# FEASIBILITY STUDY REPORT
# GROUNDWATER REMEDIATION
# BRIDGETON LANDFILL
# ST. LOUIS COUNTY, MISSOURI

*Prepared for:*

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## EXECUTIVE SUMMARY

This Feasibility Study Report (FS) presents the results of preliminary evaluation of potential groundwater remediation alternatives at Bridgeton Landfill in St. Louis County, Missouri (Plate 1). For purposes of this FS, the contributing sources to groundwater contamination are the North Quarry and South Quarry solid waste landfill areas located within the footprint of the Bridgeton Landfill property (Site). Both of these inactive solid waste landfill areas were operated using permits issued by the Missouri Department of Natural Resources (MDNR). Preliminary costs included herein are based on experience with related types of projects and from feasibility level cost information provided by suppliers/vendors. The main findings from the FS activities are summarized below:

- Remedial Action Objectives (RAOs) are medium-specific goals for the Site that are protective of human health and the environment. Remedial alternatives were evaluated for compliance with RAOs to assess the protectiveness of each alternative. The preliminary remedial action objective was developed based on Site data, experience, and consideration of applicable or relevant and appropriate requirements (ARARs). The purpose of the RAO is to:

  > Protect human health by eliminating exposure (i.e., direct contact, ingestion, and inhalation) to groundwater with concentrations of contaminants of concern (COCs) above regulatory or risk-based standards.

- Five remedial alternatives were evaluated for this FS and include:

  **Remedial Alternative 1 - No Action**: The remedial alternative of no action was considered and is a baseline to compare the other potential remedial alternatives.

  **Remedial Alternative 2 - Monitored Natural Attenuation (MNA)**: MNA is defined as the use of natural attenuation processes within the context of a carefully controlled and monitored Site cleanup approach that will reduce contaminant concentrations to levels that are protective of human health and the environment within a reasonable time frame. Natural attenuation includes the physical, chemical, and biological processes that reduce the mass, toxicity, mobility, volume, or concentration of contaminants. MNA is not a no action alternative, but rather, an alternative that requires extensive monitoring, data evaluation, and risk assessment considerations.

**Remedial Alternative 3 – MNA and Barrier Treatment:** Alternative 3 is the same as Alternative 2 with the addition of a barrier treatment zone along the west and southwest downgradient perimeter of the Site. The barrier treatment is a supplement to MNA and should provide increased in-situ sorption and bioremediation to enhance the reduction in groundwater concentrations of COCs. Various types of barrier treatments are available to enhance bioremediation and in-situ treatment of contaminants. Creation of an effective treatment barrier requires an overlapping continuous barrier over a sufficient area. Once in the aquifer, the treatment material will sorb to or reside in the soil matrix and enhance bioremediation and contaminant sorption. Pilot testing would be required during the remedial design phase to assess the effectiveness of a barrier treatment zone.

**Remedial Alternative 4 – Hydraulic Containment:** Alternative 4 includes hydraulic containment of contaminated groundwater using a series of groundwater extraction wells along the west and southwest downgradient perimeter of the Site. Substantial additional data collection, including a groundwater pump test and treatability study, would be needed during the remedial design phase. Extracted groundwater would be treated via an on-site treatment system. Treated groundwater would be discharged via a pipeline to be constructed and extended to the Missouri River. Groundwater monitoring of an off-site groundwater monitoring network is included.

**Remedial Alternative 5 – Groundwater Containment Wall:** The construction of a groundwater containment wall (GCW) consists of mixing in-situ alluvial soils (typically clay and sand) with injected bentonite grout to construct a continuous low permeability wall that will contain contaminated groundwater within alluvium at the Site. The base of the GCW would be keyed into weathered bedrock. The feasibility level concept is that the GCW would be approximately 8,700 feet long, 20 inches wide and average 100 feet deep. Groundwater monitoring of an off-site groundwater monitoring network is included.

- The United States Environmental Protection Agency (USEPA) has established seven primary criteria for evaluating remedial alternatives. The criteria, in part, provide a basis for selecting an applicable remedial alternative. Below is a summary of the criteria in relation to the remedial alternatives.

**Overall Protection of Human Health and the Environment**: Taking no action is not protective of human and the environment because institutional controls are not required and no monitoring will be conducted to identify if groundwater conditions change and cause increased risk. Assuming groundwater contamination at concentrations above regulatory or risk-based levels has not migrated to the west of the proposed off-site monitoring well network, and the indoor inhalation pathway does not pose a risk, Alternatives 2, 3, 4 and 5 are protective of human health and the environment.

**Compliance with ARARs:** MNA complies with ARARs. Barrier treatment will need to comply with possible ARARs regarding injection of chemicals into groundwater. Pilot testing of barrier treatment will need to evaluate possible adverse water quality conditions created by injection of barrier treatment materials. Hydraulic containment and groundwater treatment by air stripping will need to comply with air and surface water discharge regulations.

**Long-Term Effectiveness and Permanence:** Each alternative (except no action) includes institutional controls to reduce potential exposure to untreated groundwater until cleanup levels are achieved. Alternatives 2 through 5 provide similar levels of long term effectiveness and permanence. Alternatives 3 through 5 may reduce the remedial time frame in comparison to MNA.

**Reduction in Toxicity, Mobility or Volume through Treatment:** Alternatives 3 through 5 involve treatment methods that reduce toxicity, mobility and volume of affected groundwater.

**Short Term Effectiveness:** Each of the alternatives would be implemented in accordance with an approved Health and Safety Plan (HASP). Barrier treatment could cause adverse water quality conditions due to the injected materials. Additional Site evaluation is needed to assess the potential remedial time frames associated with Alternatives 2 through 5.

**Implementability:** Alternatives 2 through 5 would require access agreements and regulatory approvals prior to implementation. Each alternative can be implemented using available methods and technology. Implementation of a barrier treatment system may include regulatory approval that is needed for injection of treatment materials into groundwater. Hydraulic containment has the most components associated with implementation (i.e., extraction wells, extensive piping network, substantial treatment system, pipeline construction, permits, operation and maintenance (O&M) requirements).

**Cost:** The preliminary present value costs for Alternatives 2 through 5, assuming that treatment and monitoring will require 30 years to complete, are as follows:

| | |
|---|---|
| Alternative 2 | $  5,640,772 |
| Alternative 3 | $13,391,769 |
| Alternative 4 | $14,501,653 |
| Alternative 5 | $32,780,138 |

Alternative 2 is the most cost effective alternative. Below is a summary of Alternative 2 costs compared to Alternatives 3 through 5 costs.

Alternative 3 – approximately 2.37 times greater
Alternative 4 – approximately 2.57 times greater
Alternative 5 – approximately 5.81 times greater

Due to the feasibility level and conceptual level definition of the remedial alternatives, in our opinion, the present value costs may be considered within the following accuracy ranges. Due to inadequate Site data, more accurate cost information is not available at this time.

| | | |
|---|---|---|
| Alternative 2: | -30 to +50 percent | cost range \$3,948,540 to \$8,461,158 |
| Alternative 3: | -30 to +50 percent | cost range \$9,374,239 to \$20,087,654 |
| Alternative 4: | -50 to +100 percent | cost range \$7,250,827 to \$29,003,306 |
| Alternative 5: | -30 to +50 percent | cost range \$22,946,097 to \$49,170,207 |

## 1.0 INTRODUCTION

This Feasibility Study Report (FS) presents the results of preliminary evaluation of potential groundwater remediation alternatives at Bridgeton Landfill in St. Louis County, Missouri (Plate 1). For purposes of this FS, the contributing sources to groundwater contamination are the North Quarry and South Quarry solid waste landfill areas (see Appendix A) located within the footprint of the Bridgeton Landfill property (Site). Both of these solid waste landfill areas were operated using permits issued by the MDNR. A main purpose of the FS was to evaluate preliminary groundwater remedial alternatives and associated preliminary cost information to be used as part of litigation between the Office of the Missouri Attorney General and Republic Services, Inc. et al.

This FS includes information that is at the conceptual level or screening level of detail and is limited due to a lack of adequate Site characterization data and a lack of risk assessment information including ecological risk information. For example, the extent of off-site groundwater impacts has not been defined, so it is difficult to evaluate remedial alternatives, risks, and costs. These limitations affect the degree of project or remedial alternative definition, which directly affects the accuracy of preliminary cost information. As additional Site information is developed, the evaluation of the remedial alternatives will be increased and the accuracy of the associated cost information will be improved. Preliminary costs included herein are based on our experience with related types of projects and from feasibility level cost information provided by suppliers/vendors.

## 2.0 BACKGROUND

2.1 Site Overview. As summarized in the reports referenced herein, the subject property shown on Plate 1 consists of several distinct areas (see Appendix A). Operable Unit 1 (OU1) consists of Radiological Areas 1 and 2, which contain radiologically impacted materials (RIM) associated with the West Lake Landfill. OU2 consists of the remainder of the property (non-RIM areas) and includes the inactive sanitary landfill, closed demolition landfill and the inactive North Quarry and South Quarry solid waste landfill areas. The approximate sizes of these specific areas are summarized below:

- Property Footprint - 238 acres (includes Republic Services business/hauling operations)
- OU1 – 41 acres
- North Quarry - 16 acres
- South Quarry - 35 acres
- Closed Demolition Landfill - 25 acres
- Inactive sanitary landfill – 47 acres

2.2 Site Information. For purposes of preparing this FS, we relied primarily on the following Site information/reports:

1. *Groundwater Monitoring Report, October 2013 Additional Groundwater Sampling Event, West Lake Landfill Operable Unit 1, Bridgeton, Missouri;* prepared for the Missouri/Kansas Remedial Branch - Superfund Division, U.S. Environmental Protection Agency - Region 7; prepared by Engineering Management Support, Inc.; report dated February 21, 2014 (Copy provided in Appendix A).

2. *Background Groundwater Quality, Review of 2012-14 Groundwater Data, and Potential Origin of Radium at the West Lake Landfill Site, St. Louis, County, Missouri*; prepared for the U.S. Environmental Protection Agency, Region 7; prepared by the U.S. Geological Survey, Missouri Water Science Center, report dated December 17, 2014.

3. *Draft Hydrogeologic Characterization Report for The Bridgeton Active Sanitary Landfill, Bridgeton, Missouri*; prepared for Laidlaw Waste Systems, Inc.; prepared by Golder Associates; Project No. 943-2848; report dated September 1995.

Site data and associated maps included in the above reports provide the main technical basis that there are documented releases from the North and South Quarry solid waste landfill areas to groundwater. For example, these two unlined solid waste landfill areas relied substantially on an inward hydraulic gradient to control releases to groundwater. Site data demonstrates that an inward hydraulic gradient has not been maintained, which contributes to releases to groundwater. As indicated in the February 21, 2014 Engineering Management Support, Inc. report, the most commonly detected volatile organic compound (VOC) in groundwater was benzene, which was reported to be present in 36 of the 84 monitoring wells located on or near the Site. Also noted in the referenced report is that benzene was detected in 18 monitoring wells at concentrations greater than its water quality standard of 5 micrograms per liter (ug/l). As such, VOCs and, in particular benzene, is a main focus for potential groundwater remediation at the Site.

Site data indicates that the groundwater flow direction in the area of the Site is towards the west/northwest and the Missouri River. Hydraulic gradients in bedrock at the Site indicate, in part, groundwater flow from bedrock into the alluvium. Site hydraulic gradient data indicates that some portion of the groundwater contamination that originates from the North and South Quarry solid waste landfill areas and moves into the adjacent bedrock will eventually migrate and flow into the alluvium on the west portion of the Property. Site data also indicates that portions of the North Quarry solid waste landfill area are in hydraulic connection with alluvium. Migration of groundwater contamination in deeper bedrock and below the alluvium is unknown at this time due to a lack of Site data. A general (east to west) subsurface profile through the South Quarry area is presented on Plate 2.

Other items related to impacts to off-site groundwater include possible effects to property values and placement of institutional controls (e.g., deed restrictions) on affected properties to manage potential groundwater ingestion risks and indoor vapor inhalation risks. Individual property parcels located near the Site are shown on Plate 3.

The Site and vicinity properties are currently served by a piped, potable water source. Based on a review of MDNR records, properties in the vicinity of the landfill do not currently use private groundwater wells for potable water. Based on the availability of piped, potable water and the lack of private wells in the area of the Site, it is reasonable to assume that groundwater in the vicinity of the Site will likely not be used as a potable water source.

The Site is located in a primarily commercial/industrial area. Current receptors include occupants of commercial/industrial buildings near the Site. Future residential properties, non-residential properties, and construction workers are also possible receptors.

Indoor inhalation of vapors from impacted groundwater is a potentially complete exposure pathway in the vicinity of the Site. Additionally, the construction worker exposure pathway exists for current and future construction activities in the vicinity. In our opinion, due to the lack of groundwater supply wells near the Site, and the availability of piped, potable water, the groundwater ingestion exposure pathway is not reasonably likely to be complete in the future at or near the Site. St. Louis County does not have an ordinance prohibiting the installation of potable drinking water wells. The future groundwater ingestion exposure pathway could be eliminated by implementing a durable institutional control (i.e., deed restriction) that prohibits potable water well installation on impacted properties.

The Missouri River is located approximately 7,000 feet west of the Site. Additional evaluation is needed to assess the potential risk to ecological receptors in the vicinity of the Site.

## 3.0 DEVELOPMENT OF REMEDIAL ACTION OBJECTIVES

3.1 General. Remedial Action Objectives (RAOs) are risk-based goals for the Site that are protective of human health and the environment. Remedial alternatives are evaluated and compared with the RAOs to assess the protectiveness of each alternative.

USEPA guidance indicates that Site actions must meet federal and state standards, requirements, criteria or limitations that are determined to be legally applicable or relevant and appropriate requirements (ARARs). State ARARs must also be met if they are more stringent than federal requirements. ARARs are one of the main criteria considered during the development of remedial alternatives.

Based on the lack of Site data regarding the delineation of off-site impacts to groundwater, several major assumptions were developed to assist with evaluating remedial alternatives. For purposes of the FS, we assume that effects to groundwater from the North and South Quarry solid waste landfill areas that may be present west of the Site and beyond the influence of the proposed remedial alternatives (i.e., west of the off-site sentinel well network) are below risk-based concentrations and do not pose a risk to human health and the environment.

If this assumption is not accurate and off-site groundwater impacts are found to be present west of the off-site sentinel well network at concentrations above risk-based concentrations, then substantial modifications to the proposed remedial alternatives will be required.

3.2 Remedial Action Objectives. RAOs are medium-specific goals for the Site that are protective of human health and the environment. Remedial alternatives were evaluated for compliance with RAOs to assess the protectiveness of each alternative. The preliminary RAO was developed based on Site data, experience, and consideration of ARARs. The RAO is to:

- Protect human health by eliminating exposure (i.e., direct contact, ingestion, and inhalation) to groundwater with concentrations of COCs above regulatory or risk-based standards.

3.3 Identification of ARARs. There are three types of ARARs including: 1) chemical-specific, 2) action-specific, and 3) location-specific. Chemical-specific ARARs are acceptable exposure concentrations and may be appropriate remediation goals. Action-specific ARARs relate to restrictions that may apply to a certain activity, treatment or disposal activity. Location-specific ARARs establish criteria for activities within ecologically sensitive or other regulated areas. Preliminary ARARs are summarized in Table 1.

A primary focus is to meet chemical-specific ARARs in consideration of Site risks. Chemical-specific ARARs establish the acceptable amounts or concentrations of a chemical that may be found in, or discharged to the ambient environment. Action-specific and location-specific ARARs are met by appropriate implementation of a remedial alternative.

## 4.0 IDENTIFICATION AND SCREENING OF REMEDIAL ALTERNATIVES

4.1 General. Remedial alternatives were selected based on several factors including groundwater sampling and testing results, Site conditions, and experience. Several types of technologies and methods were considered as part of the remedial alternative evaluation.

Institutional controls and property use restrictions (e.g., prohibit potable water well installation) are required for each of the alternatives (except no action) to eliminate the exposure pathway for untreated groundwater at off-site affected properties until cleanup levels are achieved.

4.2 Potential Remedial Alternatives. Five remedial alternatives were evaluated as summarized below. Except for Alternative 1 – No Action, each alternative includes substantial additional Site characterization, groundwater flow modeling, risk assessment, groundwater monitoring and institutional controls. Discreet depth, direct push (e.g., GeoProbe) groundwater sampling and testing (i.e., additional Site characterization) should be performed within the alluvium on-site and off-site prior to implementing the proposed additions to the groundwater monitoring network.

Remedial Alternative 1 - No Action

Remedial Alternative 2 - MNA

Remedial Alternative 3 – MNA and Barrier Treatment

Remedial Alternative 4 – Hydraulic Containment

Remedial Alternative 5 – Groundwater Containment Wall

4.2.1 Remedial Alternative 1 - No Action. The remedial alternative of no action was considered and is a baseline to compare to the other potential remedial alternatives.

4.2.2 Remedial Alternative 2 – Monitored Natural Attenuation. Remedial Alternative 2 is MNA combined with institutional controls to prohibit use of affected groundwater until cleanup levels are achieved. A concept of this alternative is provided on Plate 4. MNA is defined as the use of natural attenuation processes within the context of a carefully controlled and monitored Site cleanup approach that will reduce contaminant concentrations to levels that are protective of human health and the environment within a reasonable time frame. Natural attenuation includes the physical, chemical, and biological processes that reduce the mass, toxicity, mobility, volume, or concentration of contaminants. MNA is not a no action alternative, but rather, an alternative that requires extensive monitoring, data evaluation, and risk assessment considerations.

USEPA has issued guidance that provides a framework for evaluating MNA as a remedial alternative. Several factors to consider for evaluating MNA include:

- Whether the contaminants present in groundwater can be effectively remediated by natural attenuation processes;
- Whether or not the contaminant plume is stable and the potential for the environmental conditions that influence plume stability to change over time;
- Whether human health, drinking water supplies, other groundwater, surface waters, ecosystems, sediments, air or other environmental resources could be adversely impacted as a consequence of selecting MNA as the remediation option;

- Current and projected demand for the affected resource over the time period that the remedy will remain in effect;

- Whether the contamination, either by itself or as an accumulation with other nearby sources (on-site or off-site), will exert a long-term detrimental impact on available water supplies or other environmental resources;

- Whether the estimated timeframe of remediation is reasonable compared to timeframes required for other more active methods (including the anticipated effectiveness of various remedial approaches on different portions of the contaminated soil and/or groundwater);

- The nature and distribution of sources of contamination and whether these sources have been, or can be, adequately controlled;

- Whether the resulting transformation products present a greater risk, due to increased toxicity and/or mobility, than do the parent contaminants;

- The impact of existing and proposed active remediation measures upon the MNA component of the remedy, or the impact of remediation measures or other operations/activities (e.g. pumping wells) in close proximity to the Site; and

- Whether reliable site-specific mechanisms for implementing institutional controls (e.g. zoning ordinances) are available, and if an institution responsible for their monitoring and enforcement can be identified.

The above items will require further evaluation based on the results of substantial additional Site characterization during the remedial design phase. The feasibility of MNA would be based, in part, on the adequacy of source control measures including leachate and landfill gas removal at the North and South Quarry solid waste disposal areas.

4.2.3 Remedial Alternative 3 – MNA and Barrier Treatment. Alternative 3 is the same as Alternative 2 with the addition of a barrier treatment zone along the west and southwest downgradient perimeter of the Site. A concept of this alternative is provided on Plate 5. Technical and preliminary cost information for the barrier treatment is provided in Appendix B. The barrier treatment is a supplement to MNA and should provide increased in-situ sorption and bioremediation. Pilot testing would be required during the remedial design phase to assess the effectiveness of a barrier treatment zone at the Site.

4.2.4 Remedial Alternative 4 – Hydraulic Containment. Alternative 4 includes hydraulic containment of contaminated groundwater along the west and southwest downgradient perimeter of the Site. Hydraulic containment includes a series of groundwater extraction wells and an on-site treatment system with discharge of treated groundwater to the Missouri River. Our feasibility level evaluation indicates that the total volume of extracted groundwater to achieve hydraulic containment in the alluvium is greater than 1,000 gallons per minute (gpm). A concept of Alternative 4 is shown on Plate 6. For Alternative 4, substantial additional data collection, including a groundwater pump test and treatability study, is needed during the remedial design phase.

4.2.5 Remedial Alternative 5 – Groundwater Containment Wall. Alternative 5 includes a groundwater containment wall (GCW) along the south, west, and north portions of the Site that are underlain by alluvium. The groundwater containment wall consists of mixing in-situ alluvial soils with injected bentonite grout to construct a continuous, low-permeability wall that will contain contaminated groundwater with alluvium at the site. A concept of Alternative 5 is shown on Plate 7.

## 5.0 DETAILED EVALUATION OF REMEDIAL ALTERNATIVES

5.1 General. A detailed evaluation of each remedial alternative is presented in this section of the FS report. For purposes of this FS, we assessed each alternative relative to the seven criteria typically used by USEPA and summarized below. Preliminary conceptual level costs were developed for each alternative. The preliminary cost information is limited by the lack of Site characterization data and risk assessment information. Project budgets should be developed during the remedial design phase and should be based on bids from contractors and other applicable sources.

5.2 Evaluation Criteria. USEPA has established seven primary criteria for evaluating remedial alternatives. The criteria, in part, provide a basis for selecting an applicable remedial alternative. A brief description of the evaluation criteria is presented below.

**Overall Protection of Human Health and the Environment** - This threshold criterion is used to evaluate the ability of the remedial alternative to protect human health and the environment. Pathways of concern are discussed in relation to how the alternative addresses potential risks and what mechanism such as treatment or institutional controls are used to address risks. Each remedial alternative must meet this criterion.

**Compliance with ARARs** - This threshold criterion is used to evaluate compliance with the three types of ARARs (chemical, location, and action-specific). ARARs are discussed in relation to each alternative and how compliance will be attained. The remedial alternatives must meet this criterion.

**Long-Term Effectiveness and Permanence** - This balancing criterion is used to evaluate the alternatives ability to reduce potential exposure and risk. The magnitude of residual risks and the reliability of controls are addressed. The remedial alternatives are evaluated for the best result among the balancing criteria.

**Reduction of Toxicity, Mobility, or Volume through Treatment** - This balancing criterion is used to evaluate the proposed treatment processes, anticipated concentration reductions, and residuals that may remain after treatment.

**Short-Term Effectiveness** - This balancing criterion is used to evaluate the potential risks during implementation of the alternative to Site workers and nearby residents. Possible environmental impacts and mitigation options during implementation are considered. The time required to achieve RAOs is considered given adequate Site information.

**Implementability** - This balancing criterion is used to evaluate the ability to implement an alternative including the reliability of the technology, monitoring the technology, and ability to construct and operate the technology. Administrative issues such as permits, access, and approvals are considered.

**Cost** - This balancing criterion is used to evaluate the costs of the alternatives. The preliminary cost information includes engineering, construction and operation and maintenance costs. For each alternative, the preliminary cost information is presented as present value costs over an assumed 30 year operating period.

<u>5.3 Detailed Evaluation of Remedial Alternatives</u>. The detailed evaluation was conducted for the potential remedial alternatives listed below:

Remedial Alternative 1 - No Action

Remedial Alternative 2 - MNA

Remedial Alternative 3 – MNA and Barrier Treatment

Remedial Alternative 4 – Hydraulic Containment

Remedial Alternative 5 – Groundwater Containment Wall

Note that each alternative includes the use of institutional controls such as a deed restriction to reduce possible exposure to affected groundwater. In addition, Alternatives 2 through 5 include a groundwater monitoring program and contingency plan.

5.3.1 Remedial Alternative 1 - No Action. The remedial alternative of no action is usually considered as a baseline with which to compare the other potential remedial alternatives.

5.3.1.1 Alternative 1 - Description. No active remediation or monitoring would occur as part of the no action alternative. Natural processes would act to reduce groundwater concentrations over time. Groundwater monitoring would not be used to track effects to groundwater.

5.3.1.2 Alternative 1 - Overall Protection of Human Health and the Environment. Although documentation would not be available, given enough time, the no action alternative may be protective. Overall, we do not consider no action to be protective. Monitoring is not part of this alternative and would not be used to demonstrate protection to human health and the environment. Institutional controls would not be used to reduce potential exposure to untreated groundwater.

5.3.1.3 Alternative 1 - Compliance with ARARs. Action-specific and location-specific ARARs are not applicable because no remedial actions are planned. Chemical-specific ARARs could be achieved through attenuation processes over time. Monitoring would not be conducted to document groundwater conditions in comparison to ARARs.

5.3.1.4 Alternative 1 - Long-Term Effectiveness and Permanence. Alternative 1 could provide long term risk reduction through natural attenuation processes; however, monitoring is not part of the no action alternative. Documenting reductions through natural processes would not occur without monitoring. Institutional controls or property use restrictions would not be used to reduce potential exposure to untreated groundwater.

5.3.1.5 Alternative 1 - Reduction of Toxicity, Mobility, or Volume through Treatment. Active treatment would not be performed using the no action alternative. Reduction of toxicity, mobility, or volume through treatment would not be measured.

5.3.1.6 Alternative 1 - Short-Term Effectiveness. The no action alternative has no short term effects. The time to reach the RAOs would not be measured because monitoring would not occur.

5.3.1.7 Alternative 1 - Implementability. There are no implementation issues for the no action alternative.

5.3.1.8 Alternative 1 - Cost. Implementation of the no action alternative has no associated costs.

5.3.2 Remedial Alternative 2 - Monitored Natural Attenuation. MNA is a potential remedial alternative for the Site. MNA is a common approach that would require substantial additional data collection during the remedial design phase.

5.3.2.1 Alternative 2 - Description. MNA is defined as the use of natural attenuation processes within the context of a carefully controlled and monitored Site cleanup approach that will reduce contaminant concentrations to levels that are protective of human health and the environment within a reasonable time frame. Natural attenuation includes the physical, chemical, and biological processes that reduce the mass, toxicity, mobility, volume, or concentration of contaminants. MNA is not a no action alternative but rather an alternative that requires extensive monitoring, data evaluation, and risk assessment considerations.

5.3.2.2 Alternative 2 - Overall Protection of Human Health and the Environment. Deferred - Conclusions about this criteria are deferred due to lack of off-site groundwater data.

Within the context of the assumptions indicated in Section 3.1, this alternative would provide protection of human health and the environment over time due to naturally occurring processes. Reductions in groundwater concentrations would be tracked using an extensive monitoring program. Contingency measures would be in place if Site monitoring data indicated unacceptable risks in the future. Institutional controls or deed restrictions that prohibit the installation of drinking water wells at affected properties would be used to reduce potential exposure to untreated groundwater. Given successful implementation of MNA, RAOs would be achieved at the Site. A contingency plan is a major part of a MNA approach and would be implemented if unacceptable risks developed due to unexpected data trends, land or groundwater use changes, and risks to receptors.

5.3.2.3 Alternative 2 - Compliance with ARARs. Natural attenuation processes would achieve chemical-specific ARARs over time. Groundwater monitoring would be used to assess when chemical-specific ARARs are achieved. MNA would meet location-specific and action-specific ARARs.

5.3.2.4 Alternative 2 - Long-Term Effectiveness and Permanence. Natural attenuation processes acting over time would be effective for achieving the RAO. Reductions in concentrations would be tracked using an extensive groundwater monitoring program. Monitoring data would be used to ensure reduced risk and effectiveness. Property use restrictions would be effective to reduce potential ingestion of untreated groundwater until the remedy is complete. MNA is a reliable alternative that can be verified through effective monitoring. The time required to achieve RAOs may be substantial using MNA.

5.3.2.5 Alternative 2 - Reduction of Toxicity, Mobility, or Volume through Treatment. Reductions in groundwater concentrations would occur due to natural processes, which will reduce toxicity, mobility, and volume.

5.3.2.6 Alternative 2 - Short-Term Effectiveness. There are not substantial short-term effects associated with this alternative. Groundwater monitoring at the Site would be conducted in accordance with a HASP. Periodic monitoring reports would be submitted to regulatory agencies.

5.3.2.7 Alternative 2 - Implementability. This alternative can be readily implemented with the necessary personnel and equipment. Property use restrictions and access agreements would be negotiated with individual property owners. Regulatory or local approvals are not anticipated.

5.3.2.8 Alternative 2 - Cost. Preliminary present value cost for a 30-year MNA approach is $5,640,772. Details of the cost and assumptions are in Table 2. Present value cost allows different alternatives to be compared on the basis of one cost.

Preliminary costs for MNA are presented in Table 2. MNA is proposed on a semi-annual basis for a 30-year period. The monitoring program includes sampling and testing of up to 99 monitoring wells. The MNA concept includes approximately 54 existing monitoring wells and 45 additional monitoring wells to be installed west of the Site (Plate 4). In general, Alternative 2 includes the following cost items:

- Site access coordination,
- Site logistical coordination,
- Project management,
- Field observation and documentation of well installation activities,
- Geophysical utility locating,
- Air knife buried utility exploration,
- Continuous soil sampling and logging,
- Drill rig mobilization and borehole advancement,
- Monitoring well installation and materials,
- Dedicated sample tubing and pump installation and materials,
- Monitoring well surface completions,
- Monitoring well development,

- Decontamination of equipment and personnel,
- Drill cutting containment, analysis, and disposal,
- Development/purge water containment, analysis, and disposal,
- Submittal of MDNR well certifications,
- Surveying locations and measuring point elevations,
- Semi-annual groundwater sample collection and analysis (Appendix 1 list – MO landfill regulations ),
- Biennial groundwater analysis (Appendix 2 list - MO landfill regulations), and
- Well installation and semi-annual groundwater sampling reports.

5.3.3 Remedial Alternative 3 – MNA and Barrier Treatment. This alternative employs the same institutional controls and MNA as Alternative 2. In addition to MNA, barrier treatment would be conducted using numerous injection locations and commercially available remediation materials to enhance bioremediation and in-situ sorption. A concept of Alternative 3 is provided on Plate 5.

5.3.3.1 Alternative 3 – Description. Various types of barrier treatments are available to enhance bioremediation and in-situ treatment of contaminants. Information about one type of barrier treatment, liquid activated carbon, is provided in Appendix B.

A main objective in enhancing bioremediation is to increase the rate and extent of microbial degradation. A primary method for enhancing bioremediation is to increase microbial activity by addressing limiting factors (i.e., electron donors, electron acceptors, primary substrate). Materials needed for enhanced bioremediation are commonly injected in a liquid form using borings. The process requires the material to be mixed with water to form an injectable slurry which is then pressure injected (using a pump) into the zone of contamination. Creation of an effective treatment barrier requires that the treatment form an overlapping continuous barrier over a sufficient area. Once in the aquifer, the material will sorb to or reside in the soil matrix and enhance bioremediation and contaminant sorption.

