSW is considered highly compressible and will exhibit unique settlement response characteristics. HWA concluded that the main geotechnical limitation to future property development is the potential for structural damage due to load-induced settlement of the underlying MSW, including differential (non-uniform) settlement beneath and between structures. Differential settlement would occur due to load variability and the inconsistent characteristics (e.g., density, moisture content), thicknesses, and compositions of the underlying waste.

HWA evaluated the leachate sample analytical results to assess the potential for sulfate reaction with any future Portland cement concrete structures and for chloride corrosion of steel reinforcements. They concluded that special requirements would not be needed for sulfate resistance and that special coatings or lower water/cement ratios would not be required for chloride effects.

1 INTRODUCTION

From January through April 2009, SLR International Corp (SLR) completed a remedial investigation (RI) at the closed City of Yakima Landfill (Yakima Landfill). The Yakima Landfill is located at the south end of the former Boise Cascade Sawmill and Plywood Facility (sawmill). The sawmill property is located at 805 North 7th Street, in the northeastern part of Yakima, Washington (see Figure 1). The objectives of the RI included the following:

- Assess potential environmental and geotechnical conditions that could require remedial action and/or affect potential future property development, including:
    - Extent, thickness, and total volume of the municipal solid waste (MSW)
    - Geotechnical properties of the soil beneath the landfill area
    - Combustible gas distribution along the periphery of the MSW
    - Contaminant concentrations in the shallow groundwater upgradient and downgradient of the landfill
    - Shallow groundwater flow gradients upgradient and beneath the landfill
    - Geochemical characteristics of the leachate from the fill (including MSW and wood waste) at the landfill
- Evaluate the land use development constraints associated with the structural capacities of the materials beneath the property

1.1 Background

The approximate 240-acre sawmill property was developed by the Cascade Lumber Company in 1903, and lumber mill operations commenced in 1904 (Parametrix, 2008). The Cascade Lumber Company merged with Boise Payette Lumber Company between 1957 and 1958 to form Boise Cascade. Boise Cascade closed the mill operations in 2006, and the property is currently used for temporary log storage and for log chipping. Log storage occurs over portions of the Yakima Landfill.

A 1920 Sanborn Fire Insurance map shows three log ponds, railroad tracks that run generally east-west (still present), a boiler house, and several other buildings at the sawmill property (Parametrix, 2008). The southern log pond encompassed approximately 70 percent of the sawmill property to the south of the railroad tracks [URS Corporation

(URS), 2003]. The sawmill operations gradually transitioned from using log ponds to log decks with sprinklers, and the southern log pond was drained and a large portion of the pond area was used as a landfill by the city of Yakima. Photographs of the drained log pond, prior to use by the city, are presented in Appendix A.

The city of Yakima reported to the Washington Department of Ecology (Ecology) that the landfill operated between 1963 and 1970 (City of Yakima, 1996); however, the Yakima County Health District has stated that the landfill was closed in 1972 (Ecology, 1996). Washington's minimum functional standards for solid waste handling, Chapter 173-301 WAC, were not adopted until October 26, 1972, and they took affect at the end of November 1972. Unless the Yakima Landfill closed at the very end of 1972, Washington regulations for municipal solid waste landfills were not in affect during the landfill's operating life.

1.2 Previous Environmental Assessments

In 1997, Ecology required Boise Cascade to conduct a hydrogeologic study of the sawmill property as part of the facility's wastewater discharge permit. In 1998, the hydrogeologic study was conducted by Landau Associates, Inc. (Landau), and included the installation and monitoring of six groundwater monitoring wells (designated MW-5 through MW-10), as well as the monitoring of three existing groundwater monitoring wells (designated MW-1, MW-3, and MW-4). Wells MW-6, MW-7, MW-8, and MW-9 were located in the southern part of the property, near the Yakima Landfill (see Figure 2). The groundwater monitoring data showed that the general flow direction of the shallow groundwater beneath the sawmill property was consistently to the southeast, towards the Yakima River (Landau, 1998).

In 2008, Parametrix conducted a subsurface investigation at the Yakima Landfill. The objectives of the work were to assess the groundwater conditions beneath the area, to estimate the extents of the MSW, and to assess the risks associated with methane generation and migration. The work consisted of a geophysical survey; excavating 14 test pits; drilling two soil borings; installing a groundwater monitoring well (designated MW-9A) in one of the borings to replace MW-9 (a dry well); installing and sampling a soil vapor probe (designated GP-3) in one of the borings; installing and sampling two soil vapor probes (designated GP-1 and GP-2) in two of the test pits; collecting groundwater samples from wells MW-7, MW-8, and MW-9A; and collecting soil vapor samples from all of the monitoring wells in central and southern parts of the property. The locations of monitoring well MW-9A and soil vapor probes GP-1, GP-2, and GP-3 are shown on Figure 2. The results of the investigation showed that groundwater samples from wells MW-7, MW-8, and MW-9A contained dissolved iron and dissolved manganese concentrations that exceeded the federal secondary maximum contaminant levels (MCLs). The groundwater samples from wells MW-7 and MW-8 contained vinyl chloride concentrations below the Model Toxics Control Act (MTCA) Method A cleanup level. Combustible gas (presumably methane) concentrations above the upper explosive limit (15 percent by volume) were detected at soil vapor probes (GP-1 and GP-3) located north of the Yakima Landfill (Parametrix, 2008). MSW was encountered beneath the log deck; however, the lateral extents of the waste were not well defined. The log deck is located to the east and southeast of the barker area, and is surrounded by an asphalt road and dirt road (see Figure 2).

2 INVESTIGATION ACTIVITIES

To meet the project objectives described in Section 1, the RI consisted of excavating test pits, drilling and sampling soil borings, installing and sampling soil vapor probes, installing and sampling groundwater monitoring wells, and surveying the investigation locations and selected property features. The fieldwork was conducted during January, February, and April 2009. The investigation activities were conducted in accordance with the procedures described in SLR's *Remedial Investigation Work Plan, Closed City of Yakima Landfill Site, Yakima, Washington*, dated January 15, 2009.

2.1 Assessment of Municipal Solid Waste

The RI included an assessment of the MSW in the closed Yakima Landfill to define the lateral extent and thickness of the waste. In addition, the composition of the waste and selected chemical characteristics were evaluated, and a focused analysis of selected geotechnical properties was performed. Leachate samples from the waste were collected to assess geochemical characteristics and to support the geotechnical analysis.

2.1.1 Define Lateral Extents and Thickness of MSW

From January 26 to February 12, 2009, a total of 56 test pits (designated TP-8 through TP-63) were excavated along the periphery of the estimated landfill area to further delineate the lateral extents of the MSW and other fill. The locations of the test pits are shown on Figure 2. Wyser Construction, Inc. (Wyser) of Snohomish, Washington, excavated the test pits under the direction of SLR personnel. The test pits were excavated to depths that typically ranged from approximately 6 to 14 feet below ground surface (bgs). During excavation of each test pit, SLR continuously logged the soils or wastes that were encountered in accordance with the Unified Soil Classification System. The visual and manual methods described in ATSM Method D-2488 were used for soil classification. After completing each test pit, Wyser backfilled the pit with the excavated material (at the same depths that it was removed). Test pit logs that describe the encountered materials are presented in Appendix B.

MSW was observed in 36 of the test pits and the lateral extents of the waste were effectively delineated in the northern, southern, and western directions. Due to the presence of a drainage swale and a fence, test pits could not be excavated to delineate the eastern extents of the MSW; however, the eastern extent of the waste was estimated based on the eastern extent of the drained log pond and the presence of Highway 82 prior to use of the property as a landfill (see historical photographs in Appendix A). Based on the investigation results, the MSW extends from the north-central part of the log deck area to within 15 to 140 feet of the southern property line, and from near the eastern property line to at least 120 feet west of the log deck area. The MSW is also present in the southwestern part of the property and extends to near the western fence. Near the southeastern corner of the property, the MSW appears to extend beyond the eastern property line. The estimated limits of the MSW are shown on Figure 2.

From February 9 to 23, 2009, a total of 41 soil borings (designated SB-1 through SB-41) were drilled and sampled to delineate the vertical extents of the MSW. The locations of the borings are shown on Figure 2. Cascade Drilling, Inc. (Cascade) of Woodinville, Washington, conducted the drilling activities under the direction of SLR personnel. The borings were drilled by using hollow-stem auger methods to depths ranging from approximately 14 to 23 feet bgs. During drilling, soil samples were collected at approximately 2.5-foot intervals by using a split-barrel sampler. SLR personnel logged the soils or wastes encountered during the drilling and sampling of each boring. Soil boring logs that describe the encountered materials are presented in Appendix B.

Upon completion of each boring, Cascade decommissioned the boring with hydrated bentonite chips. Soil cuttings derived from the drilling were thinly spread near the boring location. Waste material in the cuttings was placed in plastic bags and disposed in a facility dumpster.

Based on the test pitting and drilling activities, MSW occurs at thicknesses of up to 15 feet, where present, and the average thickness is approximately 10 feet. The waste was thickest (greater than 12 feet thick) near the southwestern corner of the log deck, and along the western and southern edges of the log deck. An isopach map of the MSW thickness is presented on Figure 3. The top of the MSW, where present, occurred at depths ranging from approximately 1.8 to 12 feet bgs, and the bottom of the MSW occurred at depths ranging from approximately 5 to 19.5 feet bgs. The MSW thickness at each boring and test pit location is presented in Table 1.

Based on the areal extent and thickness of the MSW, we estimate that a total volume of approximately 408,500 cubic yards of MSW are present in the Yakima Landfill. During the investigation, a geotechnical engineering firm, HWA Geosciences, Inc. (HWA), measured the bulk densities of the MSW. Based on the bulk density measurements, HWA estimated a conversion factor of 1,890 pounds (0.945 tons) per cubic yard. Based on the total estimated volume of MSW and the conversion factor, the total mass of the MSW in the landfill is approximately 386,000 tons. The bulk density measurements are included in HWA's Geotechnical Feasibility Assessment Report, dated April 8, 2009. The HWA report is presented in Appendix C.

2.1.2 Waste Composition and Characterization

During the drilling activities, HWA personnel collected 19 MSW samples for physical testing at their laboratory in Lynnwood, Washington. Based on their analysis of the samples, HWA estimates that the MSW is composed of approximately 21 percent Organic-Putrescible (OP) material (food, garden, and animal waste), 56 percent Organic Non-Putrescible (ON) material (paper, wood, textiles, leather, plastic, rubber, paints, and sludge), and approximately 23 percent Inorganic-Degradable (ID) materials (such as metals) and Inorganic Non-degradable (IN) material (glass, ceramics, soil, ash, concrete, etc.) by volume. A more complete description of the composition and physical characteristics of the MSW is presented in HWA's Geotechnical Feasibility Assessment Report (see Appendix C).

A total of eight waste samples and soil (fill and former pond sludge) samples from the test pits or borings were submitted to Friedman & Bruya, Inc. (F&B) in Seattle, Washington, to characterize the material for any future off-site disposal. The samples were analyzed for TCLP metals by USEPA Methods 1311/200.8 and TCLP volatile organic compounds (VOCs) by USEPA Methods 1311/8260B or 1311/624. The sample analytical results showed that metals and VOCs were not detected at concentrations that exceeded the TCLP limits. Based on these results, any excavated waste and soil would not be classified as hazardous waste. Copies of the laboratory analytical reports are presented in Appendix D.

2.1.3 Geotechnical Analysis

During the drilling activities, HWA personnel collected soil samples for analysis of geotechnical properties. A total of 29 samples collected from fill soil and native soil were analyzed by HWA's lab for grain size distribution by using ASTM Method D422 with particle size analysis and/or hydrometer testing, and for moisture content testing by using ASTM Method D2216. In addition, five soil samples were analyzed for liquid limit, plastic limit (Atterberg limit), and plasticity index by using ASTM Method D4318. The geotechnical analytical results are presented in HWA's Geotechnical Feasibility Assessment Report (see Appendix C).

2.1.4 Leachate Sampling

To evaluate the geochemical characteristics of the leachate from the waste material, Cascade installed temporary wells in borings (SB-11, SB-13, SB-16, SB-18 and SB-19) advanced through the MSW. Each 2-inch-diameter, Schedule 40 PVC well was completed approximately 3 feet below the groundwater table beneath the MSW, and was constructed with a 5-foot-long screen that had 0.010-inch wide slots. After installation, SLR personnel purged at least one casing volume from the well by using a bailer. During purging and immediately prior to sampling, the pH, specific conductivity, redox potential, dissolved oxygen, and temperature of the purge water were measured. The samples were collected by SLR personnel using a peristaltic pump and dedicated tubing. The samples for dissolved metals analysis were filtered in the field, and the samples for all other analyses were unfiltered. After each leachate sample was collected, Cascade removed the well and abandoned the boring with bentonite chips that were hydrated concurrent with placement. The leachate samples were submitted to F&B for selected geochemical properties, including:

- pH by USEPA Methods 9040/9045
- Bicarbonate and carbonate by USEPA Method 310.1
- Anions (fluoride, chloride, nitrite, nitrate, bromine, soluble reactive phosphate, and sulfate) by USEPA Method 300.0
- Dissolved metals (arsenic, aluminum, barium, cadmium, calcium, chromium, cobalt, copper, iron, lead, magnesium, manganese, nickel, potassium, selenium, sodium, thallium, and zinc) by USEPA Method 200.8

The leachate and groundwater sample analytical results were compared to minimum groundwater screening levels based on protection of drinking water and protection of surface water (the shallow groundwater beneath the Yakima Landfill likely discharges to the Yakima River, as described in Section 2.6). The development and identification of the groundwater screening levels are presented in Appendix E. The leachate sample analytical results showed that except for dissolved arsenic, dissolved manganese, dissolved iron, dissolved sodium, and pH, all analyte concentrations in the leachate samples were below the groundwater screening levels or the method reporting limits (MRLs). All of the leachate samples contained dissolved arsenic concentrations [1.28 to 12.1 micrograms per liter (µg/L)], dissolved manganese concentrations (1,150 to 2,530 µg/L), and dissolved iron concentrations (7,780 to 43,300 µg/L) that exceeded the screening levels (0.06, 50, and 300 µg/L, respectively). The leachate samples from borings SB-11, SB-13, SB-16, and SB-18 contained dissolved sodium concentrations (21,600 to 68,700 µg/L) that exceeded the groundwater screening level (20,000 µg/L). The leachate samples from borings SB-11, SB-16, and SB-19 contained pH values (6.28 to 6.47) that were outside of the screening level range (6.5 to 8.5). The sample analytical results are presented in Tables 2 and 3, and copies of the laboratory reports are presented in Appendix D.

HWA evaluated the leachate sample analytical results to assess the potential for sulfate reaction with any future Portland cement concrete structures and for chloride corrosion of steel reinforcements. They concluded that special requirements would not be needed for sulfate resistance and that special coatings or lower water/cement ratios would not be required for chloride effects. The results of the HWA evaluation of the leachate sampling results are presented in their Geotechnical Feasibility Assessment Report (see Appendix C).

2.2 Installation and Sampling of Soil Vapor Probes

After delineating the lateral extents of the municipal solid waste, 10 soil vapor probes (designated GP-4 through GP-13) were installed on February 17, 18, 19, and 23, 2009, to assess the combustible gas distribution along the periphery of the MSW. The soil vapor probes were located approximately 5 to 65 feet outside of the waste area, at locations to the west, northwest, north, south, and southwest of the area (see Figure 4). Cascade installed the soil vapor probes under the direction of SLR personnel.

The boring for each vapor probe installation was drilled by using hollow-stem auger methods. Soil samples were collected on a continuous basis or 2.5-foot intervals by using split-barrel sampling methods, and SLR continuously logged the soil encountered during drilling. Each 1-inch-diameter Schedule 40 PVC probe was constructed with a 2.5- to 5-foot-long screen (0.020-inch slots) within the unsaturated zone at depths equivalent to the zone of nearby MSW. A blank PVC riser was attached to the screen and extended a few feet above the ground surface. The top of each riser was completed with a quick-connect fitting to facilitate sample collection.

Except for probe GP-4, the bottom of each probe (including filter pack) was installed above the groundwater table. The bottom of GP-4 was installed at a depth of approximately 6 inches below the groundwater table. A filter pack consisting of 2x12 Colorado® silica sand was installed from at least 6 inches below the bottom screen slot to at least 6 inches above the uppermost screen slot. A hydrated bentonite chip seal was installed above the filter pack to approximately 2 feet bgs, and an aboveground steel casing was installed in concrete to protect the riser. In addition, three protective steel bollards were installed around the protective casing. Soil boring logs that describe the encountered materials and include the soil vapor probe construction details are presented in Appendix B.

On February 25, 2009, SLR personnel extracted and analyzed soil vapors from each new soil vapor probe and from previously installed probe GP-3 by using a CES/Landtec GEM-2000 multi-gas meter. Prior to the RI, GP-3 was the only probe that was installed by drilling methods and properly sealed. The combustible gas meter measured the percentages of oxygen, carbon dioxide, and combustible gas (reported as methane) in the extracted soil vapors. For this investigation, the detected combustible gas were assumed to consist entirely of methane.

Unless the Yakima Landfill closed in December 1972, which is unlikely, there were no regulations that addressed landfill gas in soil; therefore, no landfill gas regulations apply to the site. However, for practical purposes, WAC 173-351-200[1] regulations for landfill gas were used for this investigation to evaluate whether the methane conditions at the site

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[1] Washington Department of Ecology. 1993. Chapter 173-351 WAC, Criteria for Municipal Solid Waste Landfills. October 26.

are protective of human health and the environment. Under these regulations, the methane concentrations generated by a landfill must not exceed the lower explosive limit (LEL; 5 percent by volume) at the property boundaries. In addition, methane concentrations must not exceed 25 percent of the LEL (1.25 percent by volume) inside of structures located on land used for the disposal of solid waste, and must not exceed 100 parts per million (ppm) inside of structures located on adjacent properties. It is important to note that these landfill gas regulations only apply to gases generated by landfill waste and not to gases generated by other sources such as wood waste.