Use of a barrier treatment to supplement MNA may result in a shorter remedial timeframe than use of only MNA. Barrier treatment may provide additional risk reduction to potential off-site receptors. Pilot testing of the barrier treatment material would be required during the remedial design. Various types of barrier treatment materials would be further evaluated during the remedial design phase.

5.3.3.2 Alternative 3 - Overall Protection of Human Health and the Environment. Deferred - Conclusions about this criteria are deferred due to the lack of off-site groundwater data.

Within the context of the assumptions indicated in Section 3.1, this alternative would provide protection of human health and the environment over time due to naturally occurring processes that are supplemented by the barrier treatment. Reductions in groundwater concentrations would be tracked using an extensive monitoring program. Contingency measures would be in place if Site monitoring data indicated unacceptable risks in the future. Institutional controls or deed restrictions that prohibit the installation of drinking water wells at affected properties would be used to reduce potential exposure to untreated groundwater. Given successful implementation of MNA and barrier treatment, RAOs would be achieved at the Site. A contingency plan is a major part of a MNA and barrier treatment approach and would be implemented if unacceptable risks developed due to unexpected data trends, land or groundwater use changes, and risks to receptors. Institutional controls or deed restrictions that prohibit the installation of drinking water wells at affected properties would be used to reduce potential exposure to untreated groundwater.

5.3.3.3 Alternative 3 - Compliance with ARARs. This method would achieve the chemical-specific ARARs by removing potential VOCs from groundwater. Pilot testing would be performed during the remedial design phase. Groundwater monitoring would be used to assess when chemical-specific ARARs are achieved. MNA and barrier treatment would need to meet action-specific ARARs related to injection of treatment materials into groundwater.

5.3.3.4 Alternative 3 - Long-Term Effectiveness and Permanence. Natural attenuation processes acting over time and supplemented by barrier treatment would be effective for achieving the RAO. Reductions in concentrations would be tracked using an extensive groundwater monitoring program. Monitoring data would be used to assess reduced risk and effectiveness. Property use restrictions would be effective to reduce potential ingestion of untreated groundwater until the remedy is complete.

5.3.3.5 Alternative 3 - Reduction of Toxicity, Mobility, or Volume through Treatment. Use of this alternative would permanently remove constituents from groundwater. This approach meets the preference for treatment technologies that permanently reduce the toxicity, mobility or volume of the hazardous substances.

5.3.3.6 Alternative 3 - Short-Term Effectiveness. The alternative can be implemented without causing increased risk to the community and workers during construction and implementation. Groundwater monitoring and placement of the barrier treatment at the Site would be conducted in accordance with a HASP.

5.3.3.7 Alternative 3 - Implementability. This alternative can be readily implemented with the necessary personnel, equipment, and materials. Property use restrictions and access agreements would be negotiated with individual property owners.

5.3.3.8 Alternative 3 - Cost. Preliminary costs for Alternative 3 are summarized in Table 3. Barrier treatment information is in Appendix B. The main cost components are similar to Alternative 2 with the addition of the barrier treatment design, pilot testing, and barrier treatment installation.

The preliminary 30-year present value cost for MNA and barrier treatment is $13,391,769 (conceptual only). As with the other remedial alternatives being evaluated, present value cost allows different alternatives to be compared on the basis of one cost.

5.3.4 Remedial Alternative 4 – Hydraulic Containment. Alternative 4 is hydraulic containment that would be implemented on the downgradient perimeter of the Site. A concept of Alternative 4 is provided on Plate 6.

5.3.4.1 Alternative 4 - Description. Alternative 4 includes hydraulic containment of affected groundwater along the west and southwest downgradient perimeter of the Site. Substantial additional data collection, including a groundwater pump test and treatability study, would be needed during the remedial design phase. Extracted groundwater would be treated via an on-site treatment system. Treated groundwater would be discharged via a pipeline to be constructed to the Missouri River.

5.3.4.2 Alternative 4 - Overall Protection of Human Health and the Environment. Deferred - Conclusions about this criteria are deferred due to the lack of off-site groundwater data.

Within the context of the assumptions indicated in Section 3.1, this alternative would achieve the RAO and provide protection of human health and the environment over time through hydraulic containment and removal of contaminants. Institutional controls or deed restrictions that prohibit the installation of drinking water wells at affected properties would be used to reduce potential exposure to untreated groundwater. Reductions in groundwater concentrations would be tracked using an extensive monitoring program. Contingency measures would be in place if Site monitoring data indicated unacceptable risks in the future.

5.3.4.3 Alternative 4 - Compliance with ARARs. This treatment alternative would achieve the chemical-specific ARARs by permanently removing constituents from groundwater in the subject area. Groundwater monitoring data would be used to assess when chemical-specific ARARs are achieved.

Treatment system discharges to air and water would need to be evaluated further to assess location-specific and action-specific ARARs.

5.3.4.4 Alternative 4 - Long-Term Effectiveness and Permanence. Hydraulic containment would be effective for achieving the RAO. Reductions in concentrations would be tracked using an extensive groundwater monitoring program. Monitoring data would be used to evaluate reduced risk and effectiveness. Property use restrictions would be effective to reduce potential ingestion of untreated groundwater until the remedy is complete. Hydraulic containment is a reliable alternative that can be verified through effective monitoring.

5.3.4.5 Alternative 4 - Reduction of Toxicity, Mobility, or Volume through Treatment. Use of this alternative would permanently remove constituents from groundwater. This alternative meets the preference for treatment technologies that permanently reduce the toxicity, mobility or volume of the constituents of concern.

5.3.4.6 Alternative 4 - Short-Term Effectiveness. Potential worker exposure to affected groundwater during construction, operation, and maintenance activities would be mitigated through the use of personal protective equipment (PPE) and a HASP.

5.3.4.7 Alternative 4 - Implementability. Hydraulic containment components are conventional and commercially available. Property access agreements and deed restrictions would be negotiated with individual property owners. Substantial additional Site data would need to be collected during the remedial design phase.

5.3.4.8 Alternative 4 - Cost. The preliminary present value costs for the hydraulic containment alternative is $14,501,653 (Table 4). Additional costs of Alternative 4 would need to be developed during the remedial design phase, which will include substantial additional data collection. Preliminary costs associated with air stripping treatment are provided in Appendix C. In general, the Alternative 4 preliminary cost summary includes the following items (conceptual only):

- Site access/utility coordination,
- Project management,
- Site characterization,
- Groundwater flow model,
- Permits, plans, surveying, utilities,
- Containment system and treatment system design,
- Treatment system and building construction
- Extraction well installation
- Piping installation
- Field observation,
- As-built survey, construction completion report,
- Operation and maintenance,
- Institutional controls,
- Monitoring well network installation,
- Groundwater sampling and testing, and
- Groundwater reporting (semi-annual)

5.3.5 Remedial Alternative 5 – Groundwater Containment Wall. Remedial Alternative 5 includes the construction of a GCW around the south, west and north areas of the property. A concept of Alternative 5 is provided on Plate 7. Substantial additional evaluation of Alternative 5 would be needed during the remedial design phase.

5.3.5.1 Alternative 5 - Description. The construction of a GCW consists of mixing in-situ alluvial soils (typically clay and sand) with injected grout to construct a continuous low permeability wall that will contain contaminated groundwater within the property. The base of the GCW will be keyed into weathered bedrock. The feasibility level concept is that the GCW will be approximately 8,700 feet long, 20-inches wide and 100 feet deep. Technical and preliminary cost information are provided in Appendix D. Semi-annual groundwater monitoring of an off-site groundwater monitoring network is a key part of Alternative 5. The source control measures including leachate and landfill gas removal currently being performed within the North and South Quarry solid waste landfill areas may be improved over time with the addition of a GCW.

5.3.5.2 Alternative 5 - Overall Protection of Human Health and the Environment. Deferred - Conclusions about this criteria are deferred due to the lack of off-site groundwater data. As with each alternative, depending on the off-site groundwater concentrations and risk assessment results (see Section 3.1), the GCW can provide protection to human health and the environment.

5.3.5.3 Alternative 3 - Compliance with ARARs. The GCW would help achieve chemical-specific ARARs by containing COCs on site. Groundwater monitoring would be used to assess when chemical-specific ARARs are achieved on-site and off-site.

5.3.5.4 Alternative 5 - Long-Term Effectiveness and Permanence. The construction of a GCW would be effective for achieving containment and reducing off-site migration. The GCW does not require long-term maintenance. A groundwater monitoring network would be established to assess the effectiveness of the GCW. The groundwater monitoring network and associated groundwater monitoring events would be in place until concentrations are below regulatory or risk based concentrations for 2-3 years or other regulatory approved time period. Monitoring data would be used to assess reduced risk and effectiveness. The construction of a GCW is a reliable alternative that can be verified through effective monitoring.

5.3.5.5 Alternative 5 - Reduction of Toxicity, Mobility, or Volume through Treatment. Reductions in groundwater concentrations in affected off-site areas will occur naturally after installation of the GCW. Natural attenuation of off-site groundwater concentrations will result in a reduction of toxicity, mobility and volume.

5.3.5.6 Alternative 5 - Short-Term Effectiveness. Alternative 5 can be implemented without causing increased risk to the community and workers during construction and implementation. Activities at the Site would be conducted in accordance with an approved HASP.

5.3.5.7 Alternative 5 - Implementability. This alternative can be implemented with the available personnel, equipment and materials. Property access agreements for installation of the monitoring well network installation would be negotiated with individual property owners. Regulatory or local approvals are not anticipated as the GCW installation will be within the property boundary.

5.3.5.8 Alternative 5 - Cost. Preliminary present value cost for the construction of a GCW is $32,780,138.00. A summary of the preliminary costs are in Table 5. In general, the Alternative 5 preliminary cost summary includes the following items (conceptual only):

- Site access/utility coordination,
- Project management,
- Site characterization,
- Groundwater flow model,
- Plans, surveying, utilities,
- Containment wall design,
- Containment wall construction,
- Field observation,
- As-built survey, construction completion report,
- Institutional controls,
- Monitoring well network installation,
- Groundwater sampling and testing, and
- Groundwater reporting (semi-annual)

## 6.0 COMPARATIVE ANALYSIS OF REMEDIAL ALTERNATIVES

6.1 Introduction. Results of the detailed evaluation are used to perform a comparative analysis to assess the relative advantages and disadvantages of each alternative. The comparative analysis, in part, can assist with providing the basis for determining a remedial alternative. The five alternatives being considered for the Site include:

- Remedial Alternative 1 - No Action

- Remedial Alternative 2 - MNA

- Remedial Alternative 3 – MNA and Barrier Treatment

- Remedial Alternative 4 – Hydraulic Containment

- Remedial Alternative 5 – Groundwater Containment Wall

Note that each alternative (except no action) includes the use of institutional controls such as a deed restriction which would prohibit the installation of potable water wells on a property to eliminate the possible ingestion of untreated groundwater. A groundwater monitoring program and contingency plans are also common to each alternative (except no action).

6.2 Overall Protection of Human Health and the Environment. Taking no action is not protective of human and the environment because institutional controls are not required and monitoring will not be conducted to identify if groundwater conditions change and cause increased risk. Assuming groundwater contamination at concentrations above regulatory or risk-based levels has not migrated to the west of the proposed off-site monitoring well network and the indoor inhalation pathway does not pose a risk, Alternatives 2, 3, 4 and 5 are protective of human health and the environment.

6.3 Compliance with ARARs. MNA complies with ARARs. Barrier treatment will need to comply with possible ARARs regarding injection of chemicals into groundwater. Pilot testing of barrier treatment will need to evaluate water quality conditions created by injection of treatment materials. Hydraulic containment and groundwater treatment by air stripping will need to comply with air and surface water discharge regulations.

6.4 Long-Term Effectiveness and Permanence. Each alternative (except no action) includes institutional controls to reduce potential exposure to untreated groundwater until cleanup levels are achieved. Alternatives 2 through 5 provide similar levels of long term effectiveness and permanence. Alternatives 3 through 5 may reduce the remedial time frame in comparison to MNA.

6.5 Reduction in Toxicity, Mobility or Volume through Treatment. Alternatives 3 through 5 involve treatment methods that reduce toxicity, mobility and volume of affected groundwater.

6.6 Short-Term Effectiveness. Each of the alternatives would be implemented in accordance with an approved HASP. Barrier treatment could cause water quality conditions due to the injected materials. Additional Site evaluation is needed to assess the potential remedial time frames associated with Alternatives 2 through 5.

6.7 Implementability. Alternatives 2 through 5 would require access agreements and regulatory approvals prior to implementation. Each alternative can be implemented using available methods and technology. Implementation of a barrier treatment may include regulatory approval that is needed for injection of treatment materials into groundwater. Hydraulic containment has the most components associated with implementation (i.e., extraction wells, extensive piping network, substantial treatment system, pipeline construction, permits, O&M requirements).

6.8 Cost. The preliminary present value costs for Alternatives 2 through 5, assuming that treatment and monitoring will require 30 years to complete, are as follows:

| | |
|---|---|
| Alternative 2 | $ 5,640,772 |
| Alternative 3 | $13,391,769 |
| Alternative 4 | $14,501,653 |
| Alternative 5 | $32,780,138 |

Alternative 2 is the most cost effective alternative. Below is a summary of Alternative 2 costs compared to Alternatives 3 through 5 costs:

Alternative 3 – approximately 2.37 times greater
Alternative 4 – approximately 2.57 times greater
Alternative 5 – approximately 5.81 times greater

Due to the feasibility level and conceptual level definition of the remedial alternatives, in our opinion, the present value costs may be considered within the following accuracy ranges.

| | | |
|---|---|---|
| Alternative 2: | -30 to +50 percent | cost range $3,948,540 to $8,461,158 |
| Alternative 3: | -30 to +50 percent | cost range $9,374,239 to $20,087,654 |
| Alternative 4: | -50 to +100 percent | cost range $7,250,827 to $29,003,306 |
| Alternative 5: | -30 to +50 percent | cost range $22,946,097 to $49,170,207 |

**APPENDIX A**

**FEBRUARY 21, 2014**
**ENGINEERING MANAGEMENT SUPPORT, INC. REPORT**

**ENGINEERING MANAGEMENT SUPPORT INC.**

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February 21, 2014

Daniel R. Gravatt
Remedial Project Manager
Missouri/Kansas Remedial Branch - Superfund Division
U.S. Environmental Protection Agency – Region 7
11201 Renner Boulevard
Lenexa, KS 66129

**SUBJECT: Groundwater Monitoring Report**
**October 2013 Additional Groundwater Sampling Event**
**West Lake Landfill Operable Unit 1, Bridgeton, Missouri**

Dear Mr. Gravatt,

On behalf of Cotter Corporation (N.S.L.), Laidlaw Waste Systems (Bridgeton), Inc., Rock Road Industries, Inc., and the United Sates Department of Energy (the "Respondents"), enclosed please find two copies of the Groundwater Monitoring Report for the October 2013 Additional Groundwater Sampling Event. We have also transmitted one copy of the report to the Shawn Muenks of the Missouri Department of Natural Resources. If you have any questions or need additional copies, please do not hesitate to contact me.

Sincerely,
**ENGINEERING MANAGEMENT SUPPORT, Inc.**

Paul V. Rosasco, P.E.

Enclosure

Distribution:

Audrey Asher – USEPA (via electronic mail only)
Shawn Muenks - Missouri Department of Natural Resources
Victoria Warren – Republic Services, Inc.
Jessica Merrigan – Lathrop & Gage, LLP
Kate Whitby - Spencer Fane Britt & Browne
Charlotte Neitzel – Bryan Cave HRO
Steven Miller - U. S. Department of Energy (via electronic mail only)
Christina Richmond – U.S. Department of Justice (via electronic mail only)
Ward Herst - Herst & Associates, Inc.

# Groundwater Monitoring Report

## October 2013 Additional Groundwater Sampling Event

## West Lake Landfill Operable Unit-1

**Prepared for**

The United States Environmental Protection Agency Region VII

**Prepared on behalf of**

The West Lake Landfill OU-1 Respondents

**Prepared by**

Engineering Management Support, Inc.
7220 West Jefferson Avenue, Suite 406
Lakewood, Colorado 80235

February 21, 2014

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## 1. INTRODUCTION

In January 2013 the U.S. Environmental Protection Agency, Region VII (EPA) directed the West Lake Landfill Operable Unit-1 (OU-1) Respondents to perform additional groundwater sampling at the West Lake Landfill Superfund Site. Discussions with EPA resulted in a decision to perform three additional rounds of groundwater sampling in April, July and October 2013. Engineering Management Support Inc. (EMSI), on behalf of Cotter Corporation (N.S.L.), Bridgeton Landfill, LLC and Rock Road Industries, Inc., and with funding provided by the United States Department of Energy (collectively, the OU-1 Respondents), prepared this report presenting the results of the October 2013 groundwater sampling.

EPA requested that, similar to the July/August 2012 additional groundwater monitoring event, all available groundwater monitoring wells at the West Lake Landfill Superfund Site property be included in the October 2013 groundwater sampling event. This includes:

- Those wells still in existence from the group of 30 wells that had previously been sampled as part of the OU-1 RI/FS;
- The group of 24 wells that had previously been sampled as part of the OU-2 RI investigation but which, prior to the July/August 2012 event, had not been sampled since 1997 and had never been sampled for Radium-228; and
- Additional wells associated with the former Bridgeton Sanitary Landfill (a/k/a the Permitted Landfill) which, prior to the July/August 2012 sampling event, had never been sampled for any radioisotopes.

As a reminder, OU-1 consists of Radiological Areas 1 and 2 which contain radiologically-impacted materials (RIM). OU-2 consists of the remainder of the Site which did not receive RIM, including the Inactive Sanitary Landfill, the Closed Demolition Landfill, and the former Permitted Landfill's North and South Quarry units.

In addition to the above wells, Bridgeton Landfill, LLC, installed eight additional groundwater monitoring wells during the periods from October 2-8 and 15-20, 2013. The wells were constructed as four clusters of two wells each. At each of the four drilling locations, a St. Louis / Upper Salem well (-SS) and Deep Salem well (-SD) were installed. As shown on Figure 1, six of the wells (PZ-209-SD and –SS, PZ-210-SD and –SS, and PZ-211-SD and –SS) were installed in the vicinity of existing groundwater monitoring wells PZ-104-SS, -SD, and -KS on the southeastern side of the overall site property. These six wells were installed in order to provide a more detailed characterization of groundwater quality in the St. Louis / Upper Salem Unit and Deep Salem Unit near the PZ-104-SS/SD/KS cluster. The remaining two wells (PZ-212-SD and –SS) were installed further to the east, at the edge of the Bridgeton Landfill facility property boundary. These wells were installed to provide additional upgradient (i.e., upgradient of all of the OU-1 and OU-2 landfill units at the site) groundwater quality data. The new wells were developed and groundwater from the wells was sampled on November 6 and 7, 2013. A copy of the Groundwater Monitoring Well Installation Report (Herst & Associates, 2014) is provided as

Appendix A to this report and the analytical results from these new wells are included in this report.

EPA further directed that the samples obtained from the wells described above be analyzed for uranium, thorium, and radium radioisotopes (including Radium-226 and Radium-228), with all radioisotopes analyzed for both total (unfiltered samples) and dissolved (filtered samples) phases; plus total and dissolved phase trace metals; and volatile organic compounds (VOCs). EPA determined that analyses of the samples for semi-volatile organic compounds (SVOCs), which was performed as part of the July/August 2012 monitoring event, did not need to be repeated as part of the additional 2013 groundwater monitoring events.

This report presents the results of the October 2013 additional groundwater monitoring activities. Analytical results from samples collected on November 6-7, 2013 for the new PZ-209 through -212 series monitoring wells are also presented. Specifically, this report includes a description of the field and sample collection activities and summaries of the results of the laboratory analyses of the groundwater samples. This report also contains copies of the various field data sheets (Appendix B), the analytical laboratory reports (Appendix C), and the data validation reports and resultant database (Appendix D). Due to the size of these documents, the appendices are contained on the included compact disk.

## 2. FIELD AND SAMPLE COLLECTION ACTIVITIES

A Sampling and Analysis Plan (SAP) and associated planning documents were prepared to describe the proposed monitoring locations, sample collection procedures, analyte list, laboratory analyses, quality assurance/quality control samples and procedures, investigative-derived waste management, health and safety procedures, and data evaluation and management procedures for the July/August 2012 additional groundwater monitoring event (EMSI, 2012). EPA approved the SAP by letter dated July 3, 2012. This SAP and the associated planning documents continued to be used for the October 2013 event.

The groundwater sampling event began on September 30, 2013 with well inspections and collection of a complete set of water level measurements from all 77 of the monitoring wells located on the property at that time. A summary of the groundwater level measurement data obtained from these 77 wells is provided in Table 1. A base map showing the locations of the monitoring wells and various Site features is presented on Figure 1. Copies of the groundwater elevation measurement and the groundwater monitoring well condition report forms are contained in Appendix B.

Collection of groundwater samples from those wells where water levels were collected on September 30, 2013, began on October 1, 2013, and continued on a daily basis five days a week until sampling activities were completed on October 15, 2013. Groundwater samples were collected by Herst & Associates personnel in accordance with the procedures set forth in the SAP. Copies of the Field Information Logs from the groundwater sampling activities are contained in Appendix B. Copies of the chain of custody forms are included in the laboratory analytical reports which are provided in Appendix C. Groundwater samples were obtained from 76 of the 77 total monitoring wells or piezometers at the Site (Table 2). Although a water level measurement was obtained from well LR-105 on September 30, 2013 (located southwest of the Inactive Sanitary Landfill), an actual sample of groundwater could not be collected due to the presence of a bend in the well casing that made it impossible to lower the sampling equipment into the saturated interval of this well. Nine field duplicate groundwater samples were also obtained during the course of the October 2013 groundwater sampling activities (Table 2).

MDNR was present for sampling activities conducted on October 7 - 9, 2013. During this period MDNR obtained split samples from 12 wells, as shown on Table 2. MDNR also collected split samples for EPA on October 7, 2013 from PZ-104-SD and on October 8, 2013 from well PZ-102-SS. The radium results from the EPA and MDNR split samples collected during the October 2013 monitoring event are provided in Section 6.

Groundwater samples from the eight new PZ-209 through -212 series wells installed in October 2013 were collected on November 6 and 7, 2013 by Herst & Associates personnel in accordance with the procedures set forth in the SAP. Copies of the Field Information Logs from these groundwater sampling activities are also contained in Appendix B. Copies of the chain of custody forms are included in the laboratory analytical reports which are provided in Appendix C. A field duplicate groundwater sample was collected from new well PZ-210-SD.

## 3. LABORATORY ANALYSES

Samples designated for radionuclide analyses were shipped by courier to the Eberline Services Oak Ridge, TN laboratory (Eberline). The sampling crews delivered samples designated for chemical analyses directly to the Test America St. Louis laboratory (Test America).

Eberline analyzed the samples for Radium-226 using EPA Modified Method 903.0; for Radium-228 using EPA Modified Method 904.0; for Thorium-228, -230 and -232 using EML Modified Method Th-01; and for Uranium-234, -235, and 238 using EML Modified Method U-02. The Eberline Analytical Reports are contained in Appendix C. The Eberline analytical laboratory reports include the laboratory results, the counting error, the combined standard uncertainty (included on the Electronic Data Deliverable [EDD] provided by the laboratory), the minimum detectable activity (MDA) levels, and associated laboratory documentation related to sample receipt, handling, preparation and analysis.

EPA (along with other agencies) has developed the Multi-Agency Radiological Laboratory Analytical Protocols (MARLAP) Manual to address the need for a nationally consistent approach to producing radioanalytical laboratory data (EPA, 2004). MARLAP states that an important aspect of sampling and measurement is uncertainty. The Combined Standard Uncertainty (CSU) can be viewed as the statistical standard deviation of an individual radiological result (McCurdy et al., 2008). The concentration of a radiological constituent in a sample is typically calculated using a mathematical equation that includes such parameters as the measured signal response of a radiation detector (events per time unit), the detector background signal response, the detector efficiency for the radiation emission producing the response, sample aliquant size processed, chemical yield of the radiochemical process, and decay and ingrowth factors based on the half-life of the radionuclide or its decay product. Each measurement parameter in the equation has its own uncertainty defined as a standard uncertainty. The CSU of the final result is determined using the common statistical approach that the variance (squared CSU) of a function of several variables can be approximated by applying the function to the variance of each variable component (for example, MARLAP, Chapter 19 [EPA, 2004]). Using this logic, the CSU of a radiological result is the square root of a sum of variances. When a concentration and its associated CSU are reported, a confidence interval can be calculated that defines the range of concentration (the lower and upper concentration) for the "true concentration" with a certain confidence. For this project, Eberline calculated and reported the CSU at the 95-percent or 2-sigma confidence level (analogous to the standard confidence level used when reporting the standard deviation for other water-quality results). The confidence level that is used when interpreting or publishing radiological results is dependent on the Data Quality Objectives (DQOs) of the project. Reporting the concentration with its corresponding CSU (as provided in the data) provides the 95-percent confidence interval. Therefore, the summary tables of the radionuclide analyses (see Section 6) include the laboratory calculated CSU associated with each sample result.

Test America analyzed the chemical samples for VOCs by gas chromatography/mass spectrometry (GC/MS) using EPA Method 8260C; for the Target Analyte List (TAL) trace metals by Inductively Coupled Plasma (ICP) using EPA Method 6010C; and for Mercury by Cold Vapor Atomic Adsorption (CVAA) using EPA Method 7470A. At the request of EPA and the United States Geological Service (USGS), samples from the October 2013 event were also analyzed for boron and strontium. The Test America Analytical Reports are included in Appendix C.

In addition to the analyses requested by EPA, the samples were analyzed for certain chemistry characterizations: major anions by Ion Chromatography (IC) using SW-846 Method 300.0; major cations by ICP using EPA Method 6010C; alkalinity by SW-846 Method 310.1; and bromide and iodide by IC using SW-846 Method 300.0. Results of these analyses can also be found in the Test America Analytical Reports included in Appendix C.

## 4. DATA VALIDATION

A Level III validation was performed consisting of manually examining data deliverables to determine data quality for the analytical results involving samples collected by the Respondents. Analytical results provided by EPA and MDNR for their split samples were not validated. All validated data were validated using method applicable guidelines and in accordance with the requirements of the National Functional Guidelines for Organic and Inorganic Data Review (EPA, 2008 and 2010) and by EPA SW-846 guidelines (EPA, 2007) specific to the method.

Radionuclides were validated in general accordance with the guidelines and criteria specified in the MARLAP Manual (EPA, 2004). Data validation included application of data qualifiers to the analytical results based on adherence to method protocols and project-specific QA/QC limits. The data validation reports for each sample delivery group are included in Appendix D.

Method protocols reviewed included:

- Analytical holding times,
- Method blanks (MB),
- Trip blanks (TB),
- Equipments blanks (EBs),
- Matrix spikes/matrix spike duplicates (MS/MSDs),
- Laboratory control samples (LCSs),
- Shipping cooler temperatures,
- Calibrations,
- Laboratory duplicates,
- Internal Standards (ISs),
- Surrogates, and
- Chemical recovery (radionuclides).

Based on the data validation, appropriate data qualifiers, if any, were added to the analytical results. An analytical database that includes the applied data qualifiers is included in Appendix D.

Data quality assessment (DQA) criteria were used to evaluate the quality of the field sampling efforts and laboratory results for compliance with project DQOs. The DQA criteria are expressed in terms of analytical precision, accuracy, representativeness, completeness, and comparability (PARCC).

**Precision** is the measure of variability between individual sample measurements under prescribed conditions. The relative percent difference (RPD) for the field duplicate, matrix spike/matrix spike duplicate (MS/MSD), and laboratory duplicate analyses demonstrate the precision of the analytical methods. An RPD within the method-specific control limit indicates satisfactory precision in a measurement system. For this sampling event, duplicate results were predominantly in control.

**Accuracy** is the degree of agreement of a measurement with an accepted reference or true value. The results of surrogate, MS/MSD, chemical recovery, and LCS analyses, when expressed in terms of percent recovery, demonstrate the accuracy of the method. Accuracy results for all methods and matrices are predominantly in control. The accuracy results which were out-of-control are not significant for any one compound, method, or matrix and do not represent a negative impact to data quality. Therefore, overall accuracy for this sampling event was acceptable, excepting only well S-5 for total and dissolved uranium results and well MW-1204 for dissolved thorium results, which in both cases were rejected because chemical recoveries were less than 20% due to spectral degradation (see Data Validation Reports "DVR 13-10095 Uranium.pdf" for the S-5 results and "DVR 13-10109 Thorium.pdf" for the MW-1204 results in Appendix D.1.).

**Representativeness.** Sample data are believed to be representative of the site conditions prevailing at the time of sample collection because most of the samples were properly collected, stored, and preserved. All samples were analyzed within holding time except nitrate for 15 samples where the laboratory experienced equipment problems and could not analyze for nitrate within the required time limit. The samples obtained from well S-5 for dissolved and total metals analyses, and from well PZ-113-AD field duplicate for total metals, were received at the laboratory without preservative. The laboratory corrected the pH to <2. Data quality was not adversely affected (see Data Validation Report "DVR-160-4022 METALS.pdf" in Appendix D.1.). Although blank contamination did occur (mostly with common lab contaminants), sample data quality was not adversely affected.

**Comparability.** All samples were reported in industry-standard units. Water reporting units were micrograms per liter (µg/L), milligrams per liter (mg/L) or picocuries per liter (pCi/L). Analytical protocols for the methods were adhered to (with the exceptions noted in this report) and analytical results are considered comparable.

**Completeness** is defined as the percentage of laboratory measurements judged to be valid on a method-by-method basis. Valid data are defined as all data and/or qualified data which meet the DQOs for this project. Data completeness is expressed as percent complete (PC), which is calculated as follows: (the number of rejected samples per compound ÷ total number of samples per compound) X 100. Completeness is 99%, understanding that all results qualified with U, UJ or J are usable to meet the project objectives of this sampling event. The goal for meeting analytical holding times was 100% completeness and was met for all samples except for the 15 nitrate sample analyses described above.

**Sensitivity** was evaluated using the RLs and MDLs for each sample as compared to project maximum allowable RLs. The laboratory RLs met required RL limits for most compounds except when adjusted for sample dilution. For radionuclides, when the sample results are greater than the MDA but have a combined standard uncertainty less than 50% of the sample activity, the sample is qualified with a J. This is an indication that the value is near the MDA and has a relatively large combined standard uncertainty as compared to the sample result.