The methane concentrations measured in the soil vapor probes ranged from 0 to 58.5 percent. The greatest methane concentrations (51.6 and 58.5 percent) were detected at the soil vapor probes (GP-11 and GP-13) located in the log deck, and the concentrations appear to be primarily derived from a wood waste source. At GP-11 and GP-13, wood waste occurs at the depths of the screened interval of each probe. To the northwest, west, and southwest of the landfill area, the methane concentrations (15.4 to 22.6 percent) exceeded the upper explosive limit (UEL; 15 percent by volume) at probes GP-3, GP-4, GP-5, GP-10, and GP-12. To the south and northeast of the landfill area (at probes GP-6 through GP-9), the methane concentrations were 0 to 0.1 percent, which are below the LEL. The combustible gas survey results are presented in Table 4, and the methane concentrations are also shown on Figure 4.

Based on the methane concentrations greater than the UEL to the west and southwest of the landfill area, five additional soil vapor probes (designated GP-14 through GP-18) were installed along the southwestern and western property lines to assess the potential methane concentrations that could be migrating off the property. The locations of GP-14 through GP-18 are shown on Figure 5. On April 15 and 16, 2009, Cascade installed the soil vapor probes under the direction of SLR personnel. The boring for each vapor probe installation was drilled by using hollow-stem auger methods. Soil samples were collected on 2.5-foot intervals by using split-barrel sampling methods, and SLR continuously logged the soil encountered during drilling. Each 1-inch-diameter Schedule 40 PVC probe was constructed with a 10-foot-long screen (0.020-inch slots) that was installed within the unsaturated zone at depths of approximately 3 to 13 feet bgs. A blank PVC riser was attached to the screen and extended to approximately 3 inches below the ground surface. The top of each riser was completed with a quick-connect fitting to allow the insertion of tubing for sample collection.

The bottom of each probe was installed above the groundwater table. A filter pack consisting of 2x12 Colorado® silica sand was installed from at least 6 inches below the bottom screen slot to at least 6 inches above the uppermost screen slot. A hydrated bentonite chip seal was installed above the filter pack to approximately 1 foot bgs, and a traffic-rated, flush-grade, steel monument was installed in concrete to protect the riser. Soil boring logs that describe the encountered materials and include the soil vapor probe construction details are presented in Appendix B.

On April 17, 2009, SLR extracted and analyzed soil vapors from probes GP-3 through GP-18 by using a CES/Landtec GEM-2000 multi-gas meter. The methane concentrations in April, which ranged from 0 to 53.7 percent, were similar to the February concentrations. The greatest methane concentrations (51.7 and 53.7 percent) were detected at the soil vapor probes (GP-11 and GP-13) located in the log deck. To the northwest, west, and southwest of the landfill area, the methane concentrations (16.2 to 32.4 percent) exceeded the UEL at probes GP-3, GP-4, GP-5, GP-10, and GP-12. Further to the west and southwest, along the property line, the methane concentrations (0 to 0.2 percent) were below the LEL. To the south and northeast of the landfill area (at probes GP-6 through GP-9), the methane concentrations (0.1 to 0.2 percent) were also below the LEL. The combustible gas survey results are presented in Table 4, and the methane concentrations for the April 17, 2009 monitoring event are also shown on Figure 5.

2.3 Installation, Monitoring, and Sampling of Groundwater Monitoring Wells

To assess the groundwater conditions at locations hydraulically upgradient (approximately northwest) of the Yakima Landfill, three groundwater monitoring wells (designated MW-11, MW-12, and MW-13) were installed at locations to the west and north of the landfill area (see Figure 2). The wells were also used to evaluate the shallow groundwater flow patterns near and beneath the landfill area.

On February 16 and 17, 2009, Cascade conducted the drilling activities under the direction of SLR personnel. The borings were drilled by using hollow-stem auger methods to a depth of approximately 22 feet bgs. During drilling, soil samples were collected at approximately 2.5-foot intervals by using a split-barrel sampler. SLR personnel logged the soils encountered during the drilling and sampling of each boring. Each 2-inch-diameter Schedule 40 PVC well was constructed using a 15-foot-long screen with 0.020-inch slots that intercepts the shallow groundwater table. A filter pack consisting of 16x30 Colorado® silica sand was installed from at least 6 inches below the bottom screen slot to approximately 2 feet above the uppermost screen slot. A hydrated bentonite chip seal was installed above the filter pack to approximately 2 feet bgs, and an aboveground steel casing was installed in concrete to protect the riser. In addition, three protective steel bollards were installed around the protective casing. Soil boring logs that describe the encountered materials and include the well construction details are presented in Appendix B.

Cascade developed each new monitoring well by using surging and bailing methods to remove fine-grained materials and ensure hydraulic continuity between the well screen and formation materials. All drilling equipment was decontaminated by steam cleaning after completing each well.

To assess the groundwater contaminant concentrations beneath the Yakima Landfill area, SLR personnel collected groundwater samples from the three new monitoring wells (MW-11, MW-12, and MW-13) and three of the existing monitoring wells (MW-7, MW-8, and MW-9A) for laboratory analysis. Each well was purged and sampled by using low-flow methods with a peristaltic pump and new polyethylene tubing. During purging and immediately prior to sampling, SLR measured the pH, specific conductivity, redox potential, dissolved oxygen, and temperature of the purge water. The samples were submitted to F&B for analysis of the following:

- VOCs by USEPA Method 8260B
- Semi-volatile organic compounds (SVOCs) by USEPA Method 8270D
- Polychlorinated biphenyls (PCBs) by USEPA Method 8082
- Total petroleum hydrocarbons (TPH) as gasoline (TPH-G) by Ecology Method NWTPH-Gx
- TPH as diesel (TPH-D) and as oil (TPH-O) by Ecology Method NWTPH-Dx (after silica gel cleanup)
- Dissolved metals (arsenic, barium, cadmium, calcium, chromium, cobalt, copper, iron, lead, magnesium, manganese, nickel, potassium, selenium, sodium, thallium, and zinc) by USEPA Method 200.8
- Alkalinity, bicarbonate, and carbonate by USEPA Method 310.1
- Anions (fluoride, chloride, nitrite, nitrate, bromide, soluble reactive phosphate, and sulfate) by USEPA Method 300.0
- pH by USEPA Method 150.1

The samples for dissolved metals analysis were filtered in the field, and the samples for all other analyses were unfiltered.

2.3.1 Groundwater Monitoring Results

On February 26, 2009, prior to collecting the groundwater samples, SLR personnel measured the depths to groundwater in the wells being sampled and in monitoring well MW-6 by using an electronic water level meter. The depths to groundwater in the wells ranged from 10.66 to 20.70 feet.

On April 17, 2009, SLR personnel measured the depths to groundwater in monitoring wells MW-6, MW-7, MW-8, MW-9A, MW-11, MW-12, and MW-13. The depths to groundwater in the wells ranged from 9.76 to 20.23 feet. The depth to groundwater measurements from February 26 and April 17, 2009, were converted to groundwater elevations based on the results of a survey conducted by Gray Surveying & Engineering, Inc. (see Section 2.4) to evaluate the groundwater flow patterns near and beneath the landfill area. A discussion of the groundwater flow patterns is presented in Section 2.6. The depth to groundwater measurements and groundwater elevations from this investigation, as well as from previous investigations, are presented in Table 5.

2.3.2 Groundwater Sample Analytical Results

The groundwater sample analytical results showed that the samples from all of the monitoring wells, except MW-9A, contained dissolved manganese concentrations (503 to 2,380 µg/L) and dissolved iron concentrations (3,300 to 24,100 µg/L) that exceeded the groundwater screening levels (50 and 300 µg/L, respectively). The groundwater samples from wells MW-7 and MW-11 contained dissolved arsenic concentrations (3.83 and 4.33 µg/L, respectively) that exceeded the groundwater screening level (0.06 µg/L). The groundwater sample from well MW-8 contained a nitrate concentration [14.4 milligrams per liter (mg/L)] and a dissolved sodium concentration (27,000 µg/L) that exceeded the groundwater screening levels (10 mg/L and 20,000 µg/L, respectively). The groundwater samples from MW-7, MW-11, MW-12, and MW-13 contained pH values (6.01 to 6.49) that were outside of the screening level range (6.5 to 8.5). VOCs (including vinyl chloride) and SVOCs were not detected in any of the groundwater samples at concentrations above the screening levels or MRLs. PCBs, TPH-G, TPH-D, and TPH-O were not detected in any of the groundwater samples at concentrations above the MRLs. The groundwater sample analytical results [for dissolved metals and conventionals (pH, bicarbonate, carbonate, and anions) only] are presented in Tables 6 and 7, respectively, and copies of the laboratory reports are presented in Appendix D.

2.3.3 Waste Disposal

The decontamination water, development water, and sampling purge water that were generated from the investigation activities were temporarily stored at the southern part of the Boise Cascade property in properly labeled, 55-gallon drums. After obtaining a temporary permit from the City of Yakima, the water was drained into the city's sanitary sewer system.

2.4 Surveying

Gray Surveying & Engineering, Inc., a licensed surveyor from Yakima, Washington, surveyed the horizontal positions and vertical elevations of all of the investigation locations and selected property features (e.g., existing monitoring wells and soil vapor probes). They also surveyed the horizontal positions of the property boundaries, fences, railroad tracks, and the former plywood plant building. The horizontal positions were surveyed to the nearest 0.1-foot relative to Washington state plane coordinates (south zone). The vertical elevations of the ground surface at each of the investigation locations and the elevations of the tops of the well and soil vapor probe casings were surveyed to the nearest 0.01-foot, relative to the NAVD 88 datum.