The groundwater data are of acceptable quality and are considered usable to support the project objectives for this sampling event. Samples are representative of the Site when used in accordance with the validation qualifiers.

## 5. GROUNDWATER LEVELS

Groundwater is present within the alluvium and bedrock deposits beneath the Site. The edge of the geomorphic floodplain for the Missouri River was evaluated as part of the Supplemental Feasibility Study (EMSI, 2011) and was determined to be located beneath the southeastern portion of the Site (Figure 2). To the northwest of this boundary, the uppermost (shallowest) groundwater occurs within the alluvial deposits. Because alluvium is not present beneath the southeastern portion of the Site, the uppermost groundwater is found in bedrock of the St. Louis Formation.

Water level measurements (Table 1) were obtained from the 77 monitoring wells existing on-site on September 30, 2013 (the PZ-209 through -212 series wells were not constructed until October 2013), and these data were used to develop a potentiometric surface (water level) map for the Site (Figure 2). Groundwater within the bedrock St. Louis Formation beneath the southern and southeastern boundaries of the Site displayed the highest water level elevations [ranging from approximately 451 to approximately 475 feet (ft) above mean sea level (amsl)], whereas the lowest groundwater elevations (approximately 420 to 430 ft amsl) were present within the alluvial deposits beneath the northern portion of the Site. These data indicate that the overall direction of the hydraulic gradient in the area of the Site is to the northwest, towards the Missouri River.

The water level data also indicate that overall, groundwater within the bedrock generally discharges to the alluvial deposits at the Site (Figure 2). With the exception of the area immediately around the North and South Quarry landfills, the water levels in the bedrock (e.g., PZ-208-SS, PZ-201A-SS, PZ-102-SS and PZ-102R-SS) are substantially higher (i.e., approximately 452 to 468 ft amsl) than the water levels in the nearby alluvial deposits (i.e., approximately 430 to 431 ft amsl), indicating that groundwater flows from the bedrock into the alluvium. In addition, water level data obtained from co-located alluvial and bedrock wells support the conclusion that groundwater within the bedrock discharges to the alluvium. The water level data indicate that the water levels within the bedrock wells are generally higher than the water levels in nearby alluvial wells, suggesting that an upward gradient generally exists from the bedrock to the alluvium beneath the Site. Comparison of the water levels in the PZ-113 well cluster indicates a slightly upward gradient between both the shallow alluvium and bedrock and between the deep alluvium and bedrock. For the co-located PZ-205 wells, there is a 2.26 foot difference in the water levels indicating an upward gradient between the St. Louis

Formation bedrock well PZ-205-SS (water level elevation 434.90) and co-located alluvial well PZ-205-AS (432.64).

Review of water level data obtained from well clusters completed within the alluvial deposits beneath the northern portion of the Site (Table 3) indicates that the relative heights of the water levels within co-located alluvial monitoring wells were variable on September 30, 2013. Some of the alluvial well clusters displayed higher water levels in the shallower alluvial wells which are completed in the upper portion of the alluvium while lower water levels appeared in the deeper alluvial wells that are completed near the base of the alluvial deposits (e.g., compare water levels from S-5, I-4, and D-3 and the S-84 and D-85 well clusters near OU-1 Area 1; the MW-102 and D-6 and the S-10, I-11 and D-12 well clusters near Area 2; and the PZ-302 well cluster near the Inactive Landfill). The water level data obtained from these well clusters indicate that a slight downward hydraulic gradient was present within the alluvial deposits beneath these portions of the Site on September 30, 2013. However, in other well clusters (e.g., compare the water levels in the S-8, I-62 and D-83 and S-82, I-9 and D-93 well clusters near Area 2 and the PZ-304 well cluster near the Inactive Landfill), the highest water levels occurred in the deeper portions of the alluvial aquifer. These data suggest that a slight upward hydraulic gradient was present within the alluvial deposits beneath these other portions of the Site on September 30, 2013.

The hydraulic gradient within the bedrock wells in the southern portion of the Site is relatively steep, as much as 17 vertical feet per 680 horizontal feet or 0.03 feet per feet (ft/ft) to the northwest beneath Area 1, and 10 feet per 135 feet (0.074 ft/ft) to 5 feet per 365 feet (0.014 ft/ft) to the northwest in the area to the east of the North Quarry Landfill. The hydraulic gradient within the alluvial deposit beneath the northern portion of the Site is very flat ranging from approximately 0.0003 to 0.0006 ft/ft beneath Areas 1 and 2. These values are within the range of values reported in the RI (EMSI, 2000). Based on reported average values of $3 \times 10^{-2}$ to $3 \times 10^{-3}$ cm/sec (85 to 8.5 ft/day) for the hydraulic conductivity of the alluvium (EMSI, 2000), an assumed effective porosity of 25%, and a hydraulic gradient of 0.0002 ft/ft to 0.0011 ft/ft, the overall velocity of groundwater flow within the alluvium would be approximately 0.0102 to 0.20 feet per day or approximately 3.7 to 73 feet per year.

## 6. GROUNDWATER SAMPLE RESULTS

This section summarizes the analytical laboratory results for the groundwater samples.

### 6.1 Radionuclides

The results of the laboratory analyses of the uranium, thorium and radium isotopes are summarized on Tables 4, 5 and 6, respectively. Of the 76 wells sampled in October 2013 (one well could not be sampled as explained above), 26 are OU-1 wells which historically have been sampled for uranium, thorium, and both Radium-226 and Radium-228. The remaining 50 wells are OU-2 RI wells which, prior to the current rounds of additional groundwater sampling initiated in July/August 2012, were previously sampled for uranium, thorium, and Radium-226 (but not Radium-228) parameters in 1997 or 2004; or are Bridgeton Landfill monitoring wells which were not previously subject to radiological sampling and so, again, were not sampled for uranium, thorium or radium prior to the current West Lake Landfill 2012/2013 additional groundwater sampling events.

In accordance with the SAP, samples collected in early November 2013 from the eight new PZ-209 through -212 series monitoring wells constructed in late October 2013 also were analyzed for the same uranium, thorium and radium isotopes as the other October 2013 groundwater sampling event wells. Accordingly, a total of 84 wells (76 of the 77 wells present on the Site prior to November of 2013 plus the eight new wells) were sampled and are included in this October 2013 groundwater monitoring report.

### 6.1.1 Uranium

Table 4 presents a summary of the analytical results of the uranium isotopes. The reported results are presented in units of activity (picocuries per liter or pCi/L) which were converted to units of mass (micrograms per liter) [µg/L] using the procedure defined by EPA (2000).

One sample contained a calculated total uranium mass concentration that exceeded the EPA Maximum Contaminant Level (MCL) of 30 µg/L (Table 4). The total fraction (unfiltered) sample from the new deep St. Louis/Salem formation monitoring well PZ-211-SD located in the southeastern side of the site contained a total uranium concentration of 70.25 µg/L (Table 4). The reported dissolved (filtered) fraction total uranium concentration from this well was only 13.75 µg/L.

Of the samples that contained total uranium less than the EPA MCL, the highest concentration of total uranium (17.63 µg/L) was detected in the total fraction sample from alluvial monitoring well S-53. The concentration of total uranium in the dissolved fraction sample from this well was 11.35 µg/L. Well S-53 is located to the west of the southern portion of the Inactive Sanitary Landfill and the South Quarry Landfill. Well MW-102, an intermediate depth alluvial monitoring well located adjacent to the northwestern boundary of Area 2, contained 15.75 µg/L uranium in the total fraction sample and 15.15 µg/L in the dissolved fraction sample during the October 2013 event. The total fraction samples from alluvial monitoring wells PZ-302-AS, PZ-302-AI, and MW-104 located at the southern edge of the site south of the Inactive Sanitary Landfill contained uranium at concentrations of 13.82, 10.27, and 9.02 µg/L, respectively.

Higher levels of uranium were also reported in the total and dissolved fraction samples for monitoring wells completed in the deeper bedrock formations located to the south (upgradient) of OU-1 Radiological Areas 1 and 2 (e.g., PZ-102-SS: 15.32 µg/L total fraction and 6.89 µg/L dissolved fraction; PZ-102R-SS: 7.82 µg/L total fraction and 7.03 µg/L dissolved fraction; PZ-111-KS: 6.66 µg/L total fraction and 7.04 µg/L dissolved fraction; and LR-104: 5.87 µg/L total fraction and 6.75 μg/L dissolved fraction). Again, all of these results were below the EPA MCL for uranium.

### 6.1.2 Thorium

Table 5 presents a summary of the analytical results of the Site groundwater samples for the thorium isotopes. Overall, only low levels (less than 1 pCi/L) of the thorium isotopes were detected in the majority of the wells. The highest total thorium (Thorium-228 plus Thorium-230 plus Thorium-232) values found in the October 2013 sampling event were reported in the total (unfiltered) fraction samples obtained from bedrock monitoring wells PZ-211-SD and PZ-102-SS, which are both located upgradient of OU-1 Areas 1 and 2, and alluvial monitoring wells D-85, S-61, and MW-104 (Table 5). In contrast, the dissolved fraction samples from these same wells contained only very low or non-detectable levels of total thorium, indicating that the thorium occurrences in these wells are most likely associated with the suspended sediment contained within the total fraction samples. There are no federal or State drinking water or other water quality standards for any of the thorium isotopes or for total thorium.

### 6.1.3 Radium

Table 6 summarizes the analytical results for the radium isotopes (Radium-226 and Radium-228) for the October 2013 groundwater samples. Figures 3 and 4 present the total and dissolved fraction Radium-226 results plotted on the Site base map. Figures 5 and 6 present the total and dissolved fraction Radium-228 results plotted on the Site base map. Figures 7 and 8 present the combined Radium-226 plus Radium-228 results for the total and dissolved fraction samples, respectively, on the Site base map. EPA has not set separate MCLs for the two radium isotopes, rather, EPA has set the MCL at 5 pCi/L for the combined total of Radium-226 and Radium-228.

#### 6.1.3.1 Radium-226

The highest levels of Radium-226 detected in the total fraction samples were for samples obtained from upgradient (of OU-1 Areas 1 and 2) bedrock monitoring wells MW-1204 (26.93 pCi/L), PZ-211-SD (22.71 pCi/L), PZ-101-SS (15.7 pCi/L), PZ-102-SS (9.93 pCi/L), and PZ-107-SS (7.73 J pCi/L); and Area 1 bedrock monitoring well PZ-115-SS (8.89 pCi/L) [Table 6 and Figure 3]. The highest levels of Radium-226 detected in the dissolved fraction samples were obtained from upgradient (of OU-1 Areas 1 and 2) bedrock monitoring wells PZ-101-SS (17.4 pCi/L), PZ-107-SS (10.01 J pCi/L), and PZ 104-SD (6.29 J pCi/L); and Area 1 bedrock monitoring well PZ-115-SS (5.6 pCi/L) [Table 6 and Figure 4]. The highest concentrations of Radium-226 detected in any of the alluvial monitoring wells occurred in the total fraction samples obtained from Area 1 monitoring well D-85 (4.46 J pCi/L) and monitoring well I-73 (4.47 J pCi/L), which is located cross-gradient of Area 1 adjacent to the South Quarry Landfill and upgradient of Area 2.

#### 6.1.3.2 Radium-228

The highest level of Radium-228 detected in the total fraction samples occurred in upgradient (of OU-1 Areas 1 and 2) bedrock monitoring wells PZ-211-SD (25.8 J+ pCi/L), PZ-209-SD (14.81 J+ pCi/L), MW-1204 (11.04 pCi/L), PZ-104-SD (8.05 J pCi/L) and PZ-200-SS (5.17 pCi/L); and in Area 1 alluvial monitoring wells I-4 (7.69 J pCi/L), PZ-113-AD (6.06 J+ pCi/L and 6.35 J+ pCi/L in the field duplicate sample), and S-84 (5.8 pCi/L in the field duplicate sample). The highest reported levels of Radium-228 detected in the dissolved fraction samples occurred in upgradient (of OU-1 Areas 1 and 2) bedrock monitoring wells PZ-104-SD (8.08 J pCi/L) and PZ-211-SD (5.65 J+ pCi/L); Area 1 alluvial monitoring well PZ-113-AD (6.2 J+ pCi/L and 8.44 J+ pCi/L in the field duplicate sample); and upgradient (of OU-1 Areas 1 and 2) alluvial monitoring wells PZ-302-AS (6.71 J+ pCi/L) and I-73 (5.8 J+ pCi/L) [Table 6 and Figure 6].

#### 6.1.3.3 Combined Radium-226 and -228

Figures 7 and 8 present the combined Radium-226 plus Radium-228 results for the total and dissolved fraction samples, respectively, plotted on the Site base map. The highest combined Radium-226 plus Radium-228 values for the total (unfiltered) fraction samples occurred in bedrock monitoring wells PZ-211-SD (48.51 pCi/L), MW-1204 (37.97 pCi/L), PZ-101-SS (15.70 pCi/L), PZ-209-SD (14.81 pCi/L), PZ-102-SS (13.37 pCi/L), PZ-104-SD (10.89 pCi/L), PZ-107-SS (7.73 pCi/L), PZ-200-SS (7.06 pCi/L), PZ-106-SS (6.98 pCi/L), and PZ-100-SS (6.52 pCi/L), and alluvial monitoring wells I-73 (9.97 pCi/L) and MW-104 (7.29 pCi/L), all of which are located upgradient or cross-gradient from Areas 1 and 2. Combined Radium-226 plus Radium-228 levels above the MCL were also reported for Area 1 alluvial monitoring wells PZ-113-AD (8.88 pCi/L and 9.09 pCi/L in the field duplicate sample), I-4 (7.69 pCi/L), S-84 (7.2 pCi/L for the field duplicate, however the investigative sample only contained 2.75 pCi/L), and D-3 (7.13 pCi/L); Area 1 bedrock monitoring wells PZ-115-SS (8.89 pCi/L) and PZ-113-SS (6.88 pCi/L); and Area 2 alluvial monitoring well D-93 (7.54 pCi/L) [Table 6 and Figure 7].

The highest combined Radium-226 plus Radium-228 values for the dissolved (filtered) fraction samples occurred in upgradient bedrock monitoring wells PZ-101-SS (17.40 pCi/L), PZ-104-SD (14.37 pCi/L), PZ-107-SS (12.31 pCi/L), PZ-100-SS (6.59 pCi/L), PZ-211-SD (6.18 pCi/L), and PZ-203-SS (5.73 pCi/L), and upgradient (of OU-1 Areas 1 and 2) alluvial monitoring wells I-73 (8.85 pCi/L) and PZ-302-AS (6.97 pCi/L). Combined Radium-226 plus Radium-228 levels above the MCL were also reported for Area 1 alluvial monitoring wells PZ-113-AD (8.5 pCi/l and 10.82 pCi/L in the field duplicate sample) and D-3 (7.24 pCi/L); Area 1 bedrock monitoring wells PZ-113-SS (6.68 pCi/L) and PZ-115-SS (5.6 pCi/L); Inactive Sanitary Landfill monitoring well D-87 (6.44 pCi/L and 5.86 pCi/L in the field duplicate sample); and in Area 2 alluvial monitoring wells D-6 (6.28 pCi/L) and D-93 (6.23 pCi/L) [Table 6 and Figure 8].

A total of 30 of the 84 monitoring wells sampled for the October 2013 event showed an exceedance of the combined Radium-226 plus Radium-228 MCL of 5 pCi/L, either for total and dissolved fraction, total fraction only, or dissolved fraction only. The combined Radium-226 plus Radium-228 results from 14 of the 84 monitoring wells exceeded the MCL for both the total fraction and the dissolved fraction. These include four bedrock monitoring wells located upgradient of OU-1 Areas 1 and 2 (PZ-100-SS, PZ-101-SS, PZ-104-SD, PZ-107-SS, and PZ-211-SD); one alluvial well (I-73) located upgradient of OU-1 Area 2 and cross-gradient of Area 1; four Area 1 alluvial (D-3 and PZ-113-AD) and bedrock (PZ-113-SS and PZ-115-SS) monitoring wells; three Area 2 alluvial monitoring wells (D-6, D-83, and D-93); and one Inactive Sanitary Landfill monitoring well (D-87) [Table 6 and Figures 7 and 8]. The combined total fraction (but not the dissolved fraction) radium results in 12 other monitoring wells exceeded the MCL. These 12 monitoring wells include three alluvial wells (D-81, MW-104, and PZ-304-AI) located upgradient or cross-gradient of Areas 1 and 2 and six bedrock monitoring wells (MW-1204, PZ-102-SS, PZ-106-SS, PZ-200-SS, PZ-204A-SS, and PZ-209-SD) located upgradient of OU-1 Areas 1 and 2; two Area 1 alluvial monitoring wells (I-4 and S-84 field duplicate [although the S-84 investigative sample was only 2.75 pCi/L]); and one (I-9) Area 2 alluvial monitoring well [Table 6 and Figure 7]. The combined dissolved fraction (but not the total fraction) radium results in four monitoring wells exceeded the MCL, including bedrock monitoring wells PZ-105-SS and PZ-203-SS located upgradient of OU-1 Areas 1 and 2 and alluvial monitoring wells LR-103 and PZ-302-AS, which are located upgradient of Area 2 and cross-gradient of Area 1.

The combined Radium-226 plus Radium-228 results for the other 54 of the 84 monitoring wells sampled for the October 2013 event were less than, and for the majority of the wells significantly less than, the EPA MCL of 5 pCi/L. For the combined total fraction, results for 16 of the 54 wells were less than 1 pCi/L; six were between 1 and 2 pCi/L; 11 were between 2 and 3 pCi/L; 15 were between 3 and 4 pCi/L; and only six were between 4 and 5 pCi/L.

#### 6.1.3.4 Duplicate Sample Results for Radium

Nine field duplicate samples were collected as part of the October 2013 event (Tables 2 and 7). Field duplicate samples were obtained by filling two sets of sample bottles and submitting the two samples to the laboratories as unique samples. Comparisons of the field duplicate sample results for total and dissolved Radium-226 and Radium-228 are presented on Table 7. Relative percent difference (RPD) values are provided on Table 7 to assist in the evaluation of the field duplicate sample results.

The highest RPDs for the Radium-226 results were obtained from sample pairs that contained the lowest radium activity levels (i.e., less than 1 pCi/L of radium), and generally were associated with values that were qualified by the laboratory or the data validation effort as being estimated values. When the combined standard uncertainty values of the sample results are considered, the total Radium-226 results obtained from the duplicate samples were generally equivalent to the original samples.

In the cases where Radium-228 was detected in both the original and field duplicate sample and considering those sample pairs where the values were qualified by the laboratory or the data validation effort as being estimated, the results are generally equivalent with the exception of the duplicate sample results obtained from monitoring well S-84 (Table 7). Both the total and dissolved fraction results obtained from the S-84 field duplicate sample were approximately twice the results obtained for the original investigative sample. This condition was also observed in the July 2013 results from well S-84, where, based on results obtained from a laboratory duplicate sample, it was determined that the variability in the reported results from monitoring well S-84 appears to reflect analytical variability as opposed to variability arising from sample collection.

The Radium-228 results for several of the other duplicate samples were non-detect in the original sample, the duplicate sample or both samples (Table 7). In instances where one sample reportedly contained a detectable level of Radium-228 but the other sample did not, comparison of the minimum detectable activity (MDA) value for the non-detect result to the detected result in the other sample and consideration of the combined standard uncertainty of the results indicates that the results, although non-detect for one sample, are generally consistent.

#### 6.1.3.5 Split Sample Results for Radium

MDNR collected both total and dissolved fraction split samples from 11 monitoring wells (S-5, S-82, D-3, D-6, D-83, D-85, D-93, PZ-101-SS, PZ-102-SS, PZ-104-SD, and PZ-113-AD) during the October 2013 sampling event. MDNR also collected a total fraction-only split sample from well I-9. On behalf of EPA, MDNR collected split samples (total fraction-only) from PZ-102-SS and PZ-104-SD. The list of wells where split samples were collected is provided on Table 2.

Analytical results for Radium-226 and Radium-228 for the split samples are included on Table 8. The results provided by MDNR and EPA were unvalidated. For comparison purposes, the validated radium results for the split and field duplicate samples collected by the Respondents are also shown on Table 8. RPD values are provided on Table 8 to assist in the evaluation of the split sample results.

For the total fraction samples from well PZ-102-SS, even if the combined standard uncertainty values of the sample results are considered, the RPDs for Radium-226 (54 percent between the investigative sample collected by the Respondents and the EPA split sample; and 65 percent between the investigative sample and the MDNR split sample) indicate that the results are substantially different, with the result obtained by the Respondents significantly higher than those obtained from the EPA and MDNR split samples. It should be noted that MDNR used the same radiochemistry laboratory as Respondents to perform MDNR's analyses of the split samples. A substantial difference was also observed for the Radium-226 results in the total fraction samples from well PZ-101-SS, and the Radium-228 results in the total fraction samples from well S-5. Given that MDNR used the same analytical laboratory as the Respondents, the variability in the sample results likely reflects inherent variability in sample handling, preservation, laboratory preparation, and laboratory analysis.

With the exception of Radium-226 in the dissolved fraction sample from well D-83, for both the total and dissolved fraction samples from all of the other wells, the highest RPDs for the Radium-226 and Radium-228 results were obtained from split samples that were associated with results that were qualified by the laboratory or the Respondents' data validation effort as being estimated values. When considering the combined standard uncertainty values for Radium-226 in the dissolved fraction sample from well D-83, the results obtained from the MDNR split sample were generally equivalent to the results from the sample collected by the Respondents.

#### 6.1.3.6 Comparison to Prior Radium Sampling Results

Figures 9 and 10 present the historic total and dissolved Radium-226 results obtained for samples collected during the October 2013, July 2013, April 2013, and July/August 2012 sampling events, as well as those reported for the OU-1 RI/FS sampling events (McLaren Hart, 1996, and EMSI, 2000 and 2006), and the OU-2 RI/FS sampling events (Herst & Associates, 2005). Because the OU-2 RI/FS samples were only analyzed for Radium-226 (the RIM-associated radium isotope) and not Radium-228, these figures only include results for Radium-226 at those OU-2 wells. Likewise, because the Bridgeton Sanitary Landfill was not required to monitor for radiological parameters, the monitoring well results for the former Permitted Landfill do not include radiological parameters prior to the July/August 2012 sampling event. Finally, the Radium-226 results for split samples collected by EPA during the August 2012 (dissolved-only), April 2013 (total-only), July 2013 (total-only), and October 2013 (total-only, with two samples collected by MDNR for EPA) sampling events; and by MDNR during the August 2012, July 2013, and October 2013 sampling events (MDNR did not collect split samples in April 2013), are also included on Figures 9 and 10.

### 6.2 Trace Metals

The groundwater samples (including those from the eight new PZ-209 through -212 series wells sampled in November 2013) were analyzed for 19 trace metals, exclusive of the major chemistry cations (e.g., calcium, magnesium, sodium and potassium). Results obtained for the 13 most frequently detected trace metals are summarized on Table 9.

Arsenic was detected in one or both of the sample fractions (total or dissolved) obtained from 26 of the 84 monitoring wells. All of these 26 monitoring wells reportedly contained arsenic concentrations in the total, dissolved, or both fractions at levels that were at or exceeded the drinking water standard (MCL) of 10 µg/L. The highest reported arsenic concentrations (130 to 250 µg/L) were found in alluvial wells S-82, S-84, I-73, MW-102, PZ-112-AS, PZ-114-AS, PZ-302-AS, PZ-303-AS, and PZ-304-AS (Table 9).

The most frequently detected trace metals were iron and manganese (Table 9). Iron was detected in 74 wells. The majority (70) of the iron results exceed the drinking water standard (which is a secondary standard based on aesthetic considerations) of 300 µg/L. The highest levels of iron (i.e., greater than 50,000 µg/L) were found in both the total (unfiltered) and dissolved (filtered) sample fractions obtained from alluvial wells S-10, S-84, I-73, D-85, MW-1204, PZ-114-AS, PZ-302-AS, and PZ-303-AS; and only the total fraction samples obtained from MW-104 and PZ-205-AS.

Manganese was detected in 73 wells. The manganese results in 69 of the 73 wells exceeded the drinking water standard (a secondary standard based on aesthetic considerations) of 50 µg/L. The highest levels of manganese (i.e., greater than 5,000 µg/L) were found in the total and dissolved sample fractions obtained from alluvial wells S-10, MW-1204, and PZ-113-AS and bedrock well PZ-200-SS; and the total sample fraction from alluvial well MW-104.

It should be noted that the solubility of arsenic, iron and manganese is largely controlled by their oxidation states, with the reduced form of these metals possessing higher solubility values. Consequently, these metals are commonly detected at solid waste landfills where the anaerobic biodegradation of organic matter and the decreased infiltration of typically oxygen-rich precipitation (recharge) due to the presence of a lower permeability landfill cover results in the creation of reducing conditions. The presence of these trace metals can reflect dissolution of the metals from either the waste materials or dissolution of naturally occurring arsenic, iron and manganese within cover soil material, contained in the waste materials, or in the soil and bedrock adjacent to the waste deposits.

## 6.3 Volatile Organic Compounds

Table 10 presents a summary of the primary VOCs that were detected in the groundwater samples. The most commonly detected VOC was benzene, which was reported to be present in 36 of the 84 wells. Other VOCs (exclusive of common laboratory contaminants) that were detected in a number of the groundwater wells included cis-1,2-dichloroethene (detected in 15 of the wells), chlorobenzene (detected in 25 of the wells), methyl-tert-butyl ether [MTBE] (detected in 18 of the wells), and 1,4-dichlorobenzene (detected in 17 of the wells). Other VOCs that were detected include ethyl benzene (detected in 11 of the wells), isopropylbenzene [also known as cumene] (detected in 15 of the wells), xylenes (detected in 15 of the wells), and toluene (detected in 13 of the wells). Vinyl chloride was only detected in four of the wells.

Benzene was detected in 18 monitoring wells at concentrations greater than its water quality standard of 5 µg/L. The highest concentrations of benzene were detected in bedrock monitoring wells PZ-104-SS and PZ-104-SD, which are located upgradient of all of the OU-1 and OU-2 landfill units at the site, and alluvial monitoring well PZ-205-AS. Alluvial monitoring well PZ-205-AS is located upgradient of OU-1 Area 2 and cross-gradient of Area 1. Groundwater monitoring wells PZ-104-SS, PZ-104-SD, and PZ-205-AS are all located adjacent to the South Quarry Landfill. These are the same wells in which the higher levels of other hydrocarbon constituents (e.g., ethyl benzene, cumene, xylenes and MTBE) were detected, although the highest xylene levels were found in PZ-303-AS. Water quality in monitoring wells adjacent to the South Quarry Landfill is being addressed by Herst & Associates as part of an assessment pursuant to the Missouri Solid Waste Regulations.

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# Tables

**Table 1: Groundwater Elevation Measurements, September 30, 2013, West Lake Landfill OU-1**

| Well | Top of Casing (TOC) Elevation (ft. MSL)* | Water Level (ft. below TOC) | Water Level Elevation (ft. MSL) | Well | Top of Casing (TOC) Elevation (ft. MSL)* | Water Level (ft. below TOC) | Water Level Elevation (ft. MSL) |
|---|---|---|---|---|---|---|---|
| D-3 | 467.92 | 37.50 | 430.42 | PZ-106-SD | 463.36 | 12.38 | 450.98 |
| D-6 | 447.09 | 17.36 | 429.73 | PZ-106-SS | 462.71 | 11.39 | 451.32 |
| D-12 | 479.67 | 49.61 | 430.06 | PZ-107-SS | 464.56 | 33.62 | 430.94 |
| D-13 | 470.25 | 40.05 | 430.20 | PZ-109-SS | 458.56 | 27.81 | 430.75 |
| D-14 | 483.09 | 30.17 | 452.92 | PZ-110-SS | 461.15 | 30.65 | 430.50 |
| D-81 | 450.87 | 20.34 | 430.53 | PZ-111-KS | 465.56 | 9.11 | 456.45 |
| D-83 | 448.55 | 18.37 | 430.18 | PZ-111-SD | 466.46 | 35.11 | 431.35 |
| D-85 | 457.06 | 26.63 | 430.43 | PZ-112-AS | 462.29 | 31.87 | 430.42 |
| D-87 | 464.41 | 44.05 | 420.36 | PZ-113-AD | 461.54 | 30.98 | 430.56 |
| D-93 | 450.76 | 19.75 | 431.01 | PZ-113-AS | 461.40 | 30.90 | 430.50 |
| I-4 | 465.88 | 35.39 | 430.49 | PZ-113-SS | 461.77 | 31.17 | 430.60 |
| I-9 | 449.84 | 20.68 | 429.16 | PZ-114-AS | 451.26 | 20.54 | 430.72 |
| I-11 | 480.01 | 49.89 | 430.12 | PZ-115-SS | 452.27 | 17.11 | 435.16 |
| I-62 | 446.37 | 16.00 | 430.37 | PZ-116-SS | 484.85 | 24.21 | 460.64 |
| I-65 | 441.53 | 11.49 | 430.04 | PZ-200-SS | 485.57 | 26.27 | 459.30 |
| I-66 | 441.87 | 11.54 | 430.33 | PZ-201A-SS | 480.20 | 11.95 | 468.25 |
| I-67 | 441.78 | 11.45 | 430.33 | PZ-202-SS | 481.02 | 15.49 | 465.53 |
| I-68 | 450.39 | 19.92 | 430.47 | PZ-203-SS | 486.44 | 25.23 | 461.21 |
| I-73 | 461.40 | 30.73 | 430.67 | PZ-204A-SS | 462.60 | 5.63 | 456.97 |
| LR-100 | 468.14 | 16.58 | 451.56 | PZ-204-SS | 464.79 | 7.52 | 457.27 |
| LR-103 | 470.54 | 39.95 | 430.59 | PZ-205-AS | 459.95 | 27.31 | 432.64 |
| LR-104 | 459.38 | 28.55 | 430.83 | PZ-205-SS | 461.73 | 26.83 | 434.90 |
| LR-105 | 485.36 | 31.39 | 453.97 | PZ-206-SS | 460.29 | 26.80 | 433.49 |
| MW-102 | 447.90 | 17.93 | 429.97 | PZ-207-AS | 462.17 | 31.77 | 430.40 |
| MW-103 | 438.85 | 8.85 | 430.00 | PZ-208-SS | 474.19 | 21.40 | 452.79 |
| MW-104 | 440.91 | 10.39 | 430.52 | PZ-302-AI | 451.02 | 20.52 | 430.50 |
| MW-1204 | 485.53 | 25.38 | 460.15 | PZ-302-AS | 451.33 | 20.56 | 430.77 |
| PZ-100-KS | 485.61 | 26.07 | 459.54 | PZ-303-AS | 453.08 | 23.08 | 430.00 |
| PZ-100-SD | 485.72 | 34.99 | 450.73 | PZ-304-AI | 453.86 | 23.48 | 430.38 |
| PZ-100-SS | 485.75 | 33.72 | 452.03 | PZ-304-AS | 453.61 | 23.26 | 430.35 |
| PZ-101-SS | 491.26 | 54.49 | 436.77 | PZ-305-AI | 459.83 | 29.01 | 430.82 |
| PZ-102R-SS | 485.62 | 25.48 | 460.14 | S-5 | 466.45 | 35.76 | 430.69 |
| PZ-102-SS | 483.90 | 24.77 | 459.13 | S-8 | 443.83 | 13.81 | 430.02 |
| PZ-103-SS | 483.56 | 8.64 | 474.92 | S-10 | 480.06 | 49.94 | 430.12 |
| PZ-104-KS | 483.95 | 20.05 | 463.90 | S-53 | 444.18 | 13.70 | 430.48 |
| PZ-104-SD | 483.51 | 21.99 | 461.52 | S-61 | 449.52 | 19.53 | 429.99 |
| PZ-104-SS | 483.45 | 19.56 | 463.89 | S-82 | 449.94 | 19.79 | 430.15 |
| PZ-105-SS | 483.51 | 24.69 | 458.82 | S-84 | 456.78 | 26.34 | 430.44 |
| PZ-106-KS | 464.20 | 5.05 | 459.15 | | | | |

* Survey Data provided by Aquaterra in a spreadsheet dated 9/14/2012; except for I-4, D-13, PZ-112-AS, and PZ-207-AS, which were provided by an April 17, 2013 electronic mail from Weaver Boos Consultants.