2.5 Site Geology

The subsurface materials encountered during the investigation included fill and alluvial gravel, sand, and silt. The fill materials consist of sand, silt, gravelly silt, sandy gravel, silty gravel, wood waste, and MSW. Fill materials extend to depths of as much as 24.5 feet bgs. Sandy gravel with cobbles, interpreted as native soil, is typically present below the fill materials. Locally, silty sand, silty gravel, or sandy silt occurs between the fill and sandy gravel units.

Geologic cross sections were prepared to illustrate the distribution of soil and fill materials near and beneath the Yakima Landfill. The cross-section locations are shown on Figure 6, and the cross sections are presented on Figures 7 and 8. The cross sections and the bottom of the MSW elevation data presented in Table 1 show that the depth of the MSW throughout the landfill area is apparently above an elevation of 1,039 feet.

2.6 Site Hydrogeology

The groundwater monitoring data from the 1998 hydrogeologic study showed that the general flow direction of the shallow groundwater beneath the sawmill property was consistently to the southeast, towards the Yakima River (Landau, 1998). The Yakima River is located approximately 300 feet to the southeast of the southeastern corner of the landfill (see Figure 1).

In February and April 2009, the depths to groundwater in the monitoring wells located near the Yakima Landfill ranged from 9.76 to 20.70 feet below the tops of the well casings (6.73 to 17.95 feet bgs). The groundwater elevations in the wells ranged from 1,038.39 to 1,055.26 feet above the NAVD 88 datum. The depth to groundwater and groundwater elevation data from the 2009 monitoring events, as well as from the previous groundwater monitoring events at the landfill area, are presented in Table 5. Construction details of the monitoring wells that were used for evaluating groundwater flow during this investigation are presented in Table 8.

Based on the groundwater elevations in the wells on February 26, 2009, as well as the approximate groundwater elevations in the borings to install soil vapor probes GP-5 and GP-10 on Feburary 17 and 18, 2009, the interpreted groundwater elevation contours beneath the landfill area are presented on Figure 9. Beneath the landfill, the groundwater generally flows from the northwest to the southeast. Near the western edge of the landfill, groundwater flow appears to be radial from the area of well MW-13. The groundwater elevation data in this area suggest that a localized groundwater recharge source (such as the stormwater pond or a leaking underground pipe) is present in the vicinity of MW-13, and that the flow from the recharge area is constrained by the relative permeabilities of surrounding soils. The groundwater elevations in the wells on April 17, 2009, indicated a similar groundwater flow pattern as shown on Figure 9.

Based on the groundwater flow directions, the monitoring wells that are located directly upgradient of the MSW and can be used to define 'background' groundwater chemistry for the local recharge area include MW-12 and MW-13. Well MW-11 is located directly upgradient of the MSW and can be used to define 'background' groundwater chemistry for the wood waste area to the north of the MSW. Wells that are located downgradient of the MSW (and the wood waste) include MW-7 and MW-8. Although well MW-9A is located upgradient of the MSW, flow near MW-9A is primarily northward (radial from the recharge area that is located near MW-13) and the flow path from MW-9A towards the MSW cannot be defined using existing data. Therefore, groundwater samples from well MW-9A are not considered representative of 'background' groundwater chemistry relative to the MSW.

Since 1998, the measured depths to groundwater in the wells located near the northern edge of the landfill (MW-6 and MW-11) have ranged from approximately 9.5 to 17.5 feet bgs, and the measured depths to groundwater in the wells located near the southern edge of the landfill (MW-7 and MW-8) have ranged from approximately 2.5 to 8.0 feet bgs. The depths to groundwater in the recharge area (near MW-13 and potentially extending towards MW-12) have only been measured during 2009, and the groundwater occurs at depths of approximately 8.0 to 12.5 feet bgs. The groundwater elevations in the recharge area ranged from approximately 1,053 to 1,055 feet above the NAVD 88 datum. Beneath the landfill (outside of the recharge area), the groundwater elevations from 1998 through 2009 ranged from approximately 1,038 to 1,047 feet above the NAVD 88 datum. A comparison of groundwater elevation data and basal elevations of the MSW show that groundwater levels are generally at or below the base of the MSW. The interpreted groundwater elevations in February 2009 are depicted on the geologic cross sections (see Figures 7 and 8).

To evaluate potential influence of the Yakima River on the groundwater beneath the Yakima Landfill, SLR reviewed April 2008 through April 2009 water elevation data from Yakima River gaging stations located upstream and downstream of the landfill property. The upstream gage (USGS gaging station 12484500) is located located at Umtanum (approximately 20 miles north of the property) and the downstream gage (USGS gaging station 12500450) is located at Union Gap (approximately 8 miles south of the property). A graph of the 2008 and 2009 water elevations at these stations are presented in Appendix F. A comparison of the groundwater elevation data and the river elevations shows that groundwater levels beneath the landfill property are similar to the Yakima River elevations. Groundwater flow near the eastern boundary of the property apparently parallels the Yakima River channel, and the groundwater may not discharge to the river at a location near the property. Therefore, it is reasonable to assume that groundwater levels beneath the property may be affected by Yakima River stage.

3 EVALUATE STRUCTURAL CAPACITIES OF MATERIALS BENEATH LANDFILL AREA

Based on the geotechnical and physical testing results and field observations, HWA evaluated the structural capacities of the existing materials beneath the Yakima Landfill. The testing results and HWA's detailed evaluation of the structural concerns associated with potential future site development were presented in a Geotechnical Feasibility Assessment Report dated April 8, 2009. A copy of the HWA report is presented in Appendix C and a brief summary of the results of their evaluation is provided below.

In regards to settlement considerations for potential future structures at the property, the MSW is considered highly compressible and will exhibit unique settlement response characteristics. HWA concluded that the main geotechnical limitation to future property development is the potential for structural damage due to load-induced settlement of the underlying MSW, including differential (non-uniform) settlement beneath and between structures. Differential settlement would occur due to load variability and the inconsistent characteristics (e.g., density, moisture content), thicknesses, and compositions of the underlying waste. To mitigate potential adverse settlement effects on future structures, HWA recommended the construction of a surcharge preload for approximately 90 to 180 days in areas where grade-supported structures will be built and where utilities or ancilliary structures will be installed adjacent to pile-supported heavy structures. Depending on the location, size, and type, certain structures may be supported at grade within a suitably designed structural fill by using spread footings or rafted mat foundations. For large and/or tall buildings or for settlement-intolerant structures (e.g., swimming pools), deep foundation support such as auger-cast piles or low displacement driven steel piles should be utilized.

HWA also evaluated potential seismic considerations for the design of future structures. They concluded that based on the presence of relatively dense native alluvial soils, the potential for seismic liquification of the soil beneath the property is low.

4 CONCLUSIONS

From January through April 2009, SLR conducted a remedial investigation at the Yakima Landfill to meet the objectives described in Section 1. Based on the investigation results that were presented in Section 2, SLR presents the following conclusions related to the environmental conditions at the property.

- All of the leachate samples collected from temporary wells contained arsenic concentrations (6.39 to 12.1 μg/L) that exceeded the groundwater screening level (0.06 μg/L); however, the groundwater sample from a developed monitoring well (MW-11) located to the north (hydraulically upgradient) of the MSW also contained an arsenic concentration (4.33 μg/L) that exceeded the screening level. This indicates that there is a source of arsenic-impacted groundwater that is upgradient of the landfill. The higher arsenic concentrations in the leachate samples may be due to arsenic-bearing colloidal oxyhydroxides entering the undeveloped temporary wells or that the MSW may be contributing to the arsenic concentrations. The groundwater sample from one of the downgradient wells (MW-7) contained an arsenic concentration (3.83 μg/L) that exceeded the screening level but was lower than the concentrations in the leachate samples and in the sample from upgradient well MW-11.

- All of the leachate samples and all of the groundwater samples, except the samples from MW-9A, contained dissolved manganese concentrations (503 to 2,530 μg/L) that exceeded the groundwater screening level (50 μg/L). The manganese concentrations in samples from wells near the groundwater recharge area (MW-9A, MW-12, and MW-13) were significantly lower than manganese concentrations in the leachate samples and in the groundwater samples collected from wells located further from the recharge area (MW-7, MW-8, and MW-11). The groundwater sample from upgradient well MW-11 contained a dissolved manganese concentration (1,410 μg/L) that exceeded the screening level, indicating that there is a source of manganese-impacted groundwater upgradient of the landfill. Since the manganese concentrations in the leachate samples and the groundwater samples from the downgradient wells (MW-7 and MW-8) are of the same order of magnitude as manganese concentrations in the well upgradient of the MSW and downgradient of the wood waste area (MW-11), the MSW is not the only source, and is not likely the primary source of the elevated manganese concentrations.

- The leachate samples from borings SB-11, SB-16, and SB-19 contained pH values (6.28 to 6.47) that were outside of the groundwater screening level range (6.5 to 8.5); however, the groundwater samples from wells (MW-11 and MW-12) located to the north (hydraulically upgradient) of the MSW contained pH values (6.28 and 6.01, respectively) that were equal to or lower than the leachate pH values. This indicates that the primary source(s) of the acidic groundwater conditions is located hydraulically upgradient of the MSW.