**Table 2: Wells Sampled During October 2013 Groundwater Monitoring Effort**

| Well | Well | Duplicate Samples | |
|---|---|---|---|
| PZ-100-SS | PZ-302-AI | S-84 | |
| PZ-100-SD | PZ-302-AS | I-9 | |
| PZ-100-KS | PZ-303-AS | I-67 | |
| PZ-101-SS | PZ-304-AS | D-87 | |
| PZ-102-SS | PZ-304-AI | LR-100 | |
| PZ-102R-SS | PZ-305-AI | PZ-106-KS | |
| PZ-103-SS | | PZ-113-AD | |
| PZ-104-SS | LR-100 | PZ-210-SD | |
| PZ-104-SD | LR-103 | PZ-304-AI | |
| PZ-104-KS | LR-104 | | |
| PZ-105-SS | | **EPA Split Samples** | |
| PZ-106-SS | MW-102 | PZ-102-SS (total fraction only) | |
| PZ-106-SD | MW-103 | PZ-104-SD (total fraction only) | |
| PZ-106-KS | MW-104 | | |
| PZ-107-SS | MW-1204 | **MDNR Split Samples** | |
| PZ-109-SS | | S-5 | |
| PZ-110-SS | S-5 | S-82 | |
| PZ-111-SD | S-8 | I-9 (total fraction only) | |
| PZ-111-KS | S-10 | D-3 | |
| PZ-112-AS | S-53 | D-6 | |
| PZ-113-AS | S-61 | D-83 | |
| PZ-113-AD | S-82 | D-85 | |
| PZ-113-SS | S-84 | D-93 | |
| PZ-114-AS | | PZ-101-SS | |
| PZ-115-SS | I-4 | PZ-102-SS | |
| PZ-116-SS | I-9 | PZ-104-SD | |
| PZ-200-SS | I-11 | PZ-113-AD | |
| PZ-201A-SS | I-62 | | |
| PZ-202-SS | I-65 | | |
| PZ-203-SS | I-66 | | |
| PZ-204-SS | I-67 | | |
| PZ-204A-SS | I-68 | **Well Legend** | |
| PZ-205-AS | I-73 | S prefix or AS suffix | Shallow alluvial well |
| PZ-205-SS | | I prefix or AI suffix | Intermediate alluvial well |
| PZ-206-SS | D-3 | D prefix or AD suffix | Deep alluvial well |
| PZ-207-AS | D-6 | SS suffix | St. Louis Fm. bedrock well |
| PZ-208-SS | D-12 | SD suffix | Salem Fm. bedrock well |
| PZ-209-SD | D-13 | KS suffix | Keokuk Fm. Bedrock well |
| PZ-209-SS | D-14 | | |
| PZ-210-SD | D-81 | | |
| PZ-210-SS | D-83 | | |
| PZ-211-SD | D-85 | | |
| PZ-211-SS | D-87 | | |
| PZ-212-SD | D-93 | | |
| PZ-212-SS | | | |
| | Total = 84 wells | Not sampled: LR-105 (see discussion in the Report text) | |

## Table 3: Vertical Groundwater Gradients, September 30, 2013

| Well | Water Level Elevation (ft amsl) | Original Top of Screen Elevation (ft amsl) | Original Bottom of Screen Elevation (ft amsl) | Midpoint Elevation of Screen Interval (ft amsl) | Head Difference (ft) | Difference in Screen Midpoint Elevations (ft) | Vertical Gradient (ft/ft) |
|---|---|---|---|---|---|---|---|
| **Alluvial Well Clusters** | | | | | | | |
| S-5 | 430.69 | 435.70 | 425.70 | 430.70 | 0.20 | 36.20 | 0.0055 |
| I-4 | 430.49 | 399.50 | 389.50 | 394.50 | 0.07 | 28.80 | 0.0024 |
| D-3 | 430.42 | 370.70 | 360.70 | 365.70 | 0.27 | 65.00 | 0.0042 |
| MW-102 | 429.97 | 432.18 | 422.18 | 427.18 | 0.24 | 84.28 | 0.0028 |
| D-6 | 429.73 | 347.90 | 337.90 | 342.90 | | | |
| S-10 | 430.12 | 445.50 | 425.50 | 435.50 | 0.00 | 43.40 | 0.0000 |
| I-11 | 430.12 | 397.10 | 387.10 | 392.10 | 0.06 | 53.40 | 0.0011 |
| D-12 | 430.06 | 343.70 | 333.70 | 338.70 | 0.06 | 96.80 | 0.0006 |
| S-8 | 430.02 | 434.80 | 414.80 | 424.80 | -0.35 | 19.70 | -0.0178 |
| I-62 | 430.37 | 410.10 | 400.10 | 405.10 | 0.19 | 47.70 | 0.0040 |
| D-83 | 430.18 | 367.40 | 347.40 | 357.40 | -0.16 | 67.40 | -0.0024 |
| S-84 | 430.44 | 432.00 | 422.00 | 427.00 | 0.01 | 45.90 | 0.0002 |
| D-85 | 430.43 | 391.10 | 371.10 | 381.10 | | | |
| S-82 | 430.15 | 432.20 | 422.20 | 427.20 | 0.99 | 26.80 | 0.0369 |
| I-9 | 429.16 | 405.40 | 395.40 | 400.40 | -1.85 | 29.70 | -0.0623 |
| D-93 | 431.01 | 380.70 | 360.70 | 370.70 | -0.86 | 56.50 | -0.0152 |
| PZ-302-AS | 430.77 | 437.30 | 427.50 | 432.40 | 0.27 | 19.90 | 0.0136 |
| PZ-302-AI | 430.50 | 417.40 | 407.60 | 412.50 | | | |
| PZ-304-AS | 430.35 | 434.30 | 424.50 | 429.40 | -0.03 | 21.70 | -0.0014 |
| PZ-304-AI | 430.38 | 412.60 | 402.80 | 407.70 | | | |
| **Alluvial and Bedrock Well Clusters** | | | | | | | |
| PZ-113-AS | 430.50 | 431.00 | 421.20 | 426.10 | -0.06 | 69.70 | -0.0009 |
| PZ-113-AD | 430.56 | 361.30 | 351.50 | 356.40 | -0.04 | 49.87 | -0.0008 |
| PZ-113-SS | 430.60 | 311.43 | 301.63 | 306.53 | -0.10 | 119.57 | -0.0008 |
| PZ-205-AS | 432.64 | 420.75 | 410.95 | 415.85 | -2.26 | 49.82 | -0.0454 |
| PZ-205-SS | 434.90 | 370.93 | 361.13 | 366.03 | | | |

Notes: Positive values for vertical gradient indicate a downward gradient whereas negative values indicate an upward gradient.

## Table 4: Summary of Uranium Results - October 2013 Groundwater Sampling, West Lake Landfill OU-1

| Sample ID | Sample Date | Uranium-234 | | | | Uranium-235 | | | | Uranium-238 | | | | TOTAL U-234 + U-235 + U-238 | | Total Uranium (µg/L) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Result | CSU | MDA | FINAL Q | Result | CSU | MDA | FINAL Q | Result | CSU | MDA | FINAL Q | | | |
| S-5 DIS | 10/7/2013 | 0 | 0.53 | 1.15 | R | 0 | 0.65 | 1.41 | R | 0.54 | 0.67 | 0.79 | R | R | * | R |
| S-5 TOT | 10/7/2013 | 0.58 | 0.78 | 1.16 | R | 0 | 0.66 | 1.44 | R | 0 | 0.54 | 1.16 | R | R | * | R |
| S-8 DIS | 10/1/2013 | 1.19 | 0.4 | 0.16 | J | 0.11 | 0.14 | 0.21 | UJ | 0.77 | 0.31 | 0.17 | J | 1.96 | * | 2.39 |
| S-8 TOT | 10/1/2013 | 1.16 | 0.37 | 0.19 | J | 0.22 | 0.17 | 0.17 | J | 1.18 | 0.37 | 0.15 | J | 2.56 | | 3.62 |
| S-10 DIS | 10/1/2013 | 0.32 | 0.24 | 0.24 | J | 0.14 | 0.17 | 0.2 | U | 0.17 | 0.18 | 0.22 | U | 0.32 | * | 0.75 |
| S-10 TOT | 10/1/2013 | 0.63 | 0.34 | 0.27 | J | 0.15 | 0.2 | 0.31 | U | 0.82 | 0.38 | 0.19 | | 1.45 | * | 2.59 |
| S-53 DIS | 10/15/2013 | 4.44 | 0.99 | 0.22 | J+ | 0.2 | 0.19 | 0.2 | J | 3.78 | 0.89 | 0.2 | | 8.42 | | 11.35 |
| S-53 TOT | 10/15/2013 | 6.83 | 1.35 | 0.2 | J+ | 0.5 | 0.31 | 0.27 | J | 5.84 | 1.2 | 0.22 | | 13.17 | | 17.63 |
| S-61 DIS | 10/3/2013 | 0.98 | 0.34 | 0.15 | J | 0.16 | 0.15 | 0.19 | UJ | 0.79 | 0.3 | 0.11 | J | 1.77 | * | 2.44 |
| S-61 TOT | 10/3/2013 | 0.91 | 0.33 | 0.11 | | 0.16 | 0.15 | 0.14 | J | 0.82 | 0.31 | 0.13 | | 1.89 | | 2.52 |
| S-82 DIS | 10/8/2013 | 1.25 | 0.42 | 0.16 | J | 0.25 | 0.2 | 0.18 | J | 0.47 | 0.24 | 0.14 | J | 1.97 | | 1.52 |
| S-82 TOT | 10/8/2013 | 0.62 | 0.29 | 0.17 | | 0.18 | 0.17 | 0.16 | J | 0.23 | 0.17 | 0.15 | J | 1.03 | | 0.77 |
| S-84 DIS | 10/9/2013 | 0.14 | 0.17 | 0.2 | UJ | -0.01 | 0.12 | 0.25 | UJ | -0.02 | 0.1 | 0.23 | UJ | ND | | 0.80 |
| S-84 FD DIS | 10/9/2013 | 0.55 | 0.38 | 0.26 | J | 0.06 | 0.15 | 0.32 | UJ | 0.11 | 0.17 | 0.26 | UJ | 0.55 | * | 0.92 |
| S-84 FD TOT | 10/9/2013 | 0.33 | 0.28 | 0.34 | UJ | -0.03 | 0.12 | 0.32 | UJ | 0.18 | 0.25 | 0.4 | UJ | ND | | 1.34 |
| S-84 TOT | 10/9/2013 | 0.56 | 0.28 | 0.23 | J | -0.04 | 0.08 | 0.24 | U | 0.44 | 0.25 | 0.22 | J | 1.00 | * | 1.42 |
| I-4 DIS | 10/7/2013 | 0.41 | 0.41 | 0.48 | UJ | 0.05 | 0.23 | 0.59 | UJ | 0.23 | 0.31 | 0.47 | UJ | ND | | 1.67 |
| I-4 TOT | 10/7/2013 | 0.58 | 0.46 | 0.36 | J | 0.52 | 0.51 | 0.63 | UJ | 0.24 | 0.29 | 0.35 | UJ | 0.58 | * | 1.33 |
| I-9 DIS | 10/8/2013 | 0.28 | 0.21 | 0.21 | J | 0.21 | 0.21 | 0.26 | U | 0.17 | 0.17 | 0.21 | U | 0.28 | * | 0.75 |
| I-9 FD DIS | 10/8/2013 | 0.35 | 0.26 | 0.19 | J | 0.16 | 0.19 | 0.23 | UJ | 0.13 | 0.18 | 0.27 | UJ | 0.35 | * | 0.91 |
| I-9 FD TOT | 10/8/2013 | 0.27 | 0.2 | 0.21 | J | 0.04 | 0.12 | 0.26 | U | 0.19 | 0.16 | 0.16 | J | 0.46 | * | 0.69 |
| I-9 TOT | 10/8/2013 | 0.14 | 0.16 | 0.21 | UJ | 0.18 | 0.2 | 0.24 | UJ | 0.2 | 0.18 | 0.17 | J | 0.20 | * | 0.71 |
| I-11 DIS | 10/1/2013 | 1.45 | 0.58 | 0.21 | J | 0.14 | 0.22 | 0.35 | UJ | 1.05 | 0.49 | 0.3 | J | 2.50 | * | 3.29 |
| I-11 TOT | 10/1/2013 | 1.34 | 0.43 | 0.12 | | 0.36 | 0.24 | 0.22 | J | 1.4 | 0.44 | 0.17 | | 3.10 | | 4.34 |
| I-62 DIS | 10/1/2013 | 0.15 | 0.12 | 0.11 | J | 0.09 | 0.11 | 0.13 | U | 0.18 | 0.14 | 0.14 | J | 0.33 | * | 0.60 |
| I-62 TOT | 10/1/2013 | 0.38 | 0.21 | 0.16 | J | 0.09 | 0.12 | 0.18 | U | 0.21 | 0.16 | 0.15 | J | 0.59 | * | 0.71 |
| I-65 DIS | 10/15/2013 | 1.04 | 0.38 | 0.18 | J+ | -0.01 | 0.07 | 0.15 | U | 0.79 | 0.32 | 0.14 | | 1.83 | * | 2.42 |
| I-65 TOT | 10/15/2013 | 1.45 | 0.47 | 0.15 | J+ | 0.31 | 0.22 | 0.16 | J | 1.06 | 0.39 | 0.15 | | 2.82 | | 3.30 |
| I-66 DIS | 10/9/2013 | 0.72 | 0.28 | 0.1 | J | 0.03 | 0.08 | 0.18 | UJ | 0.45 | 0.21 | 0.12 | J | 1.17 | * | 1.42 |

## Table 4: Summary of Uranium Results - October 2013 Groundwater Sampling, West Lake Landfill OU-1

| Sample ID | Sample Date | Uranium-234 | | | | Uranium-235 | | | | Uranium-238 | | | | TOTAL U-234 + U-235 + U-238 | Total Uranium (µg/L) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Result | CSU | MDA | FINAL Q | Result | CSU | MDA | FINAL Q | Result | CSU | MDA | FINAL Q | | |
| I-66 TOT | 10/9/2013 | 0.43 | 0.21 | 0.1 | J | 0.15 | 0.14 | 0.18 | UJ | 0.54 | 0.23 | 0.1 | J | 0.97 * | 1.69 |
| I-67 DIS | 10/3/2013 | 1.03 | 0.39 | 0.25 | | 0.17 | 0.19 | 0.26 | U | 0.33 | 0.21 | 0.2 | J | 1.36 * | 1.10 |
| I-67 FD DIS | 10/3/2013 | 0.86 | 0.36 | 0.17 | | 0.34 | 0.26 | 0.26 | J | 0.73 | 0.33 | 0.21 | | 1.93 | 2.33 |
| I-67 FD TOT | 10/3/2013 | 0.86 | 0.31 | 0.18 | J | 0.13 | 0.13 | 0.17 | UJ | 0.65 | 0.27 | 0.2 | J | 1.51 * | 2.02 |
| I-67 TOT | 10/3/2013 | 0.89 | 0.31 | 0.15 | J | 0.23 | 0.16 | 0.12 | J | 0.81 | 0.29 | 0.11 | J | 1.93 | 2.52 |
| I-68 DIS | 10/4/2013 | 0.59 | 0.24 | 0.09 | J | 0.17 | 0.15 | 0.17 | J | 0.47 | 0.22 | 0.14 | J | 1.23 | 1.48 |
| I-68 TOT | 10/4/2013 | 1.63 | 0.48 | 0.17 | | 0.11 | 0.14 | 0.21 | U | 1.36 | 0.43 | 0.12 | | 2.99 * | 4.15 |
| I-73 DIS | 10/3/2013 | -0.11 | 1.24 | 3.79 | UJ | -0.48 | 1.47 | 4.01 | UJ | 1.9 | 2.32 | 3.23 | UJ | ND | 11.48 |
| I-73 TOT | 10/3/2013 | -0.45 | 0.94 | 2.77 | UJ | 0.54 | 1.51 | 3.26 | UJ | 0.8 | 1.23 | 1.83 | UJ | ND | 6.96 |
| D-3 DIS | 10/7/2013 | 0.27 | 0.24 | 0.26 | J | 0.28 | 0.27 | 0.29 | UJ | 0.15 | 0.19 | 0.29 | UJ | 0.27 * | 1.00 |
| D-3 TOT | 10/7/2013 | 0.28 | 0.27 | 0.29 | UJ | 0.27 | 0.3 | 0.36 | UJ | 0.04 | 0.12 | 0.29 | UJ | ND | 1.03 |
| D-6 DIS | 10/8/2013 | 0.23 | 0.18 | 0.19 | J | 0.24 | 0.19 | 0.17 | J | 0.15 | 0.14 | 0.18 | U | 0.23 * | 0.65 |
| D-6 TOT | 10/8/2013 | 0.55 | 0.27 | 0.18 | | 0.04 | 0.11 | 0.24 | U | 0.05 | 0.11 | 0.2 | U | 0.55 * | 0.71 |
| D-12 DIS | 10/1/2013 | 0.2 | 0.15 | 0.14 | J | 0.28 | 0.2 | 0.16 | J | 0.19 | 0.15 | 0.15 | J | 0.67 | 0.70 |
| D-12 TOT | 10/1/2013 | 0.19 | 0.15 | 0.12 | J | 0.03 | 0.1 | 0.21 | U | 0.11 | 0.11 | 0.12 | U | 0.19 * | 0.45 |
| D-13 DIS | 10/7/2013 | 0.34 | 0.2 | 0.17 | J | 0.03 | 0.1 | 0.21 | U | 0.16 | 0.14 | 0.12 | J | 0.50 * | 0.57 |
| D-13 TOT | 10/7/2013 | 0.3 | 0.17 | 0.1 | J | 0.06 | 0.09 | 0.13 | UJ | 0.09 | 0.1 | 0.12 | UJ | 0.30 * | 0.42 |
| D-14 DIS | 10/15/2013 | 0.4 | 0.35 | 0.34 | J+ | 0.09 | 0.24 | 0.53 | UJ | 0.14 | 0.24 | 0.43 | UJ | 0.40 * | 1.53 |
| D-14 TOT | 10/15/2013 | 0.71 | 0.64 | 0.75 | UJ+ | -0.02 | 0.29 | 0.61 | UJ | -0.18 | 0.38 | 1.11 | UJ | ND | 3.59 |
| D-81 DIS | 10/3/2013 | 1.72 | 0.46 | 0.15 | J | 0.15 | 0.14 | 0.18 | UJ | 1.13 | 0.35 | 0.1 | J | 2.85 * | 3.45 |
| D-81 TOT | 10/3/2013 | 1.44 | 0.4 | 0.13 | J | 0.17 | 0.15 | 0.17 | J | 1.34 | 0.38 | 0.09 | J | 2.95 | 4.07 |
| D-83 DIS | 10/8/2013 | 0.14 | 0.21 | 0.31 | UJ | 0.18 | 0.32 | 0.55 | UJ | 0.07 | 0.21 | 0.45 | UJ | ND | 1.60 |
| D-83 TOT | 10/8/2013 | -0.01 | 0.12 | 0.24 | UJ | 0.14 | 0.24 | 0.43 | UJ | 0.15 | 0.2 | 0.28 | UJ | ND | 1.03 |
| D-85 DIS | 10/9/2013 | 0.37 | 0.19 | 0.14 | J | 0.05 | 0.08 | 0.12 | UJ | 0.04 | 0.06 | 0.11 | UJ | 0.37 * | 0.38 |
| D-85 TOT | 10/9/2013 | 1.06 | 0.35 | 0.12 | J | 0.21 | 0.17 | 0.13 | J | 1.06 | 0.35 | 0.12 | J | 2.33 | 3.26 |
| D-87 DIS | 10/2/2013 | 0.31 | 0.23 | 0.25 | J | -0.05 | 0.1 | 0.28 | U | 0.17 | 0.16 | 0.17 | J | 0.48 * | 0.64 |
| D-87 FD DIS | 10/2/2013 | 0.22 | 0.17 | 0.14 | J | 0.04 | 0.1 | 0.22 | U | 0.23 | 0.16 | 0.12 | J | 0.45 * | 0.79 |
| D-87 FD TOT | 10/2/2013 | 0.63 | 0.27 | 0.12 | | 0 | 0.09 | 0.2 | U | 0.25 | 0.18 | 0.17 | J | 0.88 * | 0.84 |
| D-87 TOT | 10/2/2013 | 1.14 | 0.4 | 0.13 | J | 0.05 | 0.11 | 0.21 | UJ | 0.63 | 0.29 | 0.18 | J | 1.77 * | 1.97 |

## Table 4: Summary of Uranium Results - October 2013 Groundwater Sampling, West Lake Landfill OU-1

| Sample ID | Sample Date | Uranium-234 | | | | Uranium-235 | | | | Uranium-238 | | | | TOTAL U-234 + U-235 + U-238 | Total Uranium (µg/L) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Result | CSU | MDA | FINAL Q | Result | CSU | MDA | FINAL Q | Result | CSU | MDA | FINAL Q | | |
| D-93 DIS | 10/8/2013 | 0.49 | 0.26 | 0.18 | J | 0.17 | 0.18 | 0.22 | U | 0.3 | 0.2 | 0.18 | J | 0.79 * | 1.00 |
| D-93 TOT | 10/8/2013 | 0.55 | 0.25 | 0.16 | | 0.04 | 0.09 | 0.18 | U | 0.31 | 0.19 | 0.16 | J | 0.86 * | 1.01 |
| LR-100 DIS | 10/4/2013 | 0.17 | 0.15 | 0.17 | J | 0.02 | 0.07 | 0.17 | U | 0.14 | 0.13 | 0.12 | J | 0.31 * | 0.50 |
| LR-100 FD DIS | 10/4/2013 | 0.33 | 0.24 | 0.17 | J | 0 | 0.14 | 0.31 | UJ | 0 | 0.11 | 0.25 | UJ | 0.33 * | 0.89 |
| LR-100 FD TOT | 10/4/2013 | 0.13 | 0.17 | 0.26 | UJ | -0.01 | 0.11 | 0.22 | UJ | 0.12 | 0.15 | 0.18 | UJ | ND | 0.64 |
| LR-100 TOT | 10/4/2013 | 0 | 0.12 | 0.27 | UJ | 0.06 | 0.15 | 0.33 | UJ | -0.01 | 0.09 | 0.19 | UJ | ND | 0.72 |
| LR-103 DIS | 10/2/2013 | 0.23 | 0.18 | 0.16 | J | 0.07 | 0.12 | 0.2 | U | 0.1 | 0.12 | 0.14 | U | 0.23 * | 0.51 |
| LR-103 TOT | 10/2/2013 | 0.15 | 0.15 | 0.18 | UJ | 0.11 | 0.13 | 0.16 | U | 0.15 | 0.15 | 0.18 | U | ND | 0.61 |
| LR-104 DIS | 10/2/2013 | 2.98 | 1.3 | 0.57 | J | 0.27 | 0.46 | 0.8 | UJ | 2.14 | 1.06 | 0.45 | J | 5.12 * | 6.75 |
| LR-104 TOT | 10/2/2013 | 2.93 | 0.66 | 0.12 | J | 0.19 | 0.17 | 0.19 | J | 1.94 | 0.51 | 0.16 | J | 5.06 | 5.87 |
| MW-102 DIS | 10/3/2013 | 5.9 | 1.13 | 0.18 | | 0.28 | 0.2 | 0.15 | J | 5.04 | 1 | 0.14 | | 11.22 | 15.15 |
| MW-102 TOT | 10/3/2013 | 6.14 | 1.22 | 0.13 | | 0.55 | 0.31 | 0.24 | J | 5.2 | 1.08 | 0.19 | | 11.89 | 15.75 |
| MW-103 DIS | 10/4/2013 | 1.2 | 0.43 | 0.21 | | 0.2 | 0.19 | 0.24 | U | 1.55 | 0.49 | 0.14 | | 2.75 * | 4.73 |
| MW-103 TOT | 10/4/2013 | 2.32 | 0.64 | 0.2 | | 0.12 | 0.16 | 0.25 | U | 2.04 | 0.58 | 0.14 | | 4.36 * | 6.19 |
| MW-104 DIS | 10/3/2013 | 2.31 | 0.6 | 0.22 | | 0.4 | 0.25 | 0.2 | J | 1.37 | 0.44 | 0.24 | | 4.08 | 4.27 |
| MW-104 TOT | 10/3/2013 | 3.49 | 0.76 | 0.17 | | 0.25 | 0.19 | 0.17 | J | 2.99 | 0.68 | 0.15 | | 6.73 | 9.02 |
| MW-1204 DIS | 10/11/2013 | 0.05 | 0.09 | 0.17 | UJ | 0.06 | 0.11 | 0.19 | U | 0.03 | 0.06 | 0.13 | UJ | ND | 0.48 |
| MW-1204 TOT | 10/11/2013 | 0.17 | 0.14 | 0.12 | J | 0.07 | 0.1 | 0.15 | U | 0.09 | 0.12 | 0.18 | UJ | 0.17 * | 0.61 |
| PZ-100-KS DIS | 10/15/2013 | 0.19 | 0.14 | 0.1 | J+ | 0.11 | 0.12 | 0.12 | UJ | 0.1 | 0.11 | 0.14 | UJ | 0.19 * | 0.47 |
| PZ-100-KS TOT | 10/15/2013 | 0.1 | 0.18 | 0.33 | UJ+ | 0 | 0.14 | 0.41 | UJ | 0.19 | 0.21 | 0.25 | UJ | ND | 0.93 |
| PZ-100-SD DIS | 10/8/2013 | 0.29 | 0.17 | 0.14 | J | 0.06 | 0.1 | 0.17 | UJ | 0.11 | 0.1 | 0.1 | J | 0.40 * | 0.41 |
| PZ-100-SD TOT | 10/8/2013 | 0.47 | 0.22 | 0.13 | J | 0.17 | 0.14 | 0.12 | J | 0.14 | 0.13 | 0.14 | J | 0.78 | 0.50 |
| PZ-100-SS DIS | 10/8/2013 | 4.04 | 0.92 | 0.14 | | 0.16 | 0.17 | 0.17 | U | 1.33 | 0.46 | 0.16 | | 5.37 * | 4.04 |
| PZ-100-SS TOT | 10/8/2013 | 4.98 | 1.1 | 0.26 | | 0.27 | 0.24 | 0.28 | U | 1.92 | 0.59 | 0.25 | | 6.90 * | 5.85 |
| PZ-101-SS DIS | 10/8/2013 | 0.71 | 0.45 | 0.32 | J | -0.01 | 0.16 | 0.34 | UJ | 0.31 | 0.3 | 0.32 | UJ | 0.71 * | 1.11 |
| PZ-101-SS TOT | 10/8/2013 | 0.28 | 0.26 | 0.28 | J | 0.22 | 0.29 | 0.44 | UJ | 0.24 | 0.26 | 0.35 | UJ | 0.28 * | 1.25 |
| PZ-102R-SS DIS | 10/8/2013 | 4.4 | 0.89 | 0.17 | J | 0.65 | 0.31 | 0.19 | J | 2.26 | 0.57 | 0.13 | J | 7.31 | 7.03 |
| PZ-102R-SS TOT | 10/8/2013 | 4.31 | 0.93 | 0.16 | | 0.19 | 0.19 | 0.23 | U | 2.59 | 0.66 | 0.15 | | 6.90 * | 7.82 |
| PZ-102-SS DIS | 10/8/2013 | 4.07 | 0.78 | 0.12 | J | 0.54 | 0.25 | 0.13 | J | 2.23 | 0.52 | 0.13 | J | 6.84 | 6.89 |