- All of the leachate samples and all of the groundwater samples, except the samples from well MW-9A, contained dissolved iron concentrations (3,330 to 43,300 µg/L) that exceeded the groundwater screening level (300 µg/L). The groundwater sample from upgradient well MW-11 contained a dissolved iron concentration (24,100 µg/L) that exceeded the screening level, indicating that there is a source of iron-impacted groundwater upgradient of the landfill. Since the iron concentrations in the leachate samples and in the groundwater sample from downgradient well MW-7 are of the same order of magnitude as iron concentrations in the well upgradient of the MSW and downgradient of the wood waste area (MW-11), the MSW is not the only source, and is not likely the primary source of the elevated iron concentrations.

- The groundwater sample from downgradient well MW-8 contained a nitrate concentration (14.4 mg/L) that exceeded the groundwater screening level (10 mg/L). The other groundwater samples from this investigation and the 2008 investigation did not contain nitrate concentrations greater than 2.18 mg/L. The leachate samples only contained nitrate concentrations that ranged from 0.032 to 0.19 mg/L. Based on the groundwater and leachate concentrations, the source of the elevated nitrate concentration at MW-8 is likely MSW in the southern part of the landfill.

- The groundwater sample from downgradient well MW-8 and all of the leachate samples, except the sample from SB-19, contained dissolved sodium concentrations (21,600 to 68,700 µg/L) that exceeded the groundwater screening level (20,000 µg/L). The well located upgradient of the MSW (MW-11) contained a dissolved sodium concentration (15,300 µg/L) that was below the screening level. Since the dissolved sodium concentrations in the leachate samples and the groundwater sample from downgradient well MW-8 were greater (although within the same order of magnitude) than the dissolved sodium concentration in upgradient well MW-11, the MSW is likely a source of additional sodium.

- The groundwater samples from all of the wells did not contain vinyl chloride concentrations greater than the MRL (0.03 µg/L); however, the MRL was slightly greater than the groundwater screening level (0.025 µg/L). In 2008, groundwater samples from downgradient wells MW-7 and MW-8 contained vinyl chloride concentrations (0.060 and 0.034 µg/L, respectively) that exceeded the screening level. There is currently not enough groundwater data to identify the source of the vinyl choride.

- Preliminary groundwater indicator hazardous substances (IHSs) were selected by comparing the maximum detected concentrations with the lowest of the drinking water and surface water screening levels, and evaluating the frequency and patterns of detection (see Table 9). Based on this evaluation, the preliminary groundwater IHSs for the site are:

    - Arsenic
    - Iron
    - Manganese
    - Sodium
    - Nitrate
    - pH
    - Vinyl chloride

- The combustible gas (presumably methane) concentrations in soil vapor near the landfill were up to 58.5 percent; however, the greatest concentrations were at the soil vapor probes (GP-11 and GP-13) that are screened within wood waste. Therefore, it appears that wood waste is a significant source of methane at the landfill area.

- Methane concentrations (16.2 to 32.4 percent) in soil vapor exceeded the LEL at locations (probes GP-4, GP-5, and GP-10) where wood waste was not present. This indicates that the MSW is also a significant source of methane.

- Since the landfill extends beyond the eastern property line in a localized area near the southeastern corner of the property and the soil vapor sampling results indicate that the methane concentrations in the landfill exceed the LEL, the methane concentrations beyond the eastern property line (only near the southeastern corner of the property) likely exceed the allowable limit. The soil vapor sampling results indicate that methane concentrations in February and April 2009 are below the LEL at the southern and western property lines. It is important to note that soil vapor migration can vary seasonally.

- Since the Yakima Landfill is located within Boise Cascade property and the former plywood plant building is located less than 60 feet from the landfill, it is reasonable to consider the former plywood plant to be located on land used for the disposal of solid waste rather than on an adjacent property. Combustible gas measurements were not collected in the former plywood plant building; however, methane concentrations greater than the UEL (15 percent by volume) were measured in soil vapor probes (GP-3 and GP-10) located less than 30 feet from the building.

Therefore, it is likely that methane concentrations exceed the LEL in soils beneath at least portions of the building. It is also possible that methane concentrations exceed acceptable limits within portions of the building.

LIMITATIONS

The services described in this report were performed consistent with generally accepted professional consulting principles and practices. No other warranty, express or implied, is made. These services were performed consistent with our agreement with our client. This report is solely for the use and information of our client unless otherwise noted. Any reliance on this report by a third party is at such party's sole risk.

Opinions and recommendations contained in this report apply to conditions existing when services were performed and are intended only for the client, purposes, locations, time frames, and project parameters indicated. We are not responsible for the impacts of any changes in environmental standards, practices, or regulations subsequent to performance of services. We do not warrant the accuracy of information supplied by others, nor the use of segregated portions of this report.

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TABLES

Table 1
Thicknesses of Municipal Solid Waste
Closed City of Yakima Municipal Landfill
Yakima, Washington

Location	Ground Surface Elevation (Feet)	Approximate Elevation of Top of Wood Waste (Feet)	Approximate Elevation of Bottom of Wood Waste (Feet)	Approximate Elevation of Top of Municipal Solid Waste (Feet)	Approximate Elevation of Bottom of Municipal Solid Waste (Feet)	Approximate Thickness of Municipal Solid Waste (Feet)	Notes
TP-8	1062.46	1062.46	1057.5	1053.5	1050.5	>3.0	MSW extends beyond bottom of test pit.
TP-9	1064.84	1064.84	1058.8	1055.8	1053.8	>2.0	MSW extends beyond bottom of test pit.
TP-10	1069.30	1069.30	1061.3	1060.8	1058.8	>2.0	MSW extends beyond bottom of test pit.
TP-11	1057.05	NP		1050.1	1048.1	>2.0	MSW extends beyond bottom of test pit.
TP-12	1051.47	NP		1048.5	1044.5	>4.0	MSW extends beyond bottom of test pit.
TP-13	1060.09	1057.09	1052.6	NP			
TP-14	1059.88	1058.88 1054.88 1052.38	1056.9 1054.4 1051.9	NP			Three zones of wood waste.
TP-15	1045.95	NP		NP			
TP-16	1048.37	NP		NP			
TP-17	1049.89	NP		NP			
TP-18	1053.42	1053.42	1049.4	NP			
TP-19	1054.45	1054.45	1046.5	NP			
TP-20	1055.31	1055.31	1052.8	NP			
TP-21	1058.27	1058.27	1056.3	NP			
TP-22	1058.06	1058.06	1052.1	1050.6	1049.6	>1.0	MSW extends beyond bottom of test pit.
TP-23	1054.00	1054.00	1052.5	1050.5	1049.0	1.50	
TP-24	1050.72	NP		NP			
TP-25	1051.48	NP		1047.5	1046.0	1.50	
TP-26	1051.18	NP		1047.2	1046.2	1.00	
TP-27	1056.69	NP		1050.2	1047.7	2.50	
TP-28	1057.58	1056.58	1050.1	1050.1	1048.1	2.00	
TP-29	1061.49	1061.49	1059.5	1057.0	1056.0	>1.0	MSW extends beyond bottom of test pit.
TP-30	1062.24	1062.24	1061.7	1058.2	1055.2	>3.0	MSW extends beyond bottom of test pit.
TP-31	1063.25	NP		1059.8	1050.3	9.5	
TP-32	1063.34	NP		NP			
TP-33	1064.15	NP		1058.7	1054.7	>4.0	MSW extends beyond bottom of test pit.
TP-34	1063.54	NP		1061.0	1053.0	8.0	
TP-35	1063.46	NP		1058.5	1055.0	3.5	
TP-36	1063.74	1060.74	1059.2	1059.2	1052.7	>6.5	MSW extends beyond bottom of test pit.
TP-37	1064.40	NP		1059.9	1057.4	>2.5	MSW extends beyond bottom of test pit.
TP-38	1063.92	NP		1061.4	1057.4	>4.0	MSW extends beyond bottom of test pit.
TP-39	1064.62	1062.12	1061.6	1060.6	1056.6	>6.0	MSW extends beyond bottom of test pit.
TP-40	1064.41	1064.41	1062.9	1062.4	1058.4	>4.0	MSW extends beyond bottom of test pit.
TP-41	1065.59	1063.59 1055.59	1057.6 1049.6	NP			Two zones of wood waste.
TP-42	1065.27	1065.27	1063.3	NP			
TP-43	~1065.27	1065.27 1054.27	1055.8 1046.3	NP			MSW extends beyond bottom of test pit.
TP-44	1063.75	1059.25	1056.3	NP			MSW extends beyond bottom of test pit.
TP-45	1066.08	NP		NP			
TP-46	1069.76	1069.76	1051.3	NP			
TP-47	1069.84	1069.84	1046.8	NP			
TP-48	1069.66	1069.66	1048.7	NP			
TP-49	1069.44	1069.44	1044.9	NP			
TP-50	1069.10	1069.10	1055.1	NP			Wood waste extends beyond bottom of test pit.
TP-51	1062.58	1062.58	1057.6	1056.6	1050.1	>6.0	MSW extends beyond bottom of test pit.
TP-52	1064.43	1064.43	1060.4	1059.4	1054.4	>5.0	MSW extends beyond bottom of test pit.
TP-53	1066.08	1066.08	1062.1	NP			
TP-54	1070.81	1070.81	1058.8	NP			Wood waste extends beyond bottom of test pit.
TP-55	1069.59	1069.59	1056.6	NP			Wood waste extends beyond bottom of test pit.
TP-56	1069.22	1069.22	1063.2	NP			
TP-57*	1067.81	1067.81	1054.8	NP			Wood waste extends beyond bottom of test pit.
TP-58*	1065.54	1065.54	1048.0	NP			Wood waste extends beyond bottom of test pit.
TP-59	1065.63	1065.63	1061.6	NP			
TP-60	1071.78	1071.78 1061.78	1062.8 1059.8	NP			Two zones of wood waste. Wood waste extends beyond bottom of test pit.
TP-61	1067.55	1067.55	1061.6	1059.6	1055.6	>4.0	MSW extends beyond bottom of test pit.
TP-62	1065.44	1065.44	1053.4	NP			Wood waste extends beyond bottom of test pit.
TP-63	1065.00	NP		NP			