## Table 4: Summary of Uranium Results - October 2013 Groundwater Sampling, West Lake Landfill OU-1

| Sample ID | Sample Date | Uranium-234 | | | | Uranium-235 | | | | Uranium-238 | | | | TOTAL U-234 + U-235 + U-238 | Total Uranium (µg/L) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Result | CSU | MDA | FINAL Q | Result | CSU | MDA | FINAL Q | Result | CSU | MDA | FINAL Q | | |
| PZ-102-SS TOT | 10/8/2013 | 5.25 | 0.96 | 0.11 | J | 0.34 | 0.2 | 0.14 | J | 5.09 | 0.94 | 0.11 | J | 10.68 | 15.32 |
| PZ-103-SS DIS | 10/4/2013 | 0.29 | 0.19 | 0.14 | J | 0.06 | 0.1 | 0.17 | U | 0.13 | 0.13 | 0.15 | U | 0.29 * | 0.53 |
| PZ-103-SS TOT | 10/4/2013 | 0.73 | 0.28 | 0.16 | J | 0.01 | 0.06 | 0.17 | UJ | 0.42 | 0.21 | 0.14 | J | 1.15 * | 1.33 |
| PZ-104-KS DIS | 10/4/2013 | 0.28 | 0.19 | 0.17 | J | 0.17 | 0.16 | 0.15 | J | 0.14 | 0.13 | 0.12 | J | 0.59 | 0.50 |
| PZ-104-KS TOT | 10/4/2013 | 0.22 | 0.17 | 0.16 | J | 0.08 | 0.12 | 0.19 | U | 0.13 | 0.12 | 0.13 | J | 0.35 * | 0.48 |
| PZ-104-SD DIS | 10/7/2013 | 0.32 | 0.45 | 0.68 | UJ | 0.26 | 0.45 | 0.76 | UJ | -0.01 | 0.39 | 1 | UJ | ND | 3.33 |
| PZ-104-SD TOT | 10/7/2013 | 0.44 | 0.3 | 0.21 | J | 0.06 | 0.17 | 0.37 | UJ | 0.1 | 0.17 | 0.3 | UJ | 0.44 * | 1.07 |
| PZ-104-SS DIS | 10/9/2013 | 0.25 | 0.15 | 0.1 | J | 0.03 | 0.08 | 0.17 | UJ | 0.07 | 0.08 | 0.1 | UJ | 0.25 * | 0.38 |
| PZ-104-SS TOT | 10/9/2013 | 0.47 | 0.25 | 0.19 | J | 0.07 | 0.11 | 0.16 | U | 0.11 | 0.12 | 0.15 | UJ | 0.47 * | 0.52 |
| PZ-105-SS DIS | 10/9/2013 | 2.12 | 0.52 | 0.11 | J | 0.08 | 0.1 | 0.12 | UJ | 1.59 | 0.43 | 0.11 | J | 3.71 * | 4.79 |
| PZ-105-SS TOT | 10/9/2013 | 2.24 | 0.58 | 0.14 | J | 0.21 | 0.19 | 0.21 | J | 1.49 | 0.46 | 0.17 | J | 3.94 | 4.54 |
| PZ-106-KS DIS | 10/11/2013 | 1.62 | 0.44 | 0.14 | J+ | 0.1 | 0.12 | 0.17 | UJ | 0.67 | 0.27 | 0.14 | J | 2.29 * | 2.07 |
| PZ-106-KS FD DIS | 10/11/2013 | 1.65 | 0.44 | 0.12 | J+ | 0.25 | 0.18 | 0.14 | J | 0.63 | 0.25 | 0.11 | J | 2.53 | 1.99 |
| PZ-106-KS FD TOT | 10/11/2013 | 1.8 | 0.46 | 0.13 | J+ | 0.08 | 0.1 | 0.12 | UJ | 0.32 | 0.18 | 0.11 | J | 2.12 * | 1.01 |
| PZ-106-KS TOT | 10/11/2013 | 1.98 | 0.48 | 0.13 | J+ | 0.15 | 0.13 | 0.15 | J | 0.57 | 0.24 | 0.13 | J | 2.70 | 1.77 |
| PZ-106-SD DIS | 10/8/2013 | 0.21 | 0.17 | 0.13 | J | 0.07 | 0.11 | 0.16 | UJ | 0.21 | 0.16 | 0.15 | J | 0.42 * | 0.70 |
| PZ-106-SD TOT | 10/8/2013 | 0.5 | 0.23 | 0.17 | J | 0.09 | 0.12 | 0.18 | UJ | 0.24 | 0.16 | 0.16 | J | 0.74 * | 0.80 |
| PZ-106-SS DIS | 10/7/2013 | 0.85 | 0.31 | 0.15 | J | 0.19 | 0.17 | 0.19 | J | 0.17 | 0.13 | 0.11 | J | 1.21 | 0.59 |
| PZ-106-SS TOT | 10/7/2013 | 0.93 | 0.35 | 0.12 | J | 0.11 | 0.14 | 0.22 | J | 0.41 | 0.23 | 0.17 | J | 1.45 | 1.27 |
| PZ-107-SS DIS | 10/3/2013 | 1.54 | 0.59 | 0.28 | J | 0.05 | 0.11 | 0.24 | UJ | 1.43 | 0.56 | 0.22 | J | 2.97 * | 4.37 |
| PZ-107-SS TOT | 10/3/2013 | 0.59 | 0.26 | 0.11 | | 0.22 | 0.18 | 0.17 | J | 1.09 | 0.37 | 0.13 | | 1.90 | 3.35 |
| PZ-109-SS DIS | 10/9/2013 | 0.94 | 0.31 | 0.11 | J | 0.06 | 0.1 | 0.17 | UJ | 0.58 | 0.24 | 0.14 | J | 1.52 * | 1.81 |
| PZ-109-SS TOT | 10/9/2013 | 1.51 | 0.47 | 0.19 | J | 0.11 | 0.13 | 0.16 | UJ | 0.16 | 0.18 | 0.28 | UJ | 1.51 * | 0.91 |
| PZ-110-SS DIS | 10/8/2013 | 0.13 | 0.12 | 0.11 | J | 0.13 | 0.13 | 0.14 | U | 0.05 | 0.09 | 0.16 | U | 0.13 * | 0.54 |
| PZ-110-SS TOT | 10/8/2013 | 0.23 | 0.19 | 0.19 | J | 0.09 | 0.15 | 0.26 | U | 0.14 | 0.16 | 0.21 | U | 0.23 * | 0.75 |
| PZ-111-KS DIS | 10/3/2013 | 6.55 | 1.14 | 0.15 | J | 0.4 | 0.22 | 0.16 | J | 2.3 | 0.55 | 0.13 | J | 9.25 | 7.04 |
| PZ-111-KS TOT | 10/3/2013 | 7.15 | 1.48 | 0.23 | J | 0.23 | 0.21 | 0.2 | J | 2.2 | 0.66 | 0.19 | J | 9.58 | 6.66 |
| PZ-111-SD DIS | 10/7/2013 | 0.35 | 0.21 | 0.17 | J | 0.04 | 0.1 | 0.21 | U | 0.26 | 0.17 | 0.12 | J | 0.61 * | 0.87 |
| PZ-111-SD TOT | 10/7/2013 | 0.48 | 0.22 | 0.13 | | 0.1 | 0.12 | 0.17 | U | 0.16 | 0.13 | 0.12 | J | 0.64 * | 0.56 |

## Table 4: Summary of Uranium Results - October 2013 Groundwater Sampling, West Lake Landfill OU-1

| Sample ID | Sample Date | Uranium-234 | | | | Uranium-235 | | | | Uranium-238 | | | | TOTAL U-234 + U-235 + U-238 | Total Uranium (µg/L) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Result | CSU | MDA | FINAL Q | Result | CSU | MDA | FINAL Q | Result | CSU | MDA | FINAL Q | | |
| PZ-112-AS DIS | 10/2/2013 | 3.53 | 0.91 | 0.17 | J | 0.3 | 0.26 | 0.3 | J | 0.24 | 0.2 | 0.17 | J | 4.07 | 0.85 |
| PZ-112-AS TOT | 10/2/2013 | 0.09 | 0.11 | 0.13 | UJ | -0.02 | 0.08 | 0.21 | U | 0.11 | 0.13 | 0.17 | U | ND | 0.60 |
| PZ-113-AD DIS | 10/7/2013 | 0.06 | 0.16 | 0.34 | UJ | 0.14 | 0.24 | 0.42 | UJ | 0.1 | 0.16 | 0.23 | UJ | ND | 0.88 |
| PZ-113-AD FD DIS | 10/7/2013 | 0.14 | 0.17 | 0.26 | U | 0.05 | 0.13 | 0.28 | U | -0.03 | 0.08 | 0.21 | U | ND | 0.76 |
| PZ-113-AD FD TOT | 10/7/2013 | 0.26 | 0.22 | 0.23 | J | 0.02 | 0.1 | 0.29 | UJ | 0.03 | 0.08 | 0.17 | UJ | 0.26 * | 0.64 |
| PZ-113-AD TOT | 10/7/2013 | 0.17 | 0.2 | 0.26 | UJ | 0.14 | 0.21 | 0.35 | UJ | 0.08 | 0.14 | 0.24 | UJ | ND | 0.88 |
| PZ-113-AS DIS | 10/2/2013 | 0.58 | 0.24 | 0.1 | J | 0.12 | 0.13 | 0.17 | UJ | 0.49 | 0.22 | 0.14 | J | 1.07 * | 1.54 |
| PZ-113-AS TOT | 10/2/2013 | 0.75 | 0.33 | 0.18 | J | 0.16 | 0.17 | 0.24 | UJ | 0.35 | 0.22 | 0.19 | J | 1.10 * | 1.15 |
| PZ-113-SS DIS | 10/3/2013 | 1.2 | 0.36 | 0.15 | J | 0.14 | 0.14 | 0.17 | UJ | 0.48 | 0.22 | 0.15 | J | 1.68 * | 1.51 |
| PZ-113-SS TOT | 10/3/2013 | 1.19 | 0.36 | 0.19 | J | 0.07 | 0.11 | 0.19 | UJ | 0.97 | 0.32 | 0.15 | J | 2.16 * | 2.98 |
| PZ-114-AS DIS | 10/8/2013 | -0.01 | 0.06 | 0.13 | U | 0 | 0.11 | 0.24 | U | -0.01 | 0.06 | 0.13 | U | ND | 0.50 |
| PZ-114-AS TOT | 10/8/2013 | 0.13 | 0.15 | 0.2 | U | 0.12 | 0.14 | 0.17 | U | 0.15 | 0.15 | 0.16 | U | ND | 0.56 |
| PZ-115-SS DIS | 10/8/2013 | 4.18 | 0.91 | 0.13 | | 0.19 | 0.17 | 0.16 | J | 2.01 | 0.56 | 0.13 | | 6.38 | 6.08 |
| PZ-115-SS TOT | 10/8/2013 | 4.05 | 0.96 | 0.25 | | 0.34 | 0.25 | 0.23 | J | 2.15 | 0.64 | 0.3 | | 6.54 | 6.56 |
| PZ-116-SS DIS | 10/11/2013 | 5.77 | 1.13 | 0.18 | J | 0.24 | 0.19 | 0.17 | J | 1.58 | 0.48 | 0.14 | J | 7.59 | 4.82 |
| PZ-116-SS TOT | 10/11/2013 | 5.83 | 1.19 | 0.2 | J | 0.2 | 0.2 | 0.24 | U | 1.7 | 0.52 | 0.2 | J | 7.53 * | 5.18 |
| PZ-200-SS DIS | 10/2/2013 | 0.14 | 0.15 | 0.21 | UJ | -0.02 | 0.07 | 0.19 | U | 0.34 | 0.2 | 0.17 | J | 0.34 * | 1.10 |
| PZ-200-SS TOT | 10/2/2013 | 0.45 | 0.22 | 0.13 | J | 0.05 | 0.08 | 0.14 | UJ | 0.52 | 0.23 | 0.14 | J | 0.97 * | 1.61 |
| PZ-201A-SS DIS | 10/9/2013 | 2.42 | 0.6 | 0.11 | J | 0.1 | 0.13 | 0.2 | U | 1.58 | 0.46 | 0.16 | J | 4.00 * | 4.80 |
| PZ-201A-SS TOT | 10/9/2013 | 2.11 | 0.53 | 0.11 | J | 0.41 | 0.24 | 0.19 | J | 1.49 | 0.43 | 0.12 | J | 4.01 | 4.63 |
| PZ-202-SS DIS | 10/11/2013 | 1.64 | 0.55 | 0.16 | J+ | 0.09 | 0.14 | 0.2 | U | 0.84 | 0.38 | 0.19 | | 2.48 * | 2.60 |
| PZ-202-SS TOT | 10/11/2013 | 1.58 | 0.49 | 0.23 | J+ | 0.04 | 0.11 | 0.24 | U | 0.76 | 0.33 | 0.22 | | 2.34 * | 2.38 |
| PZ-203-SS DIS | 10/2/2013 | 3.07 | 0.74 | 0.18 | J | -0.02 | 0.08 | 0.2 | U | 0.58 | 0.28 | 0.16 | | 3.65 * | 1.82 |
| PZ-203-SS TOT | 10/2/2013 | 3.12 | 0.66 | 0.14 | J | 0.08 | 0.1 | 0.12 | UJ | 0.34 | 0.18 | 0.13 | J | 3.46 * | 1.07 |
| PZ-204A-SS DIS | 10/8/2013 | 1.36 | 0.5 | 0.22 | J | 0.11 | 0.17 | 0.27 | UJ | 1.09 | 0.44 | 0.22 | J | 2.45 * | 3.37 |
| PZ-204A-SS TOT | 10/8/2013 | 1.21 | 0.79 | 0.66 | J | -0.09 | 0.28 | 0.76 | UJ | 0.98 | 0.71 | 0.66 | J | 2.19 * | 3.27 |
| PZ-204-SS DIS | 10/8/2013 | 2.97 | 0.71 | 0.14 | | 0.07 | 0.12 | 0.22 | U | 1.18 | 0.4 | 0.18 | | 4.15 * | 3.62 |
| PZ-204-SS TOT | 10/8/2013 | 3.04 | 0.77 | 0.23 | | 0.2 | 0.19 | 0.2 | J | 1.53 | 0.52 | 0.34 | | 4.77 | 4.65 |
| PZ-205-AS DIS | 10/15/2013 | 0.41 | 0.22 | 0.12 | J+ | 0.15 | 0.16 | 0.22 | U | 0.14 | 0.13 | 0.14 | J | 0.55 * | 0.52 |

## Table 4: Summary of Uranium Results - October 2013 Groundwater Sampling, West Lake Landfill OU-1

| Sample ID | Sample Date | Uranium-234 | | | | Uranium-235 | | | | Uranium-238 | | | | TOTAL U-234 + U-235 + U-238 | Total Uranium (µg/L) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Result | CSU | MDA | FINAL Q | Result | CSU | MDA | FINAL Q | Result | CSU | MDA | FINAL Q | | |
| PZ-205-AS TOT | 10/15/2013 | 0.71 | 0.3 | 0.12 | J+ | 0.07 | 0.13 | 0.22 | U | 0.47 | 0.24 | 0.12 | J | 1.18 * | 1.50 |
| PZ-205-SS DIS | 10/9/2013 | 0.48 | 0.22 | 0.13 | J | 0.15 | 0.14 | 0.16 | UJ | 0.41 | 0.2 | 0.13 | J | 0.89 * | 1.30 |
| PZ-205-SS TOT | 10/9/2013 | 0.44 | 0.22 | 0.15 | J | 0.16 | 0.15 | 0.17 | U | 0.24 | 0.16 | 0.15 | J | 0.68 * | 0.79 |
| PZ-206-SS DIS | 10/7/2013 | 0.26 | 0.18 | 0.18 | J | 0.07 | 0.11 | 0.2 | U | 0.14 | 0.13 | 0.15 | U | 0.26 * | 0.54 |
| PZ-206-SS TOT | 10/7/2013 | 0.12 | 0.15 | 0.21 | U | 0.01 | 0.1 | 0.26 | U | 0.18 | 0.17 | 0.16 | J | 0.18 * | 0.66 |
| PZ-207-AS DIS | 10/4/2013 | 0.26 | 0.18 | 0.12 | J | 0.1 | 0.12 | 0.15 | U | 0.09 | 0.12 | 0.17 | U | 0.26 * | 0.58 |
| PZ-207-AS TOT | 10/4/2013 | -0.02 | 0.07 | 0.2 | U | -0.02 | 0.09 | 0.23 | U | 0.03 | 0.1 | 0.23 | U | ND | 0.79 |
| PZ-208-SS DIS | 10/8/2013 | 1.26 | 0.4 | 0.17 | J | 0.15 | 0.14 | 0.17 | UJ | 0.67 | 0.28 | 0.18 | J | 1.93 * | 2.07 |
| PZ-208-SS TOT | 10/8/2013 | 1.52 | 0.44 | 0.13 | J | 0.13 | 0.15 | 0.2 | UJ | 1.13 | 0.37 | 0.15 | J | 2.65 * | 3.46 |
| PZ-209-SD DIS | 11/7/2013 | 6.43 | 1.1 | 0.13 | J | 0.33 | 0.2 | 0.18 | J | 3.67 | 0.73 | 0.14 | J | 10.43 | 11.09 |
| PZ-209-SD TOT | 11/7/2013 | 8.49 | 1.43 | 0.14 | J | 0.18 | 0.15 | 0.13 | J | 4.36 | 0.87 | 0.11 | J | 13.03 | 13.07 |
| PZ-209-SS DIS | 11/7/2013 | 3.5 | 0.83 | 0.27 | J | 0.12 | 0.16 | 0.24 | UJ | 1.77 | 0.55 | 0.32 | J | 5.27 * | 5.38 |
| PZ-209-SS TOT | 11/7/2013 | 4.34 | 0.86 | 0.1 | | 0.27 | 0.19 | 0.13 | J | 1.65 | 0.45 | 0.1 | | 6.26 | 5.04 |
| PZ-210-SD DIS | 11/6/2013 | 5.34 | 1.03 | 0.22 | | 0.04 | 0.1 | 0.2 | U | 1.84 | 0.51 | 0.18 | | 7.18 * | 5.57 |
| PZ-210-SD FD DIS | 11/6/2013 | 4.97 | 1.07 | 0.24 | | 0.25 | 0.22 | 0.25 | J | 2.49 | 0.67 | 0.22 | | 7.71 | 7.53 |
| PZ-210-SD FD TOT | 11/6/2013 | 5.79 | 1.92 | 0.47 | J | 0.3 | 0.42 | 0.64 | UJ | 3.08 | 1.27 | 0.55 | J | 8.87 * | 9.47 |
| PZ-210-SD TOT | 11/6/2013 | 6.2 | 1.26 | 0.21 | | 0.24 | 0.21 | 0.2 | J | 2.79 | 0.72 | 0.2 | | 9.23 | 8.42 |
| PZ-210-SS DIS | 11/7/2013 | 1.76 | 0.47 | 0.16 | J+ | 0 | 0.06 | 0.19 | UJ | 0.81 | 0.3 | 0.15 | J | 2.57 * | 2.50 |
| PZ-210-SS TOT | 11/7/2013 | 1.97 | 0.55 | 0.13 | J+ | 0.04 | 0.1 | 0.23 | U | 0.55 | 0.27 | 0.18 | | 2.52 * | 1.75 |
| PZ-211-SD DIS | 11/6/2013 | 14.08 | 2.13 | 0.13 | J | 0.36 | 0.22 | 0.18 | J | 4.56 | 0.87 | 0.14 | J | 19.00 | 13.75 |
| PZ-211-SD TOT | 11/6/2013 | 26.42 | 5.11 | 0.28 | J | 1.99 | 0.82 | 0.43 | J | 23.27 | 4.56 | 0.24 | J | 51.68 | 70.25 |
| PZ-211-SS DIS | 11/7/2013 | 2.77 | 0.61 | 0.1 | J+ | 0.06 | 0.1 | 0.17 | UJ | 0.92 | 0.31 | 0.14 | J | 3.69 * | 2.82 |
| PZ-211-SS TOT | 11/7/2013 | 3.17 | 0.69 | 0.15 | J+ | 0.16 | 0.15 | 0.19 | UJ | 1.27 | 0.39 | 0.11 | J | 4.44 * | 3.87 |
| PZ-212-SD DIS | 11/7/2013 | 10.76 | 1.73 | 0.11 | J+ | 0.34 | 0.21 | 0.13 | J | 3.62 | 0.75 | 0.11 | | 14.72 | 10.94 |
| PZ-212-SD TOT | 11/7/2013 | 11.25 | 1.87 | 0.12 | J+ | 0.35 | 0.23 | 0.21 | J | 3.73 | 0.81 | 0.12 | | 15.33 | 11.28 |
| PZ-212-SS DIS | 11/7/2013 | 2.43 | 0.54 | 0.12 | J | 0.14 | 0.13 | 0.16 | UJ | 1.31 | 0.37 | 0.13 | J | 3.74 * | 3.98 |
| PZ-212-SS TOT | 11/7/2013 | 2.63 | 0.61 | 0.15 | J | 0.08 | 0.11 | 0.15 | UJ | 1.74 | 0.47 | 0.15 | J | 4.37 * | 5.25 |
| PZ-302-AI DIS | 10/3/2013 | 4.6 | 0.93 | 0.12 | | 0.32 | 0.22 | 0.18 | J | 3.44 | 0.76 | 0.13 | | 8.36 | 10.40 |
| PZ-302-AI TOT | 10/3/2013 | 4.47 | 0.82 | 0.14 | J | 0.42 | 0.22 | 0.17 | J | 3.38 | 0.67 | 0.15 | J | 8.27 | 10.27 |

## Table 4: Summary of Uranium Results - October 2013 Groundwater Sampling, West Lake Landfill OU-1

| Sample ID | Sample Date | Uranium-234 | | | | Uranium-235 | | | | Uranium-238 | | | | TOTAL U-234 + U-235 + U-238 | Total Uranium (µg/L) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Result | CSU | MDA | FINAL Q | Result | CSU | MDA | FINAL Q | Result | CSU | MDA | FINAL Q | | |
| PZ-302-AS DIS | 10/8/2013 | 0.97 | 0.35 | 0.16 | J | 0.14 | 0.15 | 0.21 | UJ | 0.36 | 0.2 | 0.12 | J | 1.33 * | 1.17 |
| PZ-302-AS TOT | 10/8/2013 | 6.22 | 1.37 | 0.17 | | 0.2 | 0.23 | 0.31 | U | 4.59 | 1.1 | 0.25 | | 10.81 * | 13.82 |
| PZ-303-AS DIS | 10/4/2013 | 0.51 | 0.29 | 0.18 | J | 0.12 | 0.16 | 0.22 | UJ | 0.48 | 0.27 | 0.16 | J | 0.99 * | 1.53 |
| PZ-303-AS TOT | 10/4/2013 | 0.87 | 0.41 | 0.26 | J | 0.05 | 0.15 | 0.34 | UJ | 0.89 | 0.41 | 0.21 | J | 1.76 * | 2.81 |
| PZ-304-AI DIS | 10/1/2013 | 0.35 | 0.28 | 0.25 | J | 0.06 | 0.18 | 0.38 | UJ | 0.1 | 0.18 | 0.31 | UJ | 0.35 * | 1.10 |
| PZ-304-AI FD DIS | 10/1/2013 | 0.18 | 0.18 | 0.21 | U | 0 | 0.13 | 0.29 | U | 0.35 | 0.24 | 0.16 | J | 0.35 * | 1.18 |
| PZ-304-AI FD TOT | 10/1/2013 | 0.15 | 0.25 | 0.42 | UJ | -0.04 | 0.22 | 0.52 | UJ | 0.16 | 0.24 | 0.36 | UJ | ND | 1.31 |
| PZ-304-AI TOT | 10/1/2013 | 0.26 | 0.24 | 0.28 | U | 0.05 | 0.12 | 0.26 | U | -0.04 | 0.18 | 0.47 | U | ND | 1.52 |
| PZ-304-AS DIS | 10/1/2013 | 0.53 | 0.47 | 0.53 | J | 0.09 | 0.22 | 0.45 | UJ | 0 | 0.24 | 0.52 | UJ | 0.53 * | 1.76 |
| PZ-304-AS TOT | 10/1/2013 | -0.04 | 0.17 | 0.43 | UJ | 0.1 | 0.28 | 0.6 | UJ | 0.15 | 0.23 | 0.34 | UJ | ND | 1.29 |
| PZ-305-AI DIS | 10/2/2013 | 0.45 | 0.26 | 0.19 | J | 0.12 | 0.14 | 0.17 | UJ | 0.04 | 0.16 | 0.32 | UJ | 0.45 * | 1.03 |
| PZ-305-AI TOT | 10/2/2013 | 0.05 | 0.08 | 0.12 | UJ | 0.17 | 0.15 | 0.14 | J | 0.09 | 0.11 | 0.16 | U | 0.09 * | 0.56 |

Notes:

All values are in units of picoCuries per liter (pCi/L), except as noted.
DIS = dissolved sample (field filtered sample); TOT = total sample (unfiltered sample)
FD = Field duplicate sample
CSU = Combined Standard Uncertainty (2-sigma)
Data Validation Qualifiers (Final Q) include: R = rejected; data not usable; U = Non-detect at the reported value;
UJ = Non-Detect at the estimated reported value; UJ+ = Non-Detect at the estimated reported value which may be biased high;
UJ- = Non-Detect at the estimated reported value which may be biased low;
J = estimated result; J+ = estimated result which may be biased high.
TOTAL U-238 + U-235 + U-234 based on sum of detected values only. The * flag indicates one or more of the individual isotopes was non-detect.
Total uranium values in µg/L based on use of Minimum Detectable Activity (MDA) values for non-detect results.

## Table 5: Summary of Thorium Isotope Results - October 2013 Groundwater Sampling, West Lake Landfill OU-1

| Sample ID | Sample Date | Thorium-228 | | | | Thorium-230 | | | | Thorium-232 | | | | TOTAL Thorium 228 + 230 + 232 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Result | CSU | MDA | FINAL Q | Result | CSU | MDA | FINAL Q | Result | CSU | MDA | FINAL Q | | |
| S-5 DIS | 10/7/2013 | -0.01 | 0.07 | 0.14 | U | 0.2 | 0.17 | 0.14 | J | 0.13 | 0.15 | 0.2 | U | 0.20 | * |
| S-5 TOT | 10/7/2013 | 0.02 | 0.1 | 0.24 | U | 0.35 | 0.24 | 0.24 | J | 0.09 | 0.12 | 0.14 | U | 0.35 | * |
| S-8 DIS | 10/1/2013 | 0.07 | 0.12 | 0.21 | U | 0.21 | 0.19 | 0.21 | J | 0 | 0.1 | 0.21 | U | 0.21 | * |
| S-8 TOT | 10/1/2013 | 0.03 | 0.07 | 0.15 | UJ | 0.25 | 0.17 | 0.16 | J | 0.04 | 0.07 | 0.12 | UJ | 0.25 | * |
| S-10 DIS | 10/1/2013 | -0.02 | 0.09 | 0.22 | UJ | 0.2 | 0.19 | 0.17 | J | 0.08 | 0.12 | 0.17 | UJ | 0.20 | * |
| S-10 TOT | 10/1/2013 | 0.05 | 0.12 | 0.25 | UJ | 0.19 | 0.19 | 0.2 | UJ | 0.04 | 0.12 | 0.25 | UJ | ND | * |
| S-53 DIS | 10/15/2013 | 0.2 | 0.27 | 0.36 | UJ | 0.14 | 0.21 | 0.31 | UJ | 0.07 | 0.21 | 0.44 | UJ | ND | * |
| S-53 TOT | 10/15/2013 | 0.39 | 0.22 | 0.15 | J | 0.49 | 0.24 | 0.13 | | 0.4 | 0.21 | 0.11 | J | 1.28 | |
| S-61 DIS | 10/3/2013 | 0.02 | 0.09 | 0.2 | U | 0.16 | 0.16 | 0.22 | U | -0.06 | 0.1 | 0.3 | U | ND | * |
| S-61 TOT | 10/3/2013 | 0.86 | 0.35 | 0.19 | | 6.97 | 1.64 | 0.16 | | 0.64 | 0.29 | 0.16 | | 8.47 | |
| S-82 DIS | 10/8/2013 | 0.03 | 0.08 | 0.19 | U | 0.09 | 0.13 | 0.21 | U | 0.04 | 0.1 | 0.23 | U | ND | * |
| S-82 TOT | 10/8/2013 | 0.08 | 0.18 | 0.35 | UJ | 0.06 | 0.17 | 0.36 | UJ | -0.03 | 0.12 | 0.31 | UJ | ND | * |
| S-84 DIS | 10/9/2013 | 0.08 | 0.18 | 0.36 | UJ | 0.24 | 0.25 | 0.26 | UJ | -0.02 | 0.14 | 0.43 | UJ | ND | * |
| S-84 FD DIS | 10/9/2013 | -0.02 | 0.07 | 0.19 | U | 0.45 | 0.27 | 0.18 | J | -0.02 | 0.07 | 0.18 | U | 0.45 | * |
| S-84 TOT | 10/9/2013 | 0.87 | 0.38 | 0.22 | | 0.8 | 0.36 | 0.18 | | 0.75 | 0.35 | 0.2 | | 2.42 | |
| S-84 FD TOT | 10/9/2013 | 0.44 | 0.22 | 0.17 | J | 0.46 | 0.23 | 0.17 | J | 0.45 | 0.22 | 0.18 | J | 1.35 | |
| I-4 DIS | 10/7/2013 | 0.07 | 0.12 | 0.22 | U | 0.27 | 0.21 | 0.2 | J | 0.03 | 0.07 | 0.14 | U | 0.27 | * |
| I-4 TOT | 10/7/2013 | 0.04 | 0.1 | 0.2 | U | 0.26 | 0.17 | 0.13 | J | 0.1 | 0.11 | 0.11 | U | 0.26 | * |
| I-9 DIS | 10/8/2013 | 0.03 | 0.08 | 0.18 | U | 0.1 | 0.11 | 0.11 | U | 0 | 0.08 | 0.16 | U | ND | * |
| I-9 FD DIS | 10/8/2013 | 0.12 | 0.22 | 0.39 | UJ | 0.13 | 0.16 | 0.19 | UJ | 0.11 | 0.16 | 0.24 | UJ | ND | * |
| I-9 TOT | 10/8/2013 | 0.2 | 0.15 | 0.13 | J | 0.46 | 0.24 | 0.12 | J | 0.02 | 0.05 | 0.11 | U | 0.66 | * |
| I-9 FD TOT | 10/8/2013 | 0.17 | 0.19 | 0.29 | U | 0.19 | 0.17 | 0.2 | U | 0.02 | 0.08 | 0.19 | U | ND | * |
| I-11 DIS | 10/1/2013 | 0.06 | 0.09 | 0.15 | UJ | 0.25 | 0.16 | 0.11 | J | 0 | 0.07 | 0.15 | UJ | 0.25 | * |
| I-11 TOT | 10/1/2013 | -0.08 | 0.15 | 0.46 | UJ | 0.48 | 0.4 | 0.41 | J | 0.15 | 0.24 | 0.41 | UJ | 0.48 | * |
| I-62 DIS | 10/1/2013 | 0.1 | 0.14 | 0.22 | U | 0.13 | 0.14 | 0.16 | U | 0 | 0.09 | 0.2 | U | ND | * |
| I-62 TOT | 10/1/2013 | -0.02 | 0.07 | 0.23 | U | 0.22 | 0.17 | 0.13 | J | 0.06 | 0.11 | 0.19 | U | 0.22 | * |
| I-65 DIS | 10/15/2013 | 0.03 | 0.09 | 0.19 | U | 0.38 | 0.24 | 0.19 | J | 0.09 | 0.13 | 0.19 | U | 0.38 | * |
| I-65 TOT | 10/15/2013 | 0.19 | 0.15 | 0.17 | J | 0.21 | 0.16 | 0.16 | J | 0.14 | 0.13 | 0.14 | J | 0.54 | |
| I-66 DIS | 10/9/2013 | 0.05 | 0.09 | 0.16 | U | 0.15 | 0.15 | 0.18 | U | 0.05 | 0.09 | 0.16 | U | ND | * |
| I-66 TOT | 10/9/2013 | 0.28 | 0.2 | 0.19 | J | 0.07 | 0.11 | 0.17 | U | 0.06 | 0.11 | 0.18 | U | 0.00 | * |

## Table 5: Summary of Thorium Isotope Results - October 2013 Groundwater Sampling, West Lake Landfill OU-1

| Sample ID | Sample Date | Thorium-228 | | | | Thorium-230 | | | | Thorium-232 | | | | TOTAL Thorium 228 + 230 + 232 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Result | CSU | MDA | FINAL Q | Result | CSU | MDA | FINAL Q | Result | CSU | MDA | FINAL Q | |
| I-67 DIS | 10/3/2013 | 0.03 | 0.08 | 0.16 | U | 0.15 | 0.13 | 0.13 | J | 0.05 | 0.08 | 0.11 | U | 0.15 * |
| I-67 FD DIS | 10/3/2013 | 0.02 | 0.08 | 0.18 | U | 0.14 | 0.14 | 0.19 | UJ | -0.02 | 0.1 | 0.26 | U | ND * |
| I-67 TOT | 10/3/2013 | 0.11 | 0.15 | 0.23 | U | 1.34 | 0.57 | 0.18 | J | 0.08 | 0.12 | 0.18 | U | 1.34 * |
| I-67 FD TOT | 10/3/2013 | 0.08 | 0.12 | 0.2 | U | 0.45 | 0.25 | 0.17 | J | 0.11 | 0.13 | 0.17 | U | 0.45 * |
| I-68 DIS | 10/4/2013 | 0.12 | 0.13 | 0.17 | UJ | 0.25 | 0.16 | 0.11 | J | 0.07 | 0.09 | 0.1 | UJ | 0.25 * |
| I-68 TOT | 10/4/2013 | 0.86 | 0.39 | 0.19 | | 2.25 | 0.73 | 0.14 | J | 0.42 | 0.26 | 0.21 | J | 3.53 |
| I-73 DIS | 10/3/2013 | 0.04 | 0.1 | 0.21 | U | 0.08 | 0.12 | 0.21 | U | 0.17 | 0.16 | 0.15 | J | 0.00 * |
| I-73 TOT | 10/3/2013 | 0.11 | 0.15 | 0.25 | U | 0.33 | 0.22 | 0.14 | J | 0.12 | 0.13 | 0.16 | U | 0.33 * |
| D-3 DIS | 10/7/2013 | 0.04 | 0.11 | 0.22 | U | 0.15 | 0.14 | 0.13 | J | 0.05 | 0.08 | 0.14 | U | 0.15 * |
| D-3 TOT | 10/7/2013 | -0.01 | 0.1 | 0.31 | UJ | 0.22 | 0.21 | 0.19 | J | 0.27 | 0.23 | 0.19 | J | 0.49 * |
| D-6 DIS | 10/8/2013 | 0.11 | 0.15 | 0.24 | U | 0.3 | 0.2 | 0.2 | J | 0.1 | 0.11 | 0.13 | U | 0.30 * |
| D-6 TOT | 10/8/2013 | 0.09 | 0.13 | 0.21 | UJ | 0.14 | 0.13 | 0.16 | UJ | 0.09 | 0.1 | 0.13 | UJ | ND * |
| D-12 DIS | 10/1/2013 | 0.08 | 0.15 | 0.26 | UJ | 0.28 | 0.22 | 0.17 | J | 0.03 | 0.08 | 0.2 | UJ | 0.28 * |
| D-12 TOT | 10/1/2013 | 0.04 | 0.15 | 0.32 | UJ | 0.57 | 0.31 | 0.15 | J | 0.01 | 0.07 | 0.2 | U | 0.57 * |
| D-13 DIS | 10/7/2013 | -0.08 | 0.1 | 0.33 | UJ | 0.07 | 0.12 | 0.2 | UJ | 0.03 | 0.09 | 0.2 | UJ | ND * |
| D-13 TOT | 10/7/2013 | 0.27 | 0.21 | 0.23 | J | 0.15 | 0.15 | 0.18 | U | -0.1 | 0.09 | 0.33 | U | 0.00 * |
| D-14 DIS | 10/15/2013 | 0.34 | 0.24 | 0.24 | J | 0.96 | 0.4 | 0.13 | | 0.1 | 0.13 | 0.19 | U | 1.30 * |
| D-14 TOT | 10/15/2013 | 0.15 | 0.16 | 0.24 | U | 0.5 | 0.26 | 0.17 | J | 0.11 | 0.11 | 0.12 | U | 0.50 * |
| D-81 DIS | 10/3/2013 | 0.01 | 0.08 | 0.2 | U | 0.08 | 0.1 | 0.11 | U | -0.01 | 0.06 | 0.13 | U | ND * |
| D-81 TOT | 10/3/2013 | -0.02 | 0.09 | 0.25 | U | 0.18 | 0.16 | 0.2 | U | 0.06 | 0.11 | 0.2 | U | ND * |
| D-83 DIS | 10/8/2013 | 0.18 | 0.18 | 0.21 | U | 0.34 | 0.25 | 0.19 | J | 0.22 | 0.2 | 0.19 | J | 0.56 * |
| D-83 TOT | 10/8/2013 | 0.43 | 0.29 | 0.35 | J | 0.25 | 0.19 | 0.19 | J | 0.05 | 0.09 | 0.15 | U | 0.68 * |
| D-85 DIS | 10/9/2013 | 0.05 | 0.1 | 0.17 | U | 0.03 | 0.07 | 0.16 | U | 0.05 | 0.07 | 0.11 | U | ND * |
| D-85 TOT | 10/9/2013 | 3.01 | 0.86 | 0.16 | J | 4.37 | 1.19 | 0.14 | J | 2.67 | 0.78 | 0.17 | J | 10.05 |
| D-87 DIS | 10/2/2013 | 0.15 | 0.15 | 0.18 | U | 0.15 | 0.14 | 0.18 | U | 0.15 | 0.14 | 0.18 | U | ND * |
| D-87 FD DIS | 10/2/2013 | 0.03 | 0.1 | 0.23 | U | 0.33 | 0.22 | 0.14 | J | 0.06 | 0.09 | 0.14 | U | 0.33 * |
| D-87 TOT | 10/2/2013 | 0.43 | 0.25 | 0.18 | J | 1.63 | 0.55 | 0.19 | | 0.71 | 0.32 | 0.14 | | 2.77 |
| D-87 FD TOT | 10/2/2013 | 0.37 | 0.21 | 0.14 | J | 0.81 | 0.34 | 0.11 | | 0.22 | 0.16 | 0.16 | J | 1.40 |
| D-93 DIS | 10/8/2013 | 0.33 | 0.24 | 0.26 | J | 0.55 | 0.3 | 0.15 | J | 0.03 | 0.1 | 0.21 | U | 0.88 * |
| D-93 TOT | 10/8/2013 | 0.38 | 0.24 | 0.24 | J | 0.44 | 0.24 | 0.17 | J | 0.05 | 0.08 | 0.12 | U | 0.82 * |

## Table 5: Summary of Thorium Isotope Results - October 2013 Groundwater Sampling, West Lake Landfill OU-1

| Sample ID | Sample Date | Thorium-228 | | | | Thorium-230 | | | | Thorium-232 | | | | TOTAL Thorium 228 + 230 + 232 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Result | CSU | MDA | FINAL Q | Result | CSU | MDA | FINAL Q | Result | CSU | MDA | FINAL Q | | |
| LR-100 DIS | 10/4/2013 | 0 | 0.05 | 0.14 | UJ | 0.04 | 0.06 | 0.11 | UJ | 0 | 0.04 | 0.09 | UJ | ND | * |
| LR-100 FD DIS | 10/4/2013 | 0.03 | 0.09 | 0.19 | U | 0.15 | 0.14 | 0.13 | J | 0.02 | 0.06 | 0.14 | U | 0.15 | * |
| LR-100 TOT | 10/4/2013 | -0.01 | 0.06 | 0.15 | U | 0.16 | 0.15 | 0.17 | U | 0.04 | 0.08 | 0.15 | U | ND | * |
| LR-100 FD TOT | 10/4/2013 | 0.03 | 0.13 | 0.28 | U | 0.09 | 0.11 | 0.13 | U | 0.07 | 0.11 | 0.18 | U | ND | * |
| LR-103 DIS | 10/2/2013 | 0.02 | 0.11 | 0.23 | UJ | 0.19 | 0.15 | 0.13 | J | 0.06 | 0.09 | 0.14 | UJ | 0.19 | * |
| LR-103 TOT | 10/2/2013 | 0.15 | 0.2 | 0.29 | UJ | 0.23 | 0.22 | 0.2 | J | 0.14 | 0.17 | 0.2 | UJ | 0.23 | * |
| LR-104 DIS | 10/2/2013 | -0.03 | 0.06 | 0.19 | U | 0.26 | 0.17 | 0.12 | J | 0.01 | 0.05 | 0.14 | U | 0.26 | * |
| LR-104 TOT | 10/2/2013 | -0.03 | 0.08 | 0.23 | U | 0.22 | 0.17 | 0.18 | J | 0.05 | 0.09 | 0.16 | U | 0.22 | * |
| MW-102 DIS | 10/3/2013 | -0.09 | 0.12 | 0.38 | UJ | 0.09 | 0.15 | 0.25 | UJ | 0.04 | 0.1 | 0.21 | UJ | ND | * |
| MW-102 TOT | 10/3/2013 | 1.26 | 0.46 | 0.23 | | 0.7 | 0.32 | 0.14 | | 0.55 | 0.27 | 0.14 | | 2.51 | |
| MW-103 DIS | 10/4/2013 | -0.02 | 0.06 | 0.19 | U | 0.25 | 0.17 | 0.12 | J | 0.1 | 0.1 | 0.11 | U | 0.25 | * |
| MW-103 TOT | 10/4/2013 | 1.11 | 0.42 | 0.22 | | 1.08 | 0.41 | 0.14 | J | 1.22 | 0.43 | 0.14 | | 3.41 | |
| MW-104 DIS | 10/3/2013 | 0.15 | 0.15 | 0.2 | UJ | 0.28 | 0.18 | 0.14 | J | 0.09 | 0.1 | 0.12 | UJ | 0.28 | * |
| MW-104 TOT | 10/3/2013 | 1.94 | 0.6 | 0.16 | | 2.04 | 0.64 | 0.18 | | 1.77 | 0.56 | 0.18 | | 5.75 | |
| MW-1204 DIS | 10/11/2013 | 3.34 | 5.03 | 7.07 | R | 8.52 | 8.38 | 4.54 | R | 7.6 | 7.91 | 6.51 | R | 19.46 | |
| MW-1204 TOT | 10/11/2013 | 0.17 | 0.31 | 0.55 | UJ | 0.35 | 0.33 | 0.3 | J | 0 | 0.2 | 0.43 | UJ | 0.35 | * |
| PZ-100-KS DIS | 10/15/2013 | 0.11 | 0.14 | 0.19 | U | 0.32 | 0.22 | 0.18 | J | 0.12 | 0.13 | 0.18 | U | 0.32 | * |
| PZ-100-KS TOT | 10/15/2013 | 0.23 | 0.27 | 0.4 | UJ | 0.32 | 0.31 | 0.42 | UJ | 0.09 | 0.22 | 0.44 | UJ | ND | * |
| PZ-100-SD DIS | 10/8/2013 | -0.03 | 0.06 | 0.19 | UJ | 0.26 | 0.17 | 0.14 | J | 0.04 | 0.07 | 0.1 | UJ | 0.26 | * |
| PZ-100-SD TOT | 10/8/2013 | 0.11 | 0.11 | 0.14 | UJ | 0.19 | 0.14 | 0.13 | J | 0.03 | 0.07 | 0.14 | UJ | 0.19 | * |
| PZ-100-SS DIS | 10/8/2013 | 0.07 | 0.13 | 0.24 | U | 0.34 | 0.23 | 0.2 | J | -0.01 | 0.06 | 0.13 | U | 0.34 | * |
| PZ-100-SS TOT | 10/8/2013 | 0.01 | 0.09 | 0.25 | U | 0.07 | 0.11 | 0.19 | U | 0.08 | 0.14 | 0.24 | U | ND | * |
| PZ-101-SS DIS | 10/8/2013 | 0.27 | 0.21 | 0.27 | J | 0.13 | 0.14 | 0.19 | U | -0.01 | 0.06 | 0.18 | U | 0.00 | * |
| PZ-101-SS TOT | 10/8/2013 | 0.28 | 0.2 | 0.24 | J | 0.23 | 0.17 | 0.14 | J | 0.13 | 0.13 | 0.17 | U | 0.51 | * |
| PZ-102R-SS DIS | 10/8/2013 | 0.14 | 0.15 | 0.22 | U | 0.09 | 0.1 | 0.13 | U | 0.05 | 0.09 | 0.14 | U | ND | * |
| PZ-102R-SS TOT | 10/8/2013 | 0.13 | 0.13 | 0.17 | UJ | 0.31 | 0.19 | 0.13 | J | 0.36 | 0.2 | 0.11 | J | 0.67 | * |
| PZ-102-SS DIS | 10/8/2013 | 0.14 | 0.15 | 0.21 | U | 0.21 | 0.18 | 0.19 | J | 0.03 | 0.07 | 0.14 | U | 0.21 | * |
| PZ-102-SS TOT | 10/8/2013 | 3.03 | 0.8 | 0.13 | | 2.97 | 0.82 | 0.11 | | 2.91 | 0.77 | 0.11 | | 8.91 | |
| PZ-103-SS DIS | 10/4/2013 | 0.06 | 0.11 | 0.19 | U | 0.17 | 0.15 | 0.18 | UJ | 0.02 | 0.05 | 0.11 | U | ND | * |
| PZ-103-SS TOT | 10/4/2013 | 0.23 | 0.16 | 0.16 | J | 1 | 0.37 | 0.15 | J | 0.37 | 0.2 | 0.1 | J | 1.60 | |

## Table 5: Summary of Thorium Isotope Results - October 2013 Groundwater Sampling, West Lake Landfill OU-1

| Sample ID | Sample Date | Thorium-228 | | | | Thorium-230 | | | | Thorium-232 | | | | TOTAL Thorium 228 + 230 + 232 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Result | CSU | MDA | FINAL Q | Result | CSU | MDA | FINAL Q | Result | CSU | MDA | FINAL Q | | |
| PZ-104-KS DIS | 10/4/2013 | 0.14 | 0.2 | 0.3 | UJ | 0.07 | 0.14 | 0.25 | UJ | 0.05 | 0.14 | 0.29 | UJ | ND | * |
| PZ-104-KS TOT | 10/4/2013 | 0.06 | 0.1 | 0.18 | U | 0.24 | 0.16 | 0.12 | J | 0 | 0.07 | 0.19 | U | 0.24 | * |
| PZ-104-SD DIS | 10/7/2013 | 0.22 | 0.17 | 0.19 | J | 0.17 | 0.15 | 0.17 | J | 0.03 | 0.08 | 0.17 | U | 0.39 | * |
| PZ-104-SD TOT | 10/7/2013 | 0.12 | 0.13 | 0.18 | U | 0.21 | 0.17 | 0.17 | J | 0.05 | 0.08 | 0.12 | U | 0.21 | * |
| PZ-104-SS DIS | 10/9/2013 | 0.05 | 0.1 | 0.19 | U | 0.22 | 0.17 | 0.12 | J | 0.11 | 0.11 | 0.12 | U | 0.22 | * |
| PZ-104-SS TOT | 10/9/2013 | 0.1 | 0.12 | 0.15 | U | 0.39 | 0.23 | 0.17 | J | 0.01 | 0.06 | 0.15 | U | 0.39 | * |
| PZ-105-SS DIS | 10/9/2013 | 0 | 0.06 | 0.18 | U | 0.16 | 0.15 | 0.17 | U | 0 | 0.06 | 0.18 | U | ND | * |
| PZ-105-SS TOT | 10/9/2013 | -0.05 | 0.09 | 0.28 | UJ | 0.17 | 0.19 | 0.26 | UJ | -0.01 | 0.09 | 0.18 | UJ | ND | * |
| PZ-106-KS DIS | 10/11/2013 | -0.02 | 0.09 | 0.23 | UJ | 0.29 | 0.25 | 0.26 | J | 0.05 | 0.13 | 0.27 | UJ | 0.29 | * |
| PZ-106-KS FD DIS | 10/11/2013 | 0.12 | 0.24 | 0.44 | UJ | 0.18 | 0.23 | 0.27 | UJ | 0.12 | 0.18 | 0.27 | UJ | ND | * |
| PZ-106-KS TOT | 10/11/2013 | -0.02 | 0.07 | 0.19 | UJ | 0.22 | 0.18 | 0.19 | J | 0.05 | 0.09 | 0.17 | UJ | 0.22 | * |
| PZ-106-KS FD TOT | 10/11/2013 | 0.06 | 0.11 | 0.19 | U | 0.54 | 0.31 | 0.22 | J | 0.05 | 0.1 | 0.19 | U | 0.54 | * |
| PZ-106-SD DIS | 10/8/2013 | 0 | 0.08 | 0.18 | U | 0.17 | 0.15 | 0.17 | J | 0.03 | 0.08 | 0.17 | U | 0.17 | * |
| PZ-106-SD TOT | 10/8/2013 | 0.1 | 0.14 | 0.21 | U | 0.17 | 0.16 | 0.19 | U | 0.08 | 0.11 | 0.17 | U | ND | * |
| PZ-106-SS DIS | 10/7/2013 | 0.07 | 0.13 | 0.24 | UJ | 0.17 | 0.18 | 0.19 | UJ | 0.13 | 0.18 | 0.27 | UJ | ND | * |
| PZ-106-SS TOT | 10/7/2013 | 0.04 | 0.1 | 0.2 | U | 0.09 | 0.11 | 0.16 | U | 0.03 | 0.07 | 0.14 | U | ND | * |
| PZ-107-SS DIS | 10/3/2013 | 0 | 0.06 | 0.19 | U | 0.47 | 0.26 | 0.18 | J | 0.06 | 0.1 | 0.18 | U | 0.47 | * |
| PZ-107-SS TOT | 10/3/2013 | 0.5 | 0.27 | 0.14 | J | 0.99 | 0.42 | 0.14 | | 1 | 0.41 | 0.2 | | 2.49 | |
| PZ-109-SS DIS | 10/9/2013 | 0.02 | 0.2 | 0.43 | UJ | 0.14 | 0.19 | 0.3 | UJ | 0.06 | 0.12 | 0.22 | UJ | ND | * |
| PZ-109-SS TOT | 10/9/2013 | -0.04 | 0.11 | 0.31 | U | 0.13 | 0.15 | 0.21 | U | 0.04 | 0.1 | 0.19 | U | ND | * |
| PZ-110-SS DIS | 10/8/2013 | 0.07 | 0.12 | 0.21 | U | 0.14 | 0.13 | 0.12 | J | -0.01 | 0.06 | 0.14 | U | 0.14 | * |
| PZ-110-SS TOT | 10/8/2013 | 0 | 0.06 | 0.17 | UJ | 0.25 | 0.17 | 0.12 | J | 0.1 | 0.1 | 0.11 | UJ | 0.25 | * |
| PZ-111-KS DIS | 10/3/2013 | 0.07 | 0.12 | 0.2 | U | 0.41 | 0.25 | 0.2 | J | 0.06 | 0.09 | 0.14 | U | 0.41 | * |
| PZ-111-KS TOT | 10/3/2013 | -0.06 | 0.08 | 0.25 | U | 0.26 | 0.2 | 0.14 | J | 0.02 | 0.07 | 0.16 | U | 0.26 | * |
| PZ-111-SD DIS | 10/7/2013 | -0.08 | 0.12 | 0.36 | U | 0.11 | 0.15 | 0.23 | U | 0.12 | 0.14 | 0.2 | U | ND | * |
| PZ-111-SD TOT | 10/7/2013 | 0.05 | 0.11 | 0.21 | UJ | 0.25 | 0.2 | 0.18 | J | 0.07 | 0.1 | 0.15 | UJ | 0.25 | * |
| PZ-112-AS DIS | 10/2/2013 | 0.06 | 0.09 | 0.16 | U | 0.1 | 0.11 | 0.13 | U | 0.05 | 0.07 | 0.11 | U | ND | * |
| PZ-112-AS TOT | 10/2/2013 | 0.17 | 0.15 | 0.16 | J | 0.21 | 0.17 | 0.19 | J | 0.1 | 0.12 | 0.17 | U | 0.38 | * |
| PZ-113-AD DIS | 10/7/2013 | 0.29 | 0.19 | 0.13 | J | 0.1 | 0.11 | 0.11 | U | 0 | 0.05 | 0.11 | U | 0.00 | * |
| PZ-113-AD FD DIS | 10/7/2013 | 0.31 | 0.23 | 0.21 | J | 0.16 | 0.15 | 0.16 | J | 0.06 | 0.1 | 0.14 | U | 0.47 | * |

## Table 5: Summary of Thorium Isotope Results - October 2013 Groundwater Sampling, West Lake Landfill OU-1

| Sample ID | Sample Date | Thorium-228 | | | | Thorium-230 | | | | Thorium-232 | | | | TOTAL Thorium | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Result | CSU | MDA | FINAL Q | Result | CSU | MDA | FINAL Q | Result | CSU | MDA | FINAL Q | 228 + 230 + 232 | |
| PZ-113-AD TOT | 10/7/2013 | 0.09 | 0.12 | 0.18 | UJ | 0.16 | 0.13 | 0.14 | J | 0.04 | 0.06 | 0.09 | UJ | 0.16 | * |
| PZ-113-AD FD TOT | 10/7/2013 | 0.06 | 0.11 | 0.19 | U | 0.25 | 0.18 | 0.17 | J | 0.05 | 0.08 | 0.12 | U | 0.25 | * |
| PZ-113-AS DIS | 10/2/2013 | 0.05 | 0.09 | 0.16 | U | 0.25 | 0.16 | 0.11 | J | 0.12 | 0.11 | 0.12 | J | 0.37 | * |
| PZ-113-AS TOT | 10/2/2013 | 0.06 | 0.13 | 0.25 | U | 0.14 | 0.13 | 0.12 | J | -0.02 | 0.06 | 0.16 | U | 0.14 | * |
| PZ-113-SS DIS | 10/3/2013 | 0.02 | 0.1 | 0.23 | U | 0.18 | 0.17 | 0.23 | U | 0.06 | 0.09 | 0.13 | U | ND | * |
| PZ-113-SS TOT | 10/3/2013 | 0.16 | 0.15 | 0.17 | U | 0.43 | 0.23 | 0.16 | J | 0.18 | 0.14 | 0.11 | J | 0.61 | * |
| PZ-114-AS DIS | 10/8/2013 | -0.01 | 0.14 | 0.34 | U | 0.29 | 0.23 | 0.24 | J | -0.01 | 0.07 | 0.18 | U | 0.29 | * |
| PZ-114-AS TOT | 10/8/2013 | 0.1 | 0.12 | 0.17 | U | 0.34 | 0.2 | 0.14 | J | 0.02 | 0.05 | 0.11 | U | 0.34 | * |
| PZ-115-SS DIS | 10/8/2013 | -0.01 | 0.09 | 0.21 | UJ | 0.1 | 0.15 | 0.24 | UJ | 0 | 0.12 | 0.25 | UJ | ND | * |
| PZ-115-SS TOT | 10/8/2013 | 0.18 | 0.17 | 0.19 | U | 0.19 | 0.17 | 0.18 | J | 0.07 | 0.11 | 0.2 | U | 0.19 | * |
| PZ-116-SS DIS | 10/11/2013 | 0 | 0.14 | 0.31 | UJ | 0.3 | 0.27 | 0.3 | J | 0.15 | 0.2 | 0.3 | UJ | 0.30 | * |
| PZ-116-SS TOT | 10/11/2013 | 0.03 | 0.09 | 0.19 | U | 0.27 | 0.19 | 0.18 | J | 0.04 | 0.08 | 0.15 | U | 0.27 | * |
| PZ-200-SS DIS | 10/2/2013 | 0 | 0.06 | 0.18 | U | 0.18 | 0.15 | 0.14 | J | 0.03 | 0.08 | 0.16 | U | 0.18 | * |
| PZ-200-SS TOT | 10/2/2013 | 0.21 | 0.19 | 0.23 | U | 0.25 | 0.19 | 0.15 | J | 0.19 | 0.19 | 0.25 | U | 0.25 | * |
| PZ-201A-SS DIS | 10/9/2013 | 0.1 | 0.17 | 0.28 | UJ | 0.16 | 0.2 | 0.24 | UJ | 0 | 0.16 | 0.35 | UJ | ND | * |
| PZ-201A-SS TOT | 10/9/2013 | -0.02 | 0.07 | 0.2 | U | 0.3 | 0.22 | 0.18 | J | 0.06 | 0.1 | 0.15 | U | 0.30 | * |
| PZ-202-SS DIS | 10/11/2013 | -0.02 | 0.06 | 0.17 | U | 0.12 | 0.12 | 0.15 | U | 0 | 0.06 | 0.16 | U | ND | * |
| PZ-202-SS TOT | 10/11/2013 | 0.06 | 0.16 | 0.36 | U | 0.11 | 0.19 | 0.33 | U | 0.05 | 0.11 | 0.23 | U | ND | * |
| PZ-203-SS DIS | 10/2/2013 | 0.01 | 0.08 | 0.22 | U | 0.03 | 0.07 | 0.15 | U | 0.04 | 0.1 | 0.22 | U | ND | * |
| PZ-203-SS TOT | 10/2/2013 | -0.03 | 0.05 | 0.16 | UJ | 0.17 | 0.13 | 0.14 | J | -0.02 | 0.05 | 0.14 | UJ | 0.17 | * |
| PZ-204A-SS DIS | 10/8/2013 | 0.09 | 0.15 | 0.25 | UJ | 0.42 | 0.32 | 0.31 | J | 0.05 | 0.14 | 0.31 | UJ | 0.42 | * |
| PZ-204A-SS TOT | 10/8/2013 | 0.42 | 0.23 | 0.17 | J | 0.29 | 0.19 | 0.13 | J | 0.02 | 0.05 | 0.11 | U | 0.71 | * |
| PZ-204-SS DIS | 10/8/2013 | 0.17 | 0.16 | 0.2 | U | 0.45 | 0.24 | 0.16 | J | -0.01 | 0.08 | 0.22 | U | 0.45 | * |
| PZ-204-SS TOT | 10/8/2013 | 0.17 | 0.15 | 0.17 | J | 0.35 | 0.2 | 0.11 | J | 0.22 | 0.16 | 0.16 | J | 0.74 | |
| PZ-205-AS DIS | 10/15/2013 | 0.02 | 0.07 | 0.15 | U | 0.07 | 0.11 | 0.18 | U | 0.03 | 0.09 | 0.19 | U | ND | * |
| PZ-205-AS TOT | 10/15/2013 | 0.64 | 0.28 | 0.14 | J | 0.81 | 0.32 | 0.15 | J | 0.45 | 0.23 | 0.13 | J | 1.90 | |
| PZ-205-SS DIS | 10/9/2013 | 0.13 | 0.28 | 0.53 | UJ | 0.08 | 0.21 | 0.43 | UJ | 0.15 | 0.2 | 0.31 | UJ | ND | * |
| PZ-205-SS TOT | 10/9/2013 | 0.22 | 0.19 | 0.24 | U | 0.33 | 0.22 | 0.19 | J | 0.03 | 0.06 | 0.13 | U | 0.33 | * |
| PZ-206-SS DIS | 10/7/2013 | 0.07 | 0.13 | 0.24 | U | 0.4 | 0.28 | 0.19 | J | 0.22 | 0.2 | 0.19 | J | 0.62 | * |
| PZ-206-SS TOT | 10/7/2013 | -0.01 | 0.13 | 0.31 | U | 0.18 | 0.16 | 0.2 | U | 0.06 | 0.11 | 0.2 | U | ND | * |