Table 1
Thicknesses of Municipal Solid Waste
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Yakima, Washington

Location	Ground Surface Elevation (Feet)	Approximate Elevation of Top of Wood Waste (Feet)	Approximate Elevation of Bottom of Wood Waste (Feet)	Approximate Elevation of Top of Municipal Solid Waste (Feet)	Approximate Elevation of Bottom of Municipal Solid Waste (Feet)	Approximate Thickness of Municipal Solid Waste (Feet)	Notes
SB-1	1053.37	NP		1050.4	1042.9	7.5	
SB-2	1054.95	1054.95	1048.0	1048.0	1041.5	6.5	
SB-3	1057.91	1056.61	1050.9	1045.9	1042.4	3.5	
SB-4	1059.17	1059.17	1048.7	1048.7	1044.7	4.0	
SB-5	1058.29	1057.99	1052.3	1052.3	1042.3	10.0	
SB-6	1060.02	1059.72	1059.0	1054.5	1044.5	10.0	
SB-7	1062.05	1062.05	1059.1	1058.6	1046.1	12.5	
SB-8	1063.18	NP		1053.7	1046.2	7.5	
SB-9	1062.66	1062.66	1060.2	1058.2	1053.2	5.0	
SB-10	1063.96	1063.96	1060.5	1058.0 1050.5	1057.0 1047.0	1.0 3.5	Two zones of MSW.
SB-11	1064.00	1064.00	1062.0	1059.5	1052.0	7.5	
SB-12	1063.26	1063.26	1060.3	1060.3	1045.3	15.0	
SB-13	1060.65	1060.65	1057.7	1057.7	1042.7	15.0	
SB-14	1060.74	1060.74	1057.2	1054.7	1042.7	12.0	
SB-15	1058.77	1058.77	1058.3	1051.8	1039.3	12.5	
SB-16	1056.25	NP		1051.8	1039.3	12.5	
SB-17	1053.21	NP		1047.2	1041.7	5.5	
SB-18	1064.27	1064.27	1058.3	1058.3	1045.3	13.0	
SB-19	1060.86	1060.86	1055.4	1053.9	1042.9	11.0	
SB-20	1062.25	1062.25	1057.8	1055.3	1046.8	8.5	
SB-21	1063.80	1063.80	1055.3	1054.3	1044.8	9.5	
SB-22	1058.85	1058.85	1058.4	1057.1	1051.9	5.2	
SB-23	1059.30	NP		1056.3	1052.3	4.0	
SB-24	1058.79	1057.29	1051.8	1051.8	1044.3	7.5	
SB-25	1058.01	NP		1051.0	1043.5	7.5	
SB-26	1058.50	NP		1054.0	1044.0	10.0	
SB-27	1063.45	1063.45	1059.0	1059.0	1050.5	8.5	
SB-28	1060.00	1060.00	1057.0	1054.5	1048.0	6.5	
SB-29	1068.95	1068.95 1060.95	1062.0 1048.0	1062.0	1061.0	1.0	Two zones of wood waste.
SB-30	1066.98	1066.98 1057.48	1059.0 1046.5	1059.0	1057.5	1.5	Two zones of wood waste.
SB-31	1063.77	1060.27	1059.3	1055.3	1049.3	6.0	
SB-32	1062.60	1062.60	1059.6	1059.1	1045.6	13.5	
SB-33	1063.90	1063.90	1058.4	1054.4	1044.4	10.0	
SB-34	1061.41	1061.41	1058.4	1054.4	1043.4	11.0	
SB-35	1060.03	1060.03	1053.5	1053.0	1042.0	11.0	
SB-36	1059.20	1059.20	1053.2	1052.2	1042.2	10.0	
SB-37	1063.93	1063.93	1058.4	1056.9	1049.4	7.5	
SB-38	1062.63	1062.63	1056.6	1053.6	1045.6	8.0	
SB-39	1061.64	1061.64	1057.1	1054.6	1044.6	10.0	
SB-40	1060.15	1060.15	1056.7	1055.7	1045.7	10.0	
SB-41	1064.60	1064.60	1063.1	1057.6	1045.1	12.5	
GP-4	1063.52	NP		NP			
GP-5	1063.31	NP		NP			
GP-6	1058.30	1058.30	1057.8	NP			
GP-7	1045.54	1045.54	1044.5	NP			
GP-8	1046.98	1046.98	1045.5	NP			
GP-9	1048.09	1048.09	1046.6	NP			
GP-10	1065.30	NP		NP			
GP-11	1065.58	1065.58 1057.08	1061.6 1050.1	NP			Wood waste extends beyond bottom of boring.
GP-12	1062.34	1062.34	1059.3	NP			
GP-13	1062.49	1062.49 1057.99	1059.5 1052.5	NP			Wood waste extends beyond bottom of boring.
MW-11	1063.19	1063.19	1048.7	NP			
MW-12	1065.73	NP		NP			
MW-13	1063.56	NP		NP			

NOTES:
All elevations relative to NAVD 88 datum.
* = Elevation adjusted 5 feet because ground surface elevation was surveyed after surficial wood waste was removed from area.
NP = No waste present.
MSW = Municipal solid waste.

Table 2
Leachate Sample Analytical Results - Dissolved Metals
Closed City of Yakima Municipal Landfill
Yakima, Washington

Sample ID	Date	Analytical Result[a] (µg/L)																
		Arsenic	Barium	Cadmium	Calcium	Cobalt	Copper	Chromium	Iron	Lead	Magnesium	Manganese	Nickel	Potassium	Selenium	Sodium	Thallium	Zinc
Lowest Groundwater Screening Level[b]		**0.06**	**1,000**	**0.34**	**NE**	**NE**	**17[c]**	**10[d]/258[c,e]**	**300**	**4.1[c]**	**NE**	**50**	**100[c]**	**NE**	**5**	**20,000**	**0.24**	**153[c]**
SB-11-Leachate	2/11/2009	**1.28**	50.4	<1[f]	30,100	<1	<1	<1	**7,780**	<1	12,800	**1,150**	1.66	6,870	<1	**21,600**	<1[f]	7.39
SB-13-Leachate	2/11/2009	**6.39**	121	<1[f]	55,200	2.20	2.32	1.20	**25,900**	<1	21,800	**2,390**	5.90	20,700	2.92	**68,700**	<1[f]	9.29
SB-16-Leachate	2/11/2009	**7.34**	131	<1[f]	44,800	1.34	<1	<1	**39,900**	<1	17,600	**1,330**	3.69	31,300	<1	**29,400**	<1[f]	4.63
SB-18-Leachate	2/12/2009	**8.10**	121	<1[f]	59,700	3.15	1.46	<1	**36,500**	<1	22,100	**2,530**	5.48	15,500	2.46	**46,500**	<1[f]	19.2
SB-19-Leachate	2/12/2009	**12.1**	91	<1[f]	45,000	1.30	<1	<1	**43,300**	<1	16,400	**1,940**	3.79	10,700	<1	18,600	<1[f]	6.97

Notes:

NE = Cleanup level not established.
µg/L = micrograms per liter (ppb).
Values in **bold** exceed the groundwater screening level.

[a] Samples analyzed by EPA Method 200.8.

[b] Groundwater screening levels were the lowest selected federal maximum contaminant level (MCL) for protection of drinking water or the lowest available state water quality criteria (WQC) for protection of surface water. If an MCL or a WQC were not available, then the screening level was obtained from the MTCA Method B equation for groundwater or surface water.

[c] Corrected for hardness.

[d] For Chromium VI.

[e] For Chromium III.

[f] Method reporting limits exceeded the screening level.

Table 3
Leachate Sample Analytical Results - Conventionals
Closed City of Yakima Municipal Landfill
Yakima, Washington

Sample ID	Date	Analytical Result (mg/L)										
		pH[a]	Alkalinity[b] (mg $CaCO_3$/L)	Carbonate[b] (mg $CaCO_3$/L)	Bicarbonate[b] (mg $CaCO_3$/L)	Bromide[c] (mg/L)	Chloride[c] (mg/L)	Fluoride[c] (mg/L)	Nitrate[c] (mg/L)	Nitrite[c] (mg/L)	SRP[c] (mg/L)	Sulfate[c] (mg/L)
Lowest Groundwater Screening Level[d]		**6.5 to 8.5**	**NE**	**NE**	**NE**	**NE**	**230**	**2**	**10**	**1**	**NE**	**250**
SB-11-Leachate	2/11/2009	**6.28**	234	<1	170	<0.3	10.5	0.37	0.032	<0.002	0.004	2.11
SB-13-Leachate	2/11/2009	6.55	326	<1	195	<0.3	128	0.37	0.12	0.003	0.004	29.1
SB-16-Leachate	2/11/2009	**6.47**	438	<1	229	<0.3	21.6	0.30	0.19	0.004	0.009	<1
SB-18-Leachate	2/12/2009	6.52	441	<1	223	<0.3	37.9	0.67	0.14	0.005	0.007	0.007
SB-19-Leachate	2/12/2009	**6.42**	301	<1	131	<0.3	13.5	0.50	0.13	0.006	0.005	1.40

Notes:

NE = Cleanup level not established.

mg/L = milligrams per liter (ppm).