## Table 5: Summary of Thorium Isotope Results - October 2013 Groundwater Sampling, West Lake Landfill OU-1

| Sample ID | Sample Date | Thorium-228 | | | | Thorium-230 | | | | Thorium-232 | | | | TOTAL Thorium 228 + 230 + 232 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Result | CSU | MDA | FINAL Q | Result | CSU | MDA | FINAL Q | Result | CSU | MDA | FINAL Q | | |
| PZ-207-AS DIS | 10/4/2013 | 0.05 | 0.09 | 0.17 | U | 0.05 | 0.09 | 0.15 | U | 0.03 | 0.09 | 0.19 | U | ND | * |
| PZ-207-AS TOT | 10/4/2013 | 0 | 0.06 | 0.18 | U | 0.07 | 0.1 | 0.13 | U | 0.08 | 0.11 | 0.17 | U | ND | * |
| PZ-208-SS DIS | 10/8/2013 | 0.02 | 0.06 | 0.15 | U | 0.25 | 0.18 | 0.17 | J | 0.03 | 0.08 | 0.18 | U | 0.25 | * |
| PZ-208-SS TOT | 10/8/2013 | 0.08 | 0.12 | 0.19 | U | 0.28 | 0.2 | 0.17 | J | 0.29 | 0.21 | 0.2 | J | 0.57 | * |
| PZ-209-SD DIS | 11/7/2013 | 0.15 | 0.14 | 0.13 | J | 0.16 | 0.15 | 0.19 | UJ | 0.06 | 0.11 | 0.19 | U | 0.00 | * |
| PZ-209-SD TOT | 11/7/2013 | 0.24 | 0.23 | 0.21 | J | 0.3 | 0.27 | 0.3 | J | 0.09 | 0.14 | 0.21 | UJ | 0.54 | * |
| PZ-209-SS DIS | 11/7/2013 | 0.05 | 0.09 | 0.16 | U | 0.32 | 0.19 | 0.11 | J | 0.05 | 0.07 | 0.11 | U | 0.32 | * |
| PZ-209-SS TOT | 11/7/2013 | -0.03 | 0.16 | 0.5 | UJ | 0.28 | 0.3 | 0.3 | UJ | 0.15 | 0.25 | 0.43 | UJ | ND | * |
| PZ-210-SD DIS | 11/6/2013 | 0.12 | 0.13 | 0.16 | U | 0.33 | 0.22 | 0.18 | J | 0.04 | 0.09 | 0.18 | U | 0.33 | * |
| PZ-210-SD FD DIS | 11/6/2013 | 1.59 | 0.84 | 0.48 | J | 2.74 | 1.22 | 0.47 | J | 1.4 | 0.76 | 0.33 | J | 5.73 | |
| PZ-210-SD TOT | 11/6/2013 | 0.03 | 0.09 | 0.19 | U | 0.16 | 0.14 | 0.14 | J | -0.04 | 0.08 | 0.24 | U | 0.16 | * |
| PZ-210-SD FD TOT | 11/6/2013 | 0.03 | 0.08 | 0.17 | U | 0.25 | 0.18 | 0.14 | J | -0.01 | 0.06 | 0.14 | U | 0.25 | * |
| PZ-210-SS DIS | 11/7/2013 | 0.03 | 0.09 | 0.2 | U | 0.13 | 0.14 | 0.19 | U | -0.01 | 0.06 | 0.14 | U | ND | * |
| PZ-210-SS TOT | 11/7/2013 | 0 | 0.06 | 0.17 | U | 0.25 | 0.18 | 0.14 | J | 0.02 | 0.06 | 0.14 | U | 0.25 | * |
| PZ-211-SD DIS | 11/6/2013 | 0.57 | 0.29 | 0.23 | J | 0.95 | 0.39 | 0.18 | J | 0.85 | 0.35 | 0.14 | | 2.37 | |
| PZ-211-SD TOT | 11/6/2013 | 6.82 | 1.87 | 0.35 | J | 7.98 | 2.22 | 0.27 | J | 7.11 | 1.91 | 0.19 | J | 21.91 | |
| PZ-211-SS DIS | 11/7/2013 | -0.02 | 0.09 | 0.24 | UJ | 0.01 | 0.09 | 0.25 | UJ | 0.04 | 0.09 | 0.19 | UJ | ND | * |
| PZ-211-SS TOT | 11/7/2013 | -0.03 | 0.06 | 0.22 | U | 0.14 | 0.13 | 0.16 | U | 0.02 | 0.05 | 0.11 | U | ND | * |
| PZ-212-SD DIS | 11/7/2013 | 0.11 | 0.12 | 0.15 | U | 0.26 | 0.19 | 0.17 | J | 0.01 | 0.06 | 0.17 | U | 0.26 | * |
| PZ-212-SD TOT | 11/7/2013 | 0.23 | 0.26 | 0.39 | UJ | 0.28 | 0.26 | 0.29 | UJ | 0.01 | 0.22 | 0.5 | UJ | ND | * |
| PZ-212-SS DIS | 11/7/2013 | 0.01 | 0.07 | 0.18 | UJ | 0.17 | 0.13 | 0.1 | J | 0.02 | 0.05 | 0.12 | UJ | 0.17 | * |
| PZ-212-SS TOT | 11/7/2013 | 0.36 | 0.21 | 0.18 | J | 0.25 | 0.17 | 0.13 | J | 0 | 0.06 | 0.16 | UJ | 0.61 | * |
| PZ-302-AI DIS | 10/3/2013 | 0.09 | 0.13 | 0.2 | U | 0.27 | 0.19 | 0.13 | J | 0.09 | 0.1 | 0.13 | U | 0.27 | * |
| PZ-302-AI TOT | 10/3/2013 | 0.12 | 0.12 | 0.14 | UJ | 0.17 | 0.14 | 0.11 | J | 0.13 | 0.12 | 0.15 | UJ | 0.17 | * |
| PZ-302-AS DIS | 10/8/2013 | 0.06 | 0.1 | 0.17 | UJ | 0.16 | 0.14 | 0.13 | J | 0 | 0.08 | 0.17 | UJ | 0.16 | * |
| PZ-302-AS TOT | 10/8/2013 | 1.06 | 0.45 | 0.18 | | 0.94 | 0.43 | 0.22 | | 0.73 | 0.36 | 0.22 | | 2.73 | |
| PZ-303-AS DIS | 10/4/2013 | 0.01 | 0.07 | 0.2 | U | 0.15 | 0.15 | 0.16 | UJ | -0.01 | 0.07 | 0.14 | U | ND | * |
| PZ-303-AS TOT | 10/4/2013 | 0.13 | 0.13 | 0.14 | U | 0.32 | 0.21 | 0.13 | J | 0.16 | 0.16 | 0.19 | U | 0.32 | * |
| PZ-304-AI DIS | 10/1/2013 | 0.04 | 0.09 | 0.19 | U | 0.33 | 0.22 | 0.15 | J | 0.03 | 0.06 | 0.13 | U | 0.33 | * |
| PZ-304-AI FD DIS | 10/1/2013 | 0.2 | 0.16 | 0.18 | J | 0.16 | 0.14 | 0.12 | J | 0.07 | 0.1 | 0.13 | U | 0.36 | * |

## Table 5: Summary of Thorium Isotope Results - October 2013 Groundwater Sampling, West Lake Landfill OU-1

| Sample ID | Sample Date | Thorium-228 | | | | Thorium-230 | | | | Thorium-232 | | | | TOTAL Thorium 228 + 230 + 232 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Result | CSU | MDA | FINAL Q | Result | CSU | MDA | FINAL Q | Result | CSU | MDA | FINAL Q | | |
| PZ-304-AI TOT | 10/1/2013 | 0.09 | 0.13 | 0.19 | UJ | 0.4 | 0.26 | 0.23 | J | 0.05 | 0.1 | 0.2 | UJ | 0.40 | * |
| PZ-304-AI FD TOT | 10/1/2013 | 0 | 0.09 | 0.21 | UJ | 0.09 | 0.09 | 0.1 | UJ | 0.01 | 0.05 | 0.13 | UJ | ND | * |
| PZ-304-AS DIS | 10/1/2013 | -0.03 | 0.07 | 0.21 | U | 0.24 | 0.19 | 0.17 | J | 0 | 0.07 | 0.19 | U | 0.24 | * |
| PZ-304-AS TOT | 10/1/2013 | 0.16 | 0.18 | 0.26 | U | 0.21 | 0.18 | 0.15 | J | -0.04 | 0.08 | 0.28 | U | 0.21 | * |
| PZ-305-AI DIS | 10/2/2013 | -0.06 | 0.08 | 0.25 | UJ | 0.22 | 0.18 | 0.21 | J | 0.06 | 0.08 | 0.13 | UJ | 0.22 | * |
| PZ-305-AI TOT | 10/2/2013 | 0.17 | 0.15 | 0.2 | UJ | 0.22 | 0.15 | 0.12 | J | 0.06 | 0.09 | 0.14 | UJ | 0.22 | * |

Notes:

All values are in units of picoCuries per liter (pCi/L)

DIS = dissolved sample (field filtered sample); TOT = total sample (unfiltered sample)

CSU = Combined Standard Uncertainty (2-sigma); MDA = Minimum Detectable Activity

FD = Field duplicate sample

Data Validation Qualifiers (Final Q) include: R = rejected, data not usable; U = Non-detect at the reported value;

UJ = Non-Detect at the estimated reported value; UJ+ = Non-Detect at the estimated reported value which may be biased high;

UJ- = Non-Detect at the estimated reported value which may be biased low;

J = estimated result; J+ = estimated result which may be biased high; J- = estimated result which may be biased low

Total Thorium - 228 + 230 +232 based on sum of detected values. ND indicates that results for all Thorium isotopes were non-detect and a * flag indicates that only one or two of the isotopes were detected.

## Table 6: Summary of Radium Isotope Results - October 2013 Groundwater Sampling, West Lake Landfill OU-1

| Sample ID | Sample Date | Radium-226 | | | | Radium-228 | | | | Combined Radium 226 + 228 | | Combined Radium relative to 5 pCi/L MCL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Result | CSU | MDA | FINAL Q | Result | CSU | MDA | FINAL Q | | | |
| S-5 DIS | 10/7/2013 | 0.39 | 0.23 | 0.17 | J | -0.10 | 1.26 | 2.69 | UJ | 0.39 | * | Less Than MCL |
| S-5 TOT | 10/7/2013 | 0.37 | 0.21 | 0.16 | J | 0.31 | 1.25 | 2.63 | UJ | 0.37 | * | Less Than MCL |
| S-8 DIS | 10/1/2013 | 0.30 | 0.22 | 0.20 | J | 1.48 | 0.81 | 1.41 | J | 1.78 | | Less Than MCL |
| S-8 TOT | 10/1/2013 | 0.47 | 0.29 | 0.19 | J | 3.45 | 1.01 | 1.00 | | 3.92 | | Less Than MCL |
| S-10 DIS | 10/1/2013 | 0.17 | 0.16 | 0.16 | J | 1.05 | 0.78 | 1.47 | U | 0.17 | * | Less Than MCL |
| S-10 TOT | 10/1/2013 | 0.13 | 0.14 | 0.21 | UJ | 2.95 | 0.98 | 1.17 | | 2.95 | * | Less Than MCL |
| S-53 DIS | 10/15/2013 | 0.27 | 0.20 | 0.14 | J | 2.72 | 0.90 | 1.15 | J | 2.99 | | Less Than MCL |
| S-53 TOT | 10/15/2013 | 0.40 | 0.27 | 0.22 | J | 0.37 | 0.75 | 1.56 | UJ | 0.40 | * | Less Than MCL |
| S-61 DIS | 10/3/2013 | 0.75 | 0.37 | 0.20 | J | 1.13 | 0.67 | 1.20 | UJ+ | 0.75 | * | Less Than MCL |
| S-61 TOT | 10/3/2013 | 1.05 | 0.51 | 0.24 | J | 1.28 | 0.84 | 1.55 | UJ+ | 1.05 | * | Less Than MCL |
| S-82 DIS | 10/8/2013 | 1.33 | 0.54 | 0.32 | | 1.91 | 0.79 | 1.20 | J+ | 3.24 | | Less Than MCL |
| S-82 TOT | 10/8/2013 | 2.00 | 0.75 | 0.39 | | 2.77 | 1.04 | 1.52 | J+ | 4.77 | | Less Than MCL |
| S-84 DIS | 10/9/2013 | 0.35 | 0.29 | 0.29 | J | 1.88 | 0.80 | 1.24 | | 2.23 | | Less Than MCL |
| S-84 FD DIS | 10/9/2013 | 0.27 | 0.21 | 0.19 | J | 4.58 | 1.28 | 1.17 | | 4.85 | | Less Than MCL |
| S-84 FD TOT | 10/9/2013 | 1.40 | 0.65 | 0.37 | | 5.80 | 1.55 | 1.20 | | 7.20 | | Exceeds MCL |
| S-84 TOT | 10/9/2013 | 0.53 | 0.33 | 0.32 | J | 2.22 | 0.77 | 0.99 | | 2.75 | | Less Than MCL |
| I-4 DIS | 10/7/2013 | 0.39 | 0.43 | 0.50 | UJ | 0.14 | 0.74 | 1.55 | UJ | Non-Detect | | Less Than MCL |
| I-4 TOT | 10/7/2013 | 0.16 | 0.16 | 0.19 | UJ | 7.69 | 2.09 | 1.73 | J | 7.69 | * | Exceeds MCL |
| I-9 DIS | 10/8/2013 | 1.26 | 0.53 | 0.22 | | 3.23 | 1.13 | 1.51 | J+ | 4.49 | | Less Than MCL |
| I-9 FD DIS | 10/8/2013 | 1.83 | 0.74 | 0.29 | | 2.58 | 0.96 | 1.37 | J+ | 4.41 | | Less Than MCL |
| I-9 FD TOT | 10/8/2013 | 2.22 | 0.79 | 0.34 | J | 2.79 | 0.93 | 1.17 | J+ | 5.01 | | Exceeds MCL |
| I-9 TOT | 10/8/2013 | 2.11 | 0.78 | 0.25 | | 3.27 | 1.23 | 1.80 | J+ | 5.38 | | Exceeds MCL |
| I-11 DIS | 10/1/2013 | 0.80 | 0.40 | 0.23 | | 3.47 | 1.14 | 1.39 | | 4.27 | | Less Than MCL |
| I-11 TOT | 10/1/2013 | 1.02 | 0.46 | 0.17 | | 2.84 | 0.99 | 1.28 | | 3.86 | | Less Than MCL |
| I-62 DIS | 10/1/2013 | 0.56 | 0.32 | 0.20 | J | 0.97 | 0.80 | 1.55 | U | 0.56 | * | Less Than MCL |
| I-62 TOT | 10/1/2013 | 0.38 | 0.25 | 0.23 | J | 0.60 | 0.74 | 1.49 | U | 0.38 | * | Less Than MCL |
| I-65 DIS | 10/15/2013 | 0.14 | 0.14 | 0.16 | U | 0.06 | 0.70 | 1.49 | UJ | Non-Detect | | Less Than MCL |
| I-65 TOT | 10/15/2013 | 0.40 | 0.24 | 0.17 | J | 1.15 | 0.77 | 1.42 | UJ | 0.40 | * | Less Than MCL |
| I-66 DIS | 10/9/2013 | 0.39 | 0.27 | 0.24 | J | 0.96 | 0.71 | 1.35 | UJ+ | 0.39 | * | Less Than MCL |
| I-66 TOT | 10/9/2013 | 0.28 | 0.24 | 0.28 | J | 0.95 | 0.65 | 1.20 | UJ+ | 0.28 | * | Less Than MCL |

## Table 6: Summary of Radium Isotope Results - October 2013 Groundwater Sampling, West Lake Landfill OU-1

| Sample ID | Sample Date | Radium-226 | | | | Radium-228 | | | | Combined Radium 226 + 228 | | Combined Radium relative to 5 pCi/L MCL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Result | CSU | MDA | FINAL Q | Result | CSU | MDA | FINAL Q | | | |
| I-67 DIS | 10/3/2013 | 0.45 | 0.28 | 0.19 | J | 4.10 | 1.19 | 1.13 | J+ | 4.55 | | Less Than MCL |
| I-67 FD DIS | 10/3/2013 | 0.38 | 0.24 | 0.15 | J | 1.85 | 0.69 | 0.95 | J+ | 2.23 | | Less Than MCL |
| I-67 FD TOT | 10/3/2013 | 0.90 | 0.40 | 0.15 | J | 1.44 | 0.67 | 1.08 | J+ | 2.34 | | Less Than MCL |
| I-67 TOT | 10/3/2013 | 1.10 | 0.46 | 0.19 | J | 1.39 | 0.69 | 1.17 | J+ | 2.49 | | Less Than MCL |
| I-68 DIS | 10/4/2013 | 0.81 | 0.40 | 0.29 | J | 2.87 | 1.07 | 1.49 | J+ | 3.68 | | Less Than MCL |
| I-68 TOT | 10/4/2013 | 0.65 | 0.31 | 0.13 | J | 3.69 | 1.58 | 2.42 | J+ | 4.34 | | Less Than MCL |
| I-73 DIS | 10/3/2013 | 3.05 | 1.43 | 1.06 | J | 5.8 | 1.99 | 2.59 | J+ | 8.85 | | Exceeds MCL |
| I-73 TOT | 10/3/2013 | 4.47 | 1.79 | 0.93 | J | 5.5 | 1.93 | 2.58 | J+ | 9.97 | | Exceeds MCL |
| D-12 DIS | 10/1/2013 | 0.47 | 0.30 | 0.21 | J | 3 | 1.01 | 1.3 | | 3.47 | | Less Than MCL |
| D-12 TOT | 10/1/2013 | 0.31 | 0.26 | 0.27 | J | 2.59 | 0.89 | 1.17 | | 2.90 | | Less Than MCL |
| D-13 DIS | 10/7/2013 | 0.90 | 0.41 | 0.19 | J | 1.68 | 0.81 | 1.36 | J | 2.58 | | Less Than MCL |
| D-13 TOT | 10/7/2013 | 0.91 | 0.42 | 0.30 | J | 2.94 | 1.03 | 1.4 | J | 3.85 | | Less Than MCL |
| D-14 DIS | 10/15/2013 | 0.85 | 0.36 | 0.12 | | 1.89 | 1.26 | 2.32 | UJ | 0.85 | * | Less Than MCL |
| D-14 TOT | 10/15/2013 | 0.90 | 0.44 | 0.25 | | 2.26 | 1.05 | 1.71 | J | 3.16 | | Less Than MCL |
| D-3 DIS | 10/7/2013 | 2.81 | 0.94 | 0.20 | J | 4.43 | 1.28 | 1.28 | J | 7.24 | | Exceeds MCL |
| D-3 TOT | 10/7/2013 | 1.77 | 0.70 | 0.30 | J | 5.36 | 1.5 | 1.35 | J | 7.13 | | Exceeds MCL |
| D-6 DIS | 10/8/2013 | 2.96 | 0.95 | 0.32 | | 3.32 | 1.06 | 1.23 | J+ | 6.28 | | Exceeds MCL |
| D-6 TOT | 10/8/2013 | 2.40 | 0.80 | 0.27 | | 4 | 1.19 | 1.21 | J+ | 6.4 | | Exceeds MCL |
| D-81 DIS | 10/3/2013 | 0.26 | 0.21 | 0.18 | J | 3.14 | 1.18 | 1.7 | J+ | 3.40 | | Less Than MCL |
| D-81 TOT | 10/3/2013 | 0.73 | 0.38 | 0.29 | J | 5.4 | 1.59 | 1.67 | J+ | 6.13 | | Exceeds MCL |
| D-83 DIS | 10/8/2013 | 2.86 | 0.95 | 0.29 | | 2.81 | 1.02 | 1.41 | J+ | 5.67 | | Exceeds MCL |
| D-83 TOT | 10/8/2013 | 3.26 | 1.04 | 0.29 | J | 3.14 | 1.01 | 1.2 | J+ | 6.40 | | Exceeds MCL |
| D-85 DIS | 10/9/2013 | 1.42 | 0.61 | 0.31 | | 0.87 | 0.72 | 1.39 | UJ+ | 1.42 | * | Less Than MCL |
| D-85 TOT | 10/9/2013 | 4.46 | 1.43 | 0.56 | J | 1.65 | 1.07 | 1.96 | UJ+ | 4.46 | * | Less Than MCL |
| D-87 DIS | 10/2/2013 | 1.77 | 0.67 | 0.19 | | 4.67 | 1.26 | 1.02 | J+ | 6.44 | | Exceeds MCL |
| D-87 FD DIS | 10/2/2013 | 2.24 | 0.78 | 0.21 | J | 3.62 | 1.05 | 1.04 | J+ | 5.86 | | Exceeds MCL |
| D-87 FD TOT | 10/2/2013 | 1.82 | 0.69 | 0.24 | J | 3.82 | 1.12 | 1.12 | J+ | 5.64 | | Exceeds MCL |
| D-87 TOT | 10/2/2013 | 2.40 | 0.82 | 0.25 | | 3.71 | 1.06 | 0.98 | J+ | 6.11 | | Exceeds MCL |
| D-93 DIS | 10/8/2013 | 3.08 | 0.97 | 0.23 | | 3.15 | 0.96 | 1.07 | J+ | 6.23 | | Exceeds MCL |
| D-93 TOT | 10/8/2013 | 3.28 | 1.03 | 0.27 | | 4.26 | 1.18 | 1.05 | J+ | 7.54 | | Exceeds MCL |

## Table 6: Summary of Radium Isotope Results - October 2013 Groundwater Sampling, West Lake Landfill OU-1

| Sample ID | Sample Date | Radium-226 | | | | Radium-228 | | | | Combined Radium 226 + 228 | | Combined Radium relative to 5 pCi/L MCL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Result | CSU | MDA | FINAL Q | Result | CSU | MDA | FINAL Q | | | |
| LR-100 DIS | 10/4/2013 | 0.56 | 0.32 | 0.2 | J | 1.46 | 0.75 | 1.29 | J+ | 2.02 | | Less Than MCL |
| LR-100 FD DIS | 10/4/2013 | 0.43 | 0.26 | 0.16 | J | 2.36 | 0.76 | 0.89 | J+ | 2.79 | | Less Than MCL |
| LR-100 FD TOT | 10/4/2013 | 0.45 | 0.26 | 0.13 | J | 1.93 | 0.74 | 1.09 | J+ | 2.38 | | Less Than MCL |
| LR-100 TOT | 10/4/2013 | 0.38 | 0.25 | 0.23 | J | 0.87 | 0.53 | 0.95 | UJ+ | 0.38 | * | Less Than MCL |
| LR-103 DIS | 10/2/2013 | 1.1 | 0.48 | 0.19 | | 4.33 | 1.34 | 1.51 | J+ | 5.43 | | Exceeds MCL |
| LR-103 TOT | 10/2/2013 | 0.71 | 0.36 | 0.16 | J | 3.78 | 1.18 | 1.33 | J+ | 4.49 | | Less Than MCL |
| LR-104 DIS | 10/2/2013 | 0.52 | 0.29 | 0.19 | J | 3.43 | 1.06 | 1.23 | J+ | 3.95 | | Less Than MCL |
| LR-104 TOT | 10/2/2013 | 0.3 | 0.23 | 0.23 | J | 3.62 | 1.08 | 1.15 | J+ | 3.92 | | Less Than MCL |
| MW-102 DIS | 10/3/2013 | 0.15 | 0.15 | 0.16 | UJ | 1.12 | 0.67 | 1.21 | UJ+ | Non-Detect | | Less Than MCL |
| MW-102 TOT | 10/3/2013 | 2.23 | 0.77 | 0.18 | J | 1.47 | 0.83 | 1.47 | J+ | 3.70 | | Less Than MCL |
| MW-103 DIS | 10/4/2013 | 0.32 | 0.22 | 0.21 | J | 0.95 | 0.8 | 1.54 | UJ+ | 0.32 | * | Less Than MCL |
| MW-103 TOT | 10/4/2013 | 0.97 | 0.42 | 0.15 | J | 2.08 | 0.94 | 1.51 | J+ | 3.05 | | Less Than MCL |
| MW-104 DIS | 10/3/2013 | 0.5 | 0.29 | 0.19 | J | 1.94 | 0.85 | 1.32 | J+ | 2.44 | | Less Than MCL |
| MW-104 TOT | 10/3/2013 | 3.14 | 1.03 | 0.26 | J | 4.15 | 1.35 | 1.61 | J+ | 7.29 | | Exceeds MCL |
| MW-1204 DIS | 10/11/2013 | 0.04 | 0.06 | 0.09 | U | -0.07 | 0.66 | 1.42 | U | Non-Detect | | Less Than MCL |
| MW-1204 TOT | 10/11/2013 | 26.93 | 6.28 | 0.4 | | 11.04 | 2.74 | 1.25 | | 37.97 | | Exceeds MCL |
| PZ-100-KS DIS | 10/15/2013 | 0.33 | 0.24 | 0.2 | J | 1.05 | 0.65 | 1.15 | UJ | 0.33 | * | Less Than MCL |
| PZ-100-KS TOT | 10/15/2013 | 0.37 | 0.24 | 0.2 | J | -0.32 | 0.62 | 1.36 | UJ | 0.37 | * | Less Than MCL |
| PZ-100-SD DIS | 10/8/2013 | 1.87 | 0.64 | 0.2 | | 0.6 | 0.55 | 1.08 | UJ+ | 1.87 | * | Less Than MCL |
| PZ-100-SD TOT | 10/8/2013 | 1.95 | 0.66 | 0.16 | | -0.29 | 0.54 | 1.18 | UJ+ | 1.95 | * | Less Than MCL |
| PZ-100-SS DIS | 10/8/2013 | 2.6 | 0.82 | 0.21 | | 3.99 | 1.15 | 1.16 | J+ | 6.59 | | Exceeds MCL |
| PZ-100-SS TOT | 10/8/2013 | 2.58 | 0.81 | 0.17 | | 3.94 | 1.19 | 1.33 | J+ | 6.52 | | Exceeds MCL |
| PZ-101-SS DIS | 10/8/2013 | 17.4 | 4.09 | 0.18 | | 0.99 | 0.67 | 1.23 | UJ+ | 17.40 | * | Exceeds MCL |
| PZ-101-SS TOT | 10/8/2013 | 15.7 | 3.72 | 0.25 | | -0.52 | 0.63 | 1.38 | UJ+ | 15.70 | * | Exceeds MCL |
| PZ-102R-SS DIS | 10/8/2013 | 1.4 | 0.54 | 0.15 | | 0.9 | 0.59 | 1.09 | UJ+ | 1.4 | * | Less Than MCL |
| PZ-102R-SS TOT | 10/8/2013 | 2.54 | 0.8 | 0.19 | | 1.81 | 0.73 | 1.07 | J+ | 4.35 | | Less Than MCL |
| PZ-102-SS DIS | 10/8/2013 | 2.96 | 0.91 | 0.16 | | 0.99 | 0.62 | 1.11 | UJ+ | 2.96 | * | Less Than MCL |
| PZ-102-SS TOT | 10/8/2013 | 9.93 | 2.49 | 0.26 | | 3.44 | 1.18 | 1.51 | J+ | 13.37 | | Exceeds MCL |
| PZ-103-SS DIS | 10/4/2013 | 2.41 | 0.83 | 0.34 | J | 2.32 | 1.03 | 1.65 | J+ | 4.73 | | Less Than MCL |
| PZ-103-SS TOT | 10/4/2013 | 2.29 | 0.89 | 0.37 | J | 1.73 | 0.96 | 1.67 | J+ | 4.02 | | Less Than MCL |

## Table 6: Summary of Radium Isotope Results - October 2013 Groundwater Sampling, West Lake Landfill OU-1

| Sample ID | Sample Date | Radium-226 | | | | Radium-228 | | | | Combined Radium 226 + 228 | | Combined Radium relative to 5 pCi/L MCL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Result | CSU | MDA | FINAL Q | Result | CSU | MDA | FINAL Q | | | |
| PZ-104-KS DIS | 10/4/2013 | 0.22 | 0.19 | 0.18 | J | 0.78 | 0.59 | 1.11 | UJ+ | 0.22 | * | Less Than MCL |
| PZ-104-KS TOT | 10/4/2013 | 0.19 | 0.18 | 0.22 | U | 2.27 | 0.76 | 0.93 | J+ | 2.27 | * | Less Than MCL |
| PZ-104-SD DIS | 10/7/2013 | 6.29 | 2.11 | 0.45 | J | 8.08 | 2.04 | 1.24 | J | 14.37 | | Exceeds MCL |
| PZ-104-SD TOT | 10/7/2013 | 2.84 | 0.84 | 0.16 | J | 8.05 | 2.05 | 1.29 | J | 10.89 | | Exceeds MCL |
| PZ-104-SS DIS | 10/9/2013 | 1.76 | 0.65 | 0.26 | | 1.63 | 0.81 | 1.37 | | 3.39 | | Less Than MCL |
| PZ-104-SS TOT | 10/9/2013 | 1.67 | 0.63 | 0.34 | | 1.89 | 0.75 | 1.13 | | 3.56 | | Less Than MCL |
| PZ-105-SS DIS | 10/9/2013 | 1.23 | 0.52 | 0.21 | | 4.12 | 1.17 | 1.1 | | 5.35 | | Exceeds MCL |
| PZ-105-SS TOT | 10/9/2013 | 1.68 | 0.62 | 0.19 | | 2.24 | 0.79 | 1.06 | | 3.92 | | Less Than MCL |
| PZ-106-KS DIS | 10/11/2013 | 0.37 | 0.27 | 0.29 | J | 1.02 | 0.62 | 1.11 | UJ | 0.37 | * | Less Than MCL |
| PZ-106-KS FD DIS | 10/11/2013 | 0.24 | 0.21 | 0.22 | J | 0.75 | 0.61 | 1.16 | UJ | 0.24 | * | Less Than MCL |
| PZ-106-KS FD TOT | 10/11/2013 | 0.44 | 0.28 | 0.22 | J | 2.31 | 0.77 | 0.97 | J | 2.75 | | Less Than MCL |
| PZ-106-KS TOT | 10/11/2013 | 0.42 | 0.28 | 0.27 | J | 1.36 | 0.7 | 1.19 | J | 1.78 | | Less Than MCL |
| PZ-106-SD DIS | 10/8/2013 | 0.9 | 0.43 | 0.31 | | 0.81 | 0.55 | 1.02 | UJ+ | 0.90 | * | Less Than MCL |
| PZ-106-SD TOT | 10/8/2013 | 1.01 | 0.45 | 0.16 | | 1.1 | 0.58 | 0.99 | J+ | 2.11 | | Less Than MCL |
| PZ-106-SS DIS | 10/7/2013 | 1.04 | 0.42 | 0.2 | J | 3.56 | 1.14 | 1.36 | J | 4.60 | | Less Than MCL |
| PZ-106-SS TOT | 10/7/2013 | 3.35 | 0.98 | 0.16 | J | 3.63 | 1.12 | 1.23 | J | 6.98 | | Exceeds MCL |
| PZ-107-SS DIS | 10/3/2013 | 10.01 | 2.51 | 0.33 | J | 2.3 | 1.01 | 1.6 | J+ | 12.31 | | Exceeds MCL |
| PZ-107-SS TOT | 10/3/2013 | 7.73 | 1.99 | 0.24 | J | 11.1 | 2.88 | 2.03 | UJ+ | 7.73 | * | Exceeds MCL |
| PZ-109-SS DIS | 10/9/2013 | 3.02 | 0.98 | 0.22 | | -0.21 | 0.66 | 1.44 | UJ+ | 3.02 | * | Less Than MCL |
| PZ-109-SS TOT | 10/9/2013 | 1.96 | 0.71 | 0.21 | | 0.91 | 0.72 | 1.37 | UJ+ | 1.96 | * | Less Than MCL |
| PZ-110-SS DIS | 10/8/2013 | 2.64 | 0.83 | 0.3 | | 1.46 | 0.88 | 1.6 | UJ+ | 2.64 | * | Less Than MCL |
| PZ-110-SS TOT | 10/8/2013 | 3.89 | 1.14 | 0.17 | | 1.15 | 0.85 | 1.6 | UJ+ | 3.89 | * | Less Than MCL |
| PZ-111-KS DIS | 10/3/2013 | 0.27 | 0.21 | 0.19 | J | 0.96 | 0.65 | 1.21 | UJ+ | 0.27 | * | Less Than MCL |
| PZ-111-KS TOT | 10/3/2013 | 0.33 | 0.26 | 0.23 | J | 0.85 | 0.66 | 1.25 | UJ+ | 0.33 | * | Less Than MCL |
| PZ-111-SD DIS | 10/7/2013 | 1.52 | 0.59 | 0.27 | J | 1.43 | 0.69 | 1.15 | J | 2.95 | | Less Than MCL |
| PZ-111-SD TOT | 10/7/2013 | 1.27 | 0.48 | 0.13 | J | 1.93 | 0.75 | 1.09 | J | 3.20 | | Less Than MCL |
| PZ-112-AS DIS | 10/2/2013 | 0.99 | 0.47 | 0.22 | | 2.97 | 0.9 | 0.98 | J+ | 3.96 | | Less Than MCL |
| PZ-112-AS TOT | 10/2/2013 | 1.94 | 0.71 | 0.23 | | 2.5 | 0.89 | 1.21 | J+ | 4.44 | | Less Than MCL |
| PZ-113-AD DIS | 10/7/2013 | 2.3 | 0.86 | 0.39 | | 6.2 | 1.57 | 0.95 | J+ | 8.5 | | Exceeds MCL |
| PZ-113-AD FD DIS | 10/7/2013 | 2.38 | 0.91 | 0.26 | | 8.44 | 2.05 | 0.88 | J+ | 10.82 | | Exceeds MCL |

**Table 6: Summary of Radium Isotope Results - October 2013 Groundwater Sampling, West Lake Landfill OU-1**

| Sample ID | Sample Date | Radium-226 | | | | Radium-228 | | | | Combined Radium 226 + 228 | | Combined Radium relative to 5 pCi/L MCL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Result | CSU | MDA | FINAL Q | Result | CSU | MDA | FINAL Q | | | |
| PZ-113-AD FD TOT | 10/7/2013 | 2.74 | 0.98 | 0.48 | | 6.35 | 1.6 | 0.89 | J+ | 9.09 | | Exceeds MCL |
| PZ-113-AD TOT | 10/7/2013 | 2.82 | 0.95 | 0.21 | | 6.06 | 1.55 | 1.01 | J+ | 8.88 | | Exceeds MCL |
| PZ-113-AS DIS | 10/2/2013 | 0.75 | 0.38 | 0.19 | J | 1.17 | 0.54 | 0.88 | J+ | 1.92 | | Less Than MCL |
| PZ-113-AS TOT | 10/2/2013 | 0.83 | 0.45 | 0.29 | J | 1.68 | 0.71 | 1.1 | J+ | 2.51 | | Less Than MCL |
| PZ-113-SS DIS | 10/3/2013 | 2.22 | 0.75 | 0.25 | J | 4.46 | 1.32 | 1.42 | J+ | 6.68 | | Exceeds MCL |
| PZ-113-SS TOT | 10/3/2013 | 3.67 | 1.1 | 0.18 | J | 3.21 | 1.07 | 1.38 | J+ | 6.88 | | Exceeds MCL |
| PZ-114-AS DIS | 10/8/2013 | 0.28 | 0.22 | 0.2 | J | 0.92 | 0.74 | 1.42 | UJ+ | 0.28 | * | Less Than MCL |
| PZ-114-AS TOT | 10/8/2013 | 0.37 | 0.28 | 0.25 | J | 0.77 | 0.76 | 1.51 | UJ+ | 0.37 | * | Less Than MCL |
| PZ-115-SS DIS | 10/8/2013 | 5.6 | 1.49 | 0.19 | | 0.56 | 0.63 | 1.27 | UJ+ | 5.6 | * | Exceeds MCL |
| PZ-115-SS TOT | 10/8/2013 | 8.89 | 2.28 | 0.19 | | -0.17 | 0.79 | 1.71 | UJ+ | 8.89 | * | Exceeds MCL |
| PZ-116-SS DIS | 10/11/2013 | 0.36 | 0.25 | 0.17 | J | 1.76 | 0.82 | 1.34 | | 2.12 | | Less Than MCL |
| PZ-116-SS TOT | 10/11/2013 | 0.33 | 0.24 | 0.2 | J | 0.48 | 0.6 | 1.2 | U | 0.33 | * | Less Than MCL |
| PZ-200-SS DIS | 10/2/2013 | 2.86 | 0.94 | 0.37 | | 2.03 | 0.74 | 1.03 | J+ | 4.89 | | Less Than MCL |
| PZ-200-SS TOT | 10/2/2013 | 1.89 | 0.69 | 0.25 | | 5.17 | 1.44 | 1.26 | J+ | 7.06 | | Exceeds MCL |
| PZ-201A-SS DIS | 10/9/2013 | 0.2 | 0.18 | 0.21 | U | 1.48 | 0.71 | 1.18 | | 1.48 | * | Less Than MCL |
| PZ-201A-SS TOT | 10/9/2013 | 0.3 | 0.24 | 0.27 | J | 1.71 | 0.71 | 1.09 | | 2.01 | | Less Than MCL |
| PZ-202-SS DIS | 10/11/2013 | 0.98 | 0.48 | 0.25 | | 0.43 | 0.58 | 1.17 | UJ | 0.98 | * | Less Than MCL |
| PZ-202-SS TOT | 10/11/2013 | 1.19 | 0.52 | 0.33 | | 1.84 | 0.78 | 1.21 | J | 3.03 | | Less Than MCL |
| PZ-203-SS DIS | 10/2/2013 | 2 | 0.69 | 0.2 | | 3.73 | 1.07 | 1.01 | J+ | 5.73 | | Exceeds MCL |
| PZ-203-SS TOT | 10/2/2013 | 1.32 | 0.52 | 0.2 | | 2.35 | 0.86 | 1.23 | J+ | 3.67 | | Less Than MCL |
| PZ-204A-SS DIS | 10/8/2013 | 1.4 | 0.57 | 0.22 | | 1.55 | 0.84 | 1.48 | J+ | 2.95 | | Less Than MCL |
| PZ-204A-SS TOT | 10/8/2013 | 1.65 | 0.6 | 0.19 | | 3.53 | 1.02 | 0.98 | J+ | 5.18 | | Exceeds MCL |
| PZ-204-SS DIS | 10/8/2013 | 0.4 | 0.26 | 0.18 | J | 0.14 | 0.53 | 1.11 | UJ+ | 0.4 | * | Less Than MCL |
| PZ-204-SS TOT | 10/8/2013 | 1.35 | 0.54 | 0.2 | | 0.45 | 0.52 | 1.04 | UJ+ | 1.35 | * | Less Than MCL |
| PZ-205-AS DIS | 10/15/2013 | 1.16 | 0.52 | 0.28 | | 1.39 | 0.81 | 1.45 | UJ | 1.16 | * | Less Than MCL |
| PZ-205-AS TOT | 10/15/2013 | 0.99 | 0.46 | 0.27 | | 1.5 | 0.83 | 1.47 | J | 2.49 | | Less Than MCL |
| PZ-205-SS DIS | 10/9/2013 | 1.01 | 0.44 | 0.25 | | 1.47 | 0.66 | 1.05 | | 2.48 | | Less Than MCL |
| PZ-205-SS TOT | 10/9/2013 | 1.38 | 0.55 | 0.26 | | 2.38 | 0.91 | 1.3 | | 3.76 | | Less Than MCL |
| PZ-206-SS DIS | 10/7/2013 | 1.46 | 0.64 | 0.23 | J | 1.58 | 0.66 | 1 | J | 3.04 | | Less Than MCL |
| PZ-206-SS TOT | 10/7/2013 | 1.61 | 0.59 | 0.3 | J | 1.33 | 0.64 | 1.05 | J | 2.94 | | Less Than MCL |

## Table 6: Summary of Radium Isotope Results - October 2013 Groundwater Sampling, West Lake Landfill OU-1

| Sample ID | Sample Date | Radium-226 | | | | Radium-228 | | | | Combined Radium 226 + 228 | Combined Radium relative to 5 pCi/L MCL |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Result | CSU | MDA | FINAL Q | Result | CSU | MDA | FINAL Q | | |
| PZ-207-AS DIS | 10/4/2013 | 0.64 | 0.36 | 0.23 | J | 1.53 | 0.67 | 1.06 | J+ | 2.17 | Less Than MCL |
| PZ-207-AS TOT | 10/4/2013 | 0.63 | 0.34 | 0.22 | J | 2.05 | 0.7 | 0.89 | J+ | 2.68 | Less Than MCL |
| PZ-208-SS DIS | 10/8/2013 | 0.4 | 0.25 | 0.15 | J | 1.15 | 0.53 | 0.84 | J+ | 1.55 | Less Than MCL |
| PZ-208-SS TOT | 10/8/2013 | 1.07 | 0.44 | 0.21 | | 1.13 | 0.55 | 0.91 | J+ | 2.20 | Less Than MCL |
| PZ-209-SD DIS | 11/7/2013 | 0.09 | 0.12 | 0.14 | U | 1.18 | 0.79 | 1.47 | UJ+ | Non-Detect | Less Than MCL |
| PZ-209-SD TOT | 11/7/2013 | 0.14 | 0.14 | 0.16 | U | 14.81 | 3.54 | 1.32 | J+ | 14.81 * | Exceeds MCL |
| PZ-209-SS DIS | 11/7/2013 | 1.05 | 0.44 | 0.15 | | 0.84 | 0.63 | 1.19 | UJ+ | 1.05 * | Less Than MCL |
| PZ-209-SS TOT | 11/7/2013 | 1.08 | 0.46 | 0.24 | | 1.37 | 0.87 | 1.59 | UJ+ | 1.08 * | Less Than MCL |
| PZ-210-SD DIS | 11/6/2013 | 0.5 | 0.28 | 0.2 | J | 0.85 | 0.72 | 1.4 | UJ+ | 0.5 * | Less Than MCL |
| PZ-210-SD FD DIS | 11/6/2013 | 1.42 | 0.53 | 0.18 | | 1.7 | 0.97 | 1.72 | UJ+ | 1.42 * | Less Than MCL |
| PZ-210-SD FD TOT | 11/6/2013 | 0.73 | 0.34 | 0.14 | J | 1.69 | 0.9 | 1.55 | J+ | 2.42 | Less Than MCL |
| PZ-210-SD TOT | 11/6/2013 | 0.58 | 0.3 | 0.19 | J | 0.07 | 0.62 | 1.31 | UJ+ | 0.58 * | Less Than MCL |
| PZ-210-SS DIS | 11/7/2013 | 0.52 | 0.31 | 0.22 | J | 0.49 | 0.56 | 1.11 | UJ- | 0.52 * | Less Than MCL |
| PZ-210-SS TOT | 11/7/2013 | 0.61 | 0.37 | 0.26 | J | -0.29 | 0.52 | 1.13 | UJ- | 0.61 * | Less Than MCL |
| PZ-211-SD DIS | 11/6/2013 | 0.53 | 0.34 | 0.24 | J | 5.65 | 1.71 | 1.91 | J+ | 6.18 | Exceeds MCL |
| PZ-211-SD TOT | 11/6/2013 | 22.71 | 5.21 | 0.31 | | 25.8 | 6.18 | 2.23 | J+ | 48.51 | Exceeds MCL |
| PZ-211-SS DIS | 11/7/2013 | 0.57 | 0.33 | 0.29 | J | 0.12 | 0.49 | 1.03 | UJ- | 0.57 * | Less Than MCL |
| PZ-211-SS TOT | 11/7/2013 | 0.56 | 0.3 | 0.2 | J | 0.58 | 0.47 | 0.89 | UJ- | 0.56 * | Less Than MCL |
| PZ-212-SD DIS | 11/7/2013 | 0.2 | 0.17 | 0.19 | J | -0.33 | 0.53 | 1.17 | UJ- | 0.2 * | Less Than MCL |
| PZ-212-SD TOT | 11/7/2013 | 0.48 | 0.26 | 0.18 | J | 0.18 | 0.47 | 0.99 | UJ- | 0.48 * | Less Than MCL |
| PZ-212-SS DIS | 11/7/2013 | 0.05 | 0.1 | 0.18 | UJ | 0.43 | 0.53 | 1.06 | UJ+ | Non-Detect | Less Than MCL |
| PZ-212-SS TOT | 11/7/2013 | 0.04 | 0.12 | 0.26 | U | -0.34 | 0.55 | 1.21 | UJ+ | Non-Detect | Less Than MCL |
| PZ-302-AI DIS | 10/3/2013 | 0.42 | 0.3 | 0.33 | J | 1.26 | 0.67 | 1.15 | J+ | 1.68 | Less Than MCL |
| PZ-302-AI TOT | 10/3/2013 | 0.5 | 0.32 | 0.3 | J | 1.18 | 0.72 | 1.3 | UJ+ | 0.5 * | Less Than MCL |
| PZ-302-AS DIS | 10/8/2013 | 0.26 | 0.22 | 0.24 | J | 6.71 | 1.66 | 0.78 | J+ | 6.97 | Exceeds MCL |
| PZ-302-AS TOT | 10/8/2013 | 1.88 | 0.69 | 0.21 | | 2.47 | 0.9 | 1.27 | J+ | 4.35 | Less Than MCL |
| PZ-303-AS DIS | 10/4/2013 | 0.69 | 0.36 | 0.21 | J | 2.34 | 1.09 | 1.78 | J+ | 3.03 | Less Than MCL |
| PZ-303-AS TOT | 10/4/2013 | 0.47 | 0.31 | 0.24 | J | 2.69 | 1.24 | 2.02 | J+ | 3.16 | Less Than MCL |
| PZ-304-AI DIS | 10/1/2013 | 1.23 | 0.53 | 0.21 | | 3.22 | 1.12 | 1.48 | | 4.45 | Less Than MCL |
| PZ-304-AI FD DIS | 10/1/2013 | 1.63 | 0.67 | 0.25 | | 2.89 | 1.1 | 1.61 | | 4.52 | Less Than MCL |

**Table 6: Summary of Radium Isotope Results - October 2013 Groundwater Sampling, West Lake Landfill OU-1**

| Sample ID | Sample Date | Radium-226 | | | | Radium-228 | | | | Combined Radium 226 + 228 | Combined Radium relative to 5 pCi/L MCL |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Result | CSU | MDA | FINAL Q | Result | CSU | MDA | FINAL Q | | |
| PZ-304-AI FD TOT | 10/1/2013 | 1.21 | 0.54 | 0.28 | | 3.98 | 1.26 | 1.49 | | 5.19 | Exceeds MCL |
| PZ-304-AI TOT | 10/1/2013 | 1.15 | 0.51 | 0.19 | | 2.22 | 0.89 | 1.31 | | 3.37 | Less Than MCL |
| PZ-304-AS DIS | 10/1/2013 | 1.52 | 0.64 | 0.21 | | 1.91 | 0.9 | 1.48 | | 3.43 | Less Than MCL |
| PZ-304-AS TOT | 10/1/2013 | 1.73 | 0.71 | 0.33 | | 2 | 0.94 | 1.54 | | 3.73 | Less Than MCL |
| PZ-305-AI DIS | 10/2/2013 | 0.84 | 0.4 | 0.21 | | 4.02 | 1.2 | 1.29 | J+ | 4.86 | Less Than MCL |
| PZ-305-AI TOT | 10/2/2013 | 0.48 | 0.3 | 0.27 | J | 3.06 | 1.03 | 1.32 | J+ | 3.54 | Less Than MCL |

Notes:

All values are in units of picoCuries per liter (pCi/L)

DIS = dissolved (filtered) sample; TOT = total (unfiltered) sample

CSU = Combined Standard Uncertainty (2-sigma); MDA = Minimum Detectable Activity

Data Validation Qualifiers (Final Q) include: U = Non-detect at the reported value, UJ = Non-Detect at the estimated reported value,
UJ+ = Non-Detect at the estimated reported value which may be biased high;
UJ- = Non-Detect at the estimated reported value which may be biased low;
J = estimated result; J+ = estimated result which may be biased high; R = rejected, data not usable.

Combined Radium-226 plus Radium-228 = the sum of the Ra-226 and Ra-228 results unless one of results was non-detect, in which case is only the detected result shown and the value is flagged with a *.

Non-Detect = neither Radium-226 nor Radium-228 were detected in the sample

MCL = Maximum Contaminant Level for drinking water systems of 5 pCi/L for combined Radium-226 plus Radium-228

FB - Field blank

FD - Field duplicate sample

## Table 7: Comparision of Radium Results for Field Duplicate Samples - October 2013 Groundwater Sampling

| Sample ID | Sample Date | Radium-226 | | | | | | Radium-228 | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Result | CSU | MDA | FINAL Q | Ra-226 = Detect? | Relative Percent Difference (%) | Result | CSU | MDA | FINAL Q | Ra228 = Detect? | Relative Percent Difference (%) |
| S-84 DIS | 10/9/2013 | 0.35 | 0.29 | 0.29 | J | Detect | | 1.88 | 0.8 | 1.24 | | Detect | |
| S-84 FD DIS | 10/9/2013 | 0.27 | 0.21 | 0.19 | J | Detect | 26 | 4.58 | 1.28 | 1.17 | | Detect | 84 |
| S-84 TOT | 10/9/2013 | 0.53 | 0.33 | 0.32 | J | Detect | | 2.22 | 0.77 | 0.99 | | Detect | |
| S-84 FD TOT | 10/9/2013 | 1.4 | 0.65 | 0.37 | | Detect | 90 | 5.8 | 1.55 | 1.2 | | Detect | 89 |
| I-67 DIS | 10/3/2013 | 0.45 | 0.28 | 0.19 | J | Detect | | 4.1 | 1.19 | 1.13 | J+ | Detect | |
| I-67 FD DIS | 10/3/2013 | 0.38 | 0.24 | 0.15 | J | Detect | 17 | 1.85 | 0.69 | 0.95 | J+ | Detect | 76 |
| I-67 TOT | 10/3/2013 | 1.1 | 0.46 | 0.19 | J | Detect | | 1.39 | 0.69 | 1.17 | J+ | Detect | |
| I-67 FD TOT | 10/3/2013 | 0.9 | 0.4 | 0.15 | J | Detect | 20 | 1.44 | 0.67 | 1.08 | J+ | Detect | 4 |
| I-9 DIS | 10/8/2013 | 1.26 | 0.53 | 0.22 | | Detect | | 3.23 | 1.13 | 1.51 | J+ | Detect | |
| I-9 FD DIS | 10/8/2013 | 1.83 | 0.74 | 0.29 | | Detect | 37 | 2.58 | 0.96 | 1.37 | J+ | Detect | 22 |
| I-9 TOT | 10/8/2013 | 2.11 | 0.78 | 0.25 | | Detect | | 3.27 | 1.23 | 1.8 | J+ | Detect | |
| I-9 FD TOT | 10/8/2013 | 2.22 | 0.79 | 0.34 | J | Detect | 5 | 2.79 | 0.93 | 1.17 | J+ | Detect | 16 |
| D-87 DIS | 10/2/2013 | 1.77 | 0.67 | 0.19 | | Detect | | 4.67 | 1.26 | 1.02 | J+ | Detect | |
| D-87 FD DIS | 10/2/2013 | 2.24 | 0.78 | 0.21 | J | Detect | 23 | 3.62 | 1.05 | 1.04 | J+ | Detect | 25 |
| D-87 TOT | 10/2/2013 | 2.4 | 0.82 | 0.25 | | Detect | | 3.71 | 1.06 | 0.98 | J+ | Detect | |
| D-87 FD TOT | 10/2/2013 | 1.82 | 0.69 | 0.24 | J | Detect | 27 | 3.82 | 1.12 | 1.12 | J+ | Detect | 3 |
| LR-100 DIS | 10/4/2013 | 0.56 | 0.32 | 0.2 | J | Detect | | 1.46 | 0.75 | 1.29 | J+ | Detect | |
| LR-100 FD DIS | 10/4/2013 | 0.43 | 0.26 | 0.16 | J | Detect | 26 | 2.36 | 0.76 | 0.89 | J+ | Detect | 47 |
| LR-100 TOT | 10/4/2013 | 0.38 | 0.25 | 0.23 | J | Detect | | 0.87 | 0.53 | 0.95 | UJ+ | Non-Detect | |
| LR-100 FD TOT | 10/4/2013 | 0.45 | 0.26 | 0.13 | J | Detect | 17 | 1.93 | 0.74 | 1.09 | J+ | Detect | Non-Detect |
| PZ-106-KS DIS | 10/11/2013 | 0.37 | 0.27 | 0.29 | J | Detect | | 1.02 | 0.62 | 1.11 | UJ | Non-Detect | |
| PZ-106-KS FD DIS | 10/11/2013 | 0.24 | 0.21 | 0.22 | J | Detect | 43 | 0.75 | 0.61 | 1.16 | UJ | Non-Detect | Non-Detect |
| PZ-106-KS TOT | 10/11/2013 | 0.42 | 0.28 | 0.27 | J | Detect | | 1.36 | 0.7 | 1.19 | J | Detect | |
| PZ-106-KS FD TOT | 10/11/2013 | 0.44 | 0.28 | 0.22 | J | Detect | 5 | 2.31 | 0.77 | 0.97 | J | Detect | 52 |
| PZ-113-AD DIS | 10/7/2013 | 2.3 | 0.86 | 0.39 | | Detect | | 6.2 | 1.57 | 0.95 | J+ | Detect | |
| PZ-113-AD FD DIS | 10/7/2013 | 2.38 | 0.91 | 0.26 | | Detect | 3 | 8.44 | 2.05 | 0.88 | J+ | Detect | 31 |
| PZ-113-AD TOT | 10/7/2013 | 2.82 | 0.95 | 0.21 | | Detect | | 6.06 | 1.55 | 1.01 | J+ | Detect | |
| PZ-113-AD FD TOT | 10/7/2013 | 2.74 | 0.98 | 0.48 | | Detect | 3 | 6.35 | 1.6 | 0.89 | J+ | Detect | 5 |
| PZ-210-SD DIS | 11/6/2013 | 0.5 | 0.28 | 0.2 | J | Detect | | 0.85 | 0.72 | 1.4 | UJ+ | Non-Detect | |
| PZ-210-SD FD DIS | 11/6/2013 | 1.42 | 0.53 | 0.18 | | Detect | 96 | 1.7 | 0.97 | 1.72 | UJ+ | Non-Detect | Non-Detect |
| PZ-210-SD TOT | 11/6/2013 | 0.58 | 0.3 | 0.19 | J | Detect | | 0.07 | 0.62 | 1.31 | UJ+ | Non-Detect | |
| PZ-210-SD FD TOT | 11/6/2013 | 0.73 | 0.34 | 0.14 | J | Detect | 23 | 1.69 | 0.9 | 1.55 | J+ | Detect | Non-Detect |
| PZ-304-AI DIS | 10/1/2013 | 1.23 | 0.53 | 0.21 | | Detect | | 3.22 | 1.12 | 1.48 | | Detect | |
| PZ-304-AI FD DIS | 10/1/2013 | 1.63 | 0.67 | 0.25 | | Detect | 28 | 2.89 | 1.1 | 1.61 | | Detect | 11 |
| PZ-304-AI TOT | 10/1/2013 | 1.15 | 0.51 | 0.19 | | Detect | | 2.22 | 0.89 | 1.31 | | Detect | |
| PZ-304-AI FD TOT | 10/1/2013 | 1.21 | 0.54 | 0.28 | | Detect | 5 | 3.98 | 1.26 | 1.49 | | Detect | 57 |

Notes: All results are in units of pCi/L; FD = Field duplicate; CSU = Combined Standard Uncertainty (2-sigma); MDA = Minimum Detectable Activity
Data Validation Qualifiers (Final Q) include: J = estimated result, J+ = estimated result which may be biased high, U = Non-detect at the reported value,
UJ+ = Non-Detect at the estimated reported value which may be biased high, and UJ- = Non-Detect at the estimated reported value which may be biased low.

1/27/14

**Table 8: Comparision of Split Sample Radium Results - October 2013 Groundwater Sampling**

| Sample ID | Sample Date | Radium-226 | | | | | | Radium-228 | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Result | CSU | MDA | FINAL Q | Ra-226 = Detect? | Relative Percent Difference (%) | Result | CSU | MDA | FINAL Q | Ra228 = Detect? | Relative Percent Difference (%) |
| D-3 TOT | 10/07/13 | 2.81 | 0.94 | 0.2 | J | Detect | | 5.36 | 1.5 | 1.35 | J | Detect | |
| D-3 MDNR TOT | 10/07/13 | 2.96 | 0.87 | 0.42 | | Detect | 5 | 5.01 | 0.96 | 1.55 | | Detect | 7 |
| D-6 TOT | 10/08/13 | 2.4 | 0.8 | 0.27 | | Detect | | 4 | 1.19 | 1.21 | J+ | Detect | |
| D-6 MDNR TOT | 10/08/13 | 2.96 | 0.87 | 0.42 | | Detect | 21 | 3.46 | 0.86 | 1.48 | | Detect | 15 |
| D-83 TOT | 10/08/13 | 3.26 | 1.04 | 0.29 | J | Detect | | 3.14 | 1.01 | 1.2 | J+ | Detect | |
| D-83 MDNR TOT | 10/08/13 | 3.20 | 0.74 | 0.23 | | Detect | 2 | 5.61 | 0.92 | 1.37 | | Detect | 56 |
| D-85 TOT | 10/09/13 | 4.46 | 1.43 | 0.56 | J | Detect | | 1.65 | 1.07 | 1.96 | UJ+ | Non-Detect | |
| D-85 MDNR TOT | 10/09/13 | 2.22 | 0.83 | 0.51 | | Detect | 67 | NM | | | | NM | NM |
| D-93 TOT | 10/08/13 | 3.28 | 1.03 | 0.27 | | Detect | | 4.26 | 1.18 | 1.05 | J+ | Detect | |
| D-93 MDNR TOT | 10/08/13 | 2.12 | 0.62 | 0.19 | | Detect | 43 | 2.91 | 1.24 | 2.37 | J | Detect | 38 |
| I-9 TOT | 10/08/13 | 2.11 | 0.78 | 0.25 | | Detect | | 3.27 | 1.23 | 1.8 | J+ | Detect | |
| I-9 MDNR TOT | 10/08/13 | 2.01 | 0.64 | 0.22 | | Detect | 5 | 3.52 | 0.88 | 1.50 | | Detect | 7 |
| PZ-101-SS TOT | 10/08/13 | 15.7 | 3.72 | 0.25 | | Detect | | -0.52 | 0.63 | 1.38 | UJ+ | Non-Detect | |
| PZ-101-SS MDNR TOT | 10/08/13 | 24.23 | 2.21 | 0.32 | | Detect | 43 | NM | | | | NM | NM |
| PZ-102-SS TOT | 10/08/13 | 9.93 | 2.49 | 0.26 | | Detect | | 3.44 | 1.18 | 1.51 | J+ | Detect | |
| PZ-102-SS EPA TOT | 10/08/13 | 5.72 | 1.06 | 0.38 | | Detect | 54 | NM | | | | NM | NM |
| PZ-102-SS MDNR TOT | 10/08/13 | 5.04 | 0.88 | 0.20 | | Detect | 65 | NM | | | | NM | NM |
| PZ-104-SD TOT | 10/07/13 | 2.84 | 0.84 | 0.16 | J | Detect | | 8.05 | 2.05 | 1.29 | J | Detect | |
| PZ-104-SD EPA TOT | 10/07/13 | 3.44 | 0.70 | 0.28 | | Detect | 19 | 1.40 | 0.69 | 1.31 | J | Detect | 141 |
| PZ-104-SD MDNR TOT | 10/07/13 | 4.15 | 0.87 | 0.22 | | Detect | 37 | 2.47 | 0.75 | 1.32 | | Detect | 106 |
| PZ-113-AD TOT | 10/07/13 | 2.82 | 0.95 | 0.21 | | Detect | | 6.06 | 1.55 | 1.01 | J+ | Detect | |
| PZ-113-AD MDNR TOT | 10/07/13 | 2.93 | 0.76 | 0.31 | | Detect | 4 | 7.08 | 1.14 | 1.83 | | Detect | 16 |
| S-5 TOT | 10/07/13 | 0.37 | 0.21 | 0.16 | J | Detect | | 0.31 | 1.25 | 2.63 | UJ | Non-Detect | |
| S-5 MDNR TOT | 10/07/13 | 0.56 | 0.51 | 0.59 | J | Detect | 41 | 8.20 | 2.39 | 4.47 | | Detect | Non-Detect |
| S-82 TOT | 10/08/13 | 2 | 0.75 | 0.39 | | Detect | | 2.77 | 1.04 | 1.52 | J+ | Detect | |
| S-82 MDNR TOT | 10/08/13 | 1.29 | 0.54 | 0.27 | | Detect | 43 | NM | | | | NM | NM |

## Table 8: Comparision of Split Sample Radium Results - October 2013 Groundwater Sampling

| Sample ID | Sample Date | Radium-226 | | | | | | Radium-228 | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Result | CSU | MDA | FINAL Q | Ra-226 = Detect? | Relative Percent Difference (%) | Result | CSU | MDA | FINAL Q | Ra228 = Detect? | Relative Percent Difference (%) |
| D-3 DIS | 10/07/13 | 2.81 | 0.94 | 0.2 | J | Detect | | 4.43 | 1.28 | 1.28 | J | Detect | |
| D-3 MDNR DIS | 10/07/13 | 2.84 | 0.83 | 0.48 | | Detect | 1 | 6.55 | 1.02 | 1.55 | | Detect | 39 |
| D-6 DIS | 10/08/13 | 2.96 | 0.95 | 0.32 | | Detect | | 3.32 | 1.06 | 1.23 | J+ | Detect | |
| D-6 MDNR DIS | 10/08/13 | 2.30 | 0.68 | 0.42 | | Detect | 25 | 4.70 | 0.91 | 1.43 | | Detect | 34 |
| D-83 DIS | 10/08/13 | 2.86 | 0.95 | 0.29 | | Detect | | 2.81 | 1.02 | 1.41 | J+ | Detect | |
| D-83 MDNR DIS | 10/08/13 | 1.53 | 0.52 | 0.22 | | Detect | 61 | 4.53 | 0.98 | 1.66 | | Detect | 47 |
| D-85 DIS | 10/09/13 | 1.42 | 0.61 | 0.31 | | Detect | | 0.87 | 0.72 | 1.39 | UJ+ | Non-Detect | |
| D-85 MDNR DIS | 10/09/13 | 1.61 | 0.66 | 0.51 | | Detect | 12 | NM | | | | NM | NM |
| D-93 DIS | 10/08/13 | 3.08 | 0.97 | 0.23 | | Detect | | 3.15 | 0.96 | 1.07 | J+ | Detect | |
| D-93 MDNR DIS | 10/08/13 | 1.97 | 0.58 | 0.28 | | Detect | 44 | 4.85 | 1.30 | 2.32 | | Detect | 