Values in **bold** are outside of the screening level range.

SRP = Soluble reactive phosphate.

[a] Samples analyzed for pH by EPA Method 9040C.

[b] Samples analyzed for alkalinity, carbonate, and bicarbonate by EPA Method 310.1.

[c] Samples analyzed for bromide, chloride, fluoride, nitrate, nitrite, SRP, and sulfate by EPA Method 300.0.

[d] Groundwater screening levels were the lowest selected federal maximum contaminant level (MCL) for protection of drinking water or the lowest available state water quality criteria (WQC) for protection of surface water. If an MCL or a WQC were not available, then the screening level was obtained from the MTCA Method B equation for groundwater or surface water. Levels for pH are shown as a screening level range.

Table 4
Combustible Gas Survey Results
Closed City of Yakima Municipal Landfill
Yakima, Washington

Soil Vapor Probe ID	Date	Gas Concentration[a] (%)		
		Combustible Gas (Presumably Methane)	Carbon Dioxide	Oxygen
GP-3	2/24/2009	19.5	14.8	0.0
	4/17/2009	17.8	12.0	0.3
GP-4	2/25/2009	22.4	9.2	0.0
	4/17/2009	21.6	11.9	0.0
GP-5	2/25/2009	17.6	13.7	0.0
	4/17/2009	16.2	12.7	0.0
GP-6	2/25/2009	0.1	12.7	6.1
	4/17/2009	0.2	11.3	8.5
GP-7	2/25/2009	0.0	1.8	19.2
	4/17/2009	0.1	2.7	19.4
GP-8	2/25/2009	0.0	3.8	15.3
	4/17/2009	0.1	4.8	14.2
GP-9	2/25/2009	0.1	2.0	17.5
	4/17/2009	0.1	3.3	17.8
GP-10	2/25/2009	22.6	16.8	0.0
	4/17/2009	32.4	21.4	0.0
GP-11	2/25/2009	58.5	33.9	0.0
	4/17/2009	51.7	35.6	0.0
GP-12	2/25/2009	15.4	18.8	0.0
	4/17/2009	21.3	21.1	0.0
GP-13	2/25/2009	51.6	40.1	0.0
	4/17/2009	53.7	43.1	0.0
GP-14	4/17/2009	0.0	3.9	15.0
GP-15	4/17/2009	0.0	2.0	18.5
GP-16	4/17/2009	0.0	1.7	19.0
GP-17	4/17/2009	0.2	1.5	19.6
GP-18	4/17/2009	0.1	0.5	21.0

Notes:

Oxygen = O_2

The lower explosive limit (LEL) and upper explosive limit (UEL) for methane are 5 percent by volume and 15 percent by volume, respectively.

[a] Concentrations were measured by using a CES/Landtec GEM-2000 multi-gas monitor.

Table 5
Groundwater Monitoring Data
Closed City of Yakima Municipal Landfill
Yakima, Washington

Well ID	Well Elevation[a] (feet)	Date	Depth to Water[b] (feet)	Groundwater Elevation (feet)
MW-6	1059.68	7/28/1998	12.70	1046.98
		8/21/1998	12.39	1047.29
		9/21/1998	12.55	1047.13
		10/16/1998	13.34	1046.34
		10/10/2006	12.63	1047.05
		2/12/2007	14.20	1045.48
		2/7/2008	15.47	1044.21
		2/26/2009	14.94	1044.74
		4/17/2009	13.39	1046.29
MW-7	1049.05	7/28/1998	7.64	1041.41
		8/21/1998	7.68	1041.37
		9/21/1998	7.84	1041.21
		10/16/1998	8.45	1040.60
		10/10/2006	8.40	1040.65
		2/12/2007	10.06	1038.99
		2/7/2008	10.89	1038.16
		2/26/2009	10.66	1038.39
		4/17/2009	9.76	1039.29
MW-8	1051.59	7/28/1998	5.57	1046.02
		8/21/1998	5.54	1046.05
		9/21/1998	5.74	1045.85
		10/16/1998	6.19	1045.40
		2/6/2008	10.70	1040.89
		2/26/2009	10.97	1040.62
		4/17/2009	10.17	1041.42
MW-9A	1064.46	3/25/2008	16.85	1047.61
		2/26/2009	15.25	1049.21
		4/17/2009	12.19	1052.27
MW-11	1065.94	2/26/2009	20.70	1045.24
		4/17/2009	20.23	1045.71
MW-12	1068.53	2/26/2009	15.40	1053.13
		4/17/2009	15.34	1053.19
MW-13	1066.13	2/26/2009	10.87	1055.26
		4/17/2009	10.87	1055.26

Notes:

[a] Top of well casing surveyed to NAVD 88 datum by Gray Surveying & Engineering, Inc., in February 2009.

[b] Depth to water measured from top of well casing by using an electric water level meter.

Wells MW-6, MW-7, MW-8, MW-11, MW-12, and MW-13 are completed above ground and the top of each well casing is approximately 3 feet above the ground surface. Well MW-9A is a flush-grade completion. The ground surface elevation at each well location is listed in Table 8.

Table 6
Groundwater Sample Analytical Results - Dissolved Metals
Closed City of Yakima Municipal Landfill
Yakima, Washington

Well ID	Date[a]	Analytical Result[b] (µg/L)																
		Arsenic	Barium	Cadmium	Calcium	Cobalt	Copper	Chromium	Iron	Lead	Magnesium	Manganese	Nickel	Potassium	Selenium	Sodium	Thallium	Zinc
Lowest Groundwater Screening Level[c]		**0.06**	**1,000**	**0.34**	**NE**	**NE**	**17[d]**	**10[e]/258[d,f]**	**300**	**4.1[d]**	**NE**	**50**	**100[d]**	**NE**	**5**	**20,000**	**0.24**	**153[d]**
MW-7	2/6/2008	<50[g]	69	<2[g]	48,100	NA	NA	<5	**37,500**	<20[g]	NA	**2,520**	NA	11,400	<50[g]	**22,900**	NA	NA
	2/26/2009	**3.83**	67.2	<1[g]	39,900	<1	<1	<1	**23,700**	<1	15,000	**1,950**	2.4	11,200	<1	19,300	<1[g]	1.66
MW-8	2/6/2008	<50[g]	72	<2[g]	39,100	NA	NA	<5	**12,200**	<20[g]	NA	**2,340**	NA	29,900	<50[g]	**33,800**	NA	NA
	2/26/2009	<1[g]	78.7	<1[g]	35,400	4.4	<1	<1	**3,330**	<1	15,600	**2,380**	9.24	23,400	1.54	**27,000**	<1[g]	2.91
MW-9A	3/25/2008	<50[g]	13	<2[g]	29,400	NA	NA	<5	270	<20[g]	NA	**872**	NA	4,400	<50[g]	15,700	NA	NA
	2/26/2009	<1[g]	11.3	<1[g]	26,600	<1	1.14	<1	<10	<1	8,570	<10	1.47	3,680	<1	10,900	<1[g]	1.25
MW-11	2/26/2009	**4.33**	51.4	<1[g]	30,000	<1	<1	<1	**24,100**	<1	10,700	**1,410**	1.62	5,810	<1	15,300	<1[g]	6.43
MW-12	2/26/2009	<1[g]	16.8	<1[g]	9,140	<1	<1	<1	**7,600**	<1	3,530	**503**	<1	1,950	<1	10,300	<1[g]	1.39
MW-13	2/26/2009	<1[g]	24.5	<1[g]	31,700	<1	<1	<1	**3,650**	<1	3,550	**649**	1.37	2,940	<1	10,700	<1[g]	1.13

Notes:

NE = Cleanup level not established.

µg/L = micrograms per liter (ppb).

Values in **bold** exceed the groundwater screening level.

[a] Samples collected on 2/6/2008 by Parametrix. Samples collected on 2/26/2009 by SLR.

[b] Samples collected on 2/6/2008 analyzed by EPA Method SW6010B. Samples collected on 2/26/2009 analyzed by EPA Method 200.8.

[c] Groundwater screening levels were the lowest selected federal maximum contaminant level (MCL) for protection of drinking water or the lowest available state water quality criteria (WQC) for protection of surface water. If an MCL or a WQC were not available, then the screening level was obtained from the MTCA Method B equation for groundwater or surface water.

[d] Corrected for hardness.

[e] For Chromium VI.

[f] For Chromium III.

[g] Method reporting limit exceeded the screening level.

Table 7
Groundwater Sample Analytical Results - Conventionals
Closed City of Yakima Municipal Landfill
Yakima, Washington

Well ID	Date[a]	Analytical Result (mg/L)										
		pH[b]	Alkalinity[c] (mg $CaCO_3$/L)	Carbonate[c] (mg $CaCO_3$/L)	Bicarbonate[c] (mg $CaCO_3$/L)	Bromide[d] (mg/L)	Chloride[d] (mg/L)	Fluoride[d] (mg/L)	Nitrate[d] (mg/L)	Nitrite[d] (mg/L)	SRP[d] (mg/L)	Sulfate[d] (mg/L)
Lowest Groundwater Screening Level[e]		**6.5 to 8.5**	**NE**	**NE**	**NE**	**NE**	**230**	**2**	**10**	**1**	**NE**	**250**
MW-7	2/6/2008	**6.49**	274	<1	274	NA	19.4	NA	<0.050	<0.050	NA	5.5
	2/26/2009	**6.28**	264	<1	121	<0.02	20.7	0.75	1.61	0.015	0.004	<1
MW-8	2/6/2008	6.76	306	<1	306	NA	32.8	NA	0.20	0.019	NA	5.6
	2/26/2009	6.54	284	<1	173	0.33	32.8	0.39	**14.4**	0.026	0.001	3.02
MW-9A	3/25/2008	6.77	127	NA	NA	NA	15.6	NA	1.41	0.22	NA	17.9
	2/26/2009	6.69	118	<1	80.6	0.05	15.2	0.32	2.18	0.014	0.12	7.9
MW-11	2/26/2009	**6.28**	216	<1	99.1	0.11	11.9	0.31	0.033	0.011	0.022	<1
MW-12	2/26/2009	**6.01**	67.5	<1	21.2	<0.02	7.62	0.80	0.014	<0.002	0.077	6.17
MW-13	2/26/2009	**6.49**	136	<1	79.0	<0.02	6.06	0.71	0.018	0.003	0.21	4.63

Notes:

NE = Cleanup level not established.

mg/L = milligrams per liter (ppm).

Values in **bold** exceed the groundwater screening level or are outside of the screening level range (pH only).

SRP = Soluble reactive phosphate.

[a] Samples collected on 2/6/2008 by Parametrix. Samples collected on 2/26/2009 by SLR.

[b] Samples collected on 2/6/2008 analyzed for pH by EPA Method 150.1. Samples collected on 2/26/2009 analyzed for pH by EPA method 9040C.

[c] Samples collected on 2/6/2008 analyzed for alkalinity, carbonate, and bicarbonate by EPA Method SM 2320. Samples collected on 2/26/2009 analyzed for alkalinity, carbonate, and bicarbonate by EPA Method 310.1.

[d] Samples collected on 2/6/2008 analyzed for chloride by EPA Method 325.2, nitrate by EPA Method 300.0, nitrite by EPA Method 353.2, and sulfate by EPA Method 375.2. Samples collected on 2/26/2009 analyzed for bromide, chloride, fluoride, nitrate, nitrite, SRP, and sulfate by EPA Method 300.0.

[e] Groundwater screening levels were the lowest selected federal maximum contaminant level (MCL) for protection of drinking water or the lowest available state water quality criteria (WQC) for protection of surface water. If an MCL or a WQC were not available, then the screening level was obtained from the MTCA Method B equation for groundwater or surface water. Levels for pH are shown as a screening level range.

Table 8
Monitoring Well Construction Details
Closed City of Yakima Municipal Landfill
Yakima, Washington

Well	Top of Casing Elevation (ft)	Ground Surface Elevation (ft)	Depth to Top of Screen (ft)	Depth to Base of Screen (ft)	Depth to Top of Sand (ft)	Depth to Bottom of Boring (ft)	Top of Screen Elevation (ft)	Base of Screen Elevation (ft)	Top of Sand Elevation (ft)	Bottom of Boring Elevation (ft)
MW-6	1059.7	1056.9	9.5	19.0	6.5	20.0	1047.4	1037.9	1050.4	1036.9
MW-7	1049.1	1046.0	4.8	14.8	3.5	15.3	1041.2	1031.2	1042.5	1030.7
MW-8	1051.6	1048.6	4.5	14.8	3.5	15.0	1044.1	1033.8	1045.1	1033.6
MW-9A	1064.5	1064.9	14.0	29.0	11.0	29.0	1050.9	1035.9	1053.9	1035.9
MW-11	1065.9	1063.2	6.0	20.8	4.0	22.0	1057.2	1042.4	1059.2	1041.2
MW-12	1068.5	1065.7	6.2	21.0	4.0	22.0	1059.5	1044.7	1061.7	1043.7
MW-13	1066.1	1063.6	6.2	21.0	4.0	21.5	1057.4	1042.6	1059.6	1042.1

Note:
Elevation data from survey conducted by Gray Surveying & Engineering, Inc., in February 2009. Elevations relative to NAVD 88 datum.

Table 9
Screening for Preliminary Indicator Hazardous Substances
Closed City of Yakima Municipal Landfill
Yakima, Washington

Analyte	Units	Number of Samples	Number of Sample Locations	Number of Sampling Periods	Number of Detections	Minimum Reporting Limit	Maximum Reporting Limit	Lowest Detected Concentration	Maximum Detected Concentration	Location and Date of Maximum Detected Concentration	Lowest Screening Level	Preliminary IHS?	Reason for Exclusion
Metals													
Arsenic	µg/L	14	10	2	7	1	50	1.28	12.1	SB-19, 2/12/09	0.058	Yes	
Barium	µg/L	14	10	2	14	--	--	16.8	131	SB-16, 2/11/09	1,000	No	Detected values below SL
Cadmium	µg/L	14	10	2	0	1	2	--	--	--	0.34	No	Never detected (note that all method reporting limits exceeded the SL)
Calcium	µg/L	14	10	2	14	--	--	30.1	48,100	MW-7, 2/6/08	--	No	SL not available; cannot establish cleanup level
Cobalt	µg/L	10	10	2	5	1	1	1.3	59,700	SB-18, 2/12/09	--	No	SL not available; cannot establish cleanup level
Copper	µg/L	10	10	2	2	1	1	1.46	2.32	SB-13, 2/11/09	17[a]	No	Detected values below SL
Chromium	µg/L	14	10	2	1	1	5	1.20	1.20	SB-13, 2/11/09	258[a,b]/10[c]	No	Detected values below SLs
Iron	µg/L	14	10	2	14	--	--	7.78	43,300	SB-19, 2/12/09	300	Yes	
Lead	µg/L	14	10	2	0	1	20	--	--	--	4.1[a]	No	Never detected (note that method reporting limits for two samples exceeded the SL)
Magnesium	µg/L	10	10	2	10	--	--	12.8	22,100	SB-18, 2/12/09	--	No	SL not available; cannot establish cleanup level
Manganese	µg/L	14	10	2	14	--	--	503	2,530	SB-18, 2/12/09	50	Yes	
Nickel	µg/L	10	10	2	9	1	1	1.37	9.24	MW-8, 2/26/09	100[a]	No	Detected values below SL
Potassium	µg/L	14	10	2	14	--	--	6.87	31,300	SB-16, 2/11/09	--	No	SL not available; cannot establish cleanup level
Selenium	µg/L	14	10	2	3	1	50	1.54	2.92	SB-13, 2/11/09	5	No	Detected values below SL (note that method reporting limits for two samples exceeded the SL)
Sodium	µg/L	14	10	2	14	--	--	18.6	68,700	SB-13, 2/11/09	20,000	Yes	
Thallium	µg/L	10	10	2	0	1	1	--	--	--	0.24	No	Never detected (note that all method reporting limits exceeded the SL)
Zinc	µg/L	10	10	2	10	--	--	1.13	19.2	SB-18, 2/12/09	153[a]	No	Detected values below SL
Conventionals													
pH	--	12	10	2	12	--	--	6.01	6.76	MW-8, 2/6/08	6.5-8.5	Yes	
Chloride	mg/L	12	10	2	12	--	--	6.06	37.9	SB-18, 2/12/09	230	No	Detected values below SL
Fluoride	mg/L	10	10	2	10	--	--	0.30	0.80	MW-12, 2/26/09	2	No	Detected values below SL
Nitrate	mg/L	12	10	2	12	0.05	0.05	0.014	14.4	MW-8, 2/26/09	10	Yes	
Nitrite	mg/L	12	10	2	10	0.002	0.05	0.003	0.026	MW-8, 2/26/09	1	No	Detected values below SL
Sulfate	mg/L	12	10	2	9	1	1	0.007	29.1	SB-13, 2/11/09	250	No	Detected values below SL
Organics													
1,1-Dichloroethane	µg/L	7	5	2	1	1	1	2.4	2.4	MW-8, 2/6/08	1,600	No	Single detected value below SL
N-Nitrosodiphenylamine	µg/L	7	5	2	2	1	1	1	1.6	MW-7, 2/6/08	3	No	Both detected values below SL
Vinyl Chloride	µg/L	7	5	2	2	0.03	0.03	0.034	0.06	MW-7, 2/6/08	0.025	Yes	

Notes:

IHS = Indicator hazardous substance.

SL = Screening level.

SVOC = Semivolatile organic compound.

VOC = Volatile organic compound.

µg/L = micrograms per liter (ppb).

mg/L = milligrams per liter (ppm).

Groundwater sample analytical results from well MW-9A were not included in analysis because the well is not considered a background location relative to the landfill.

[a] Adjusted for hardness (see Appendix F).

[b] Screening level for chromium III.

[c] Screening level for chromium VI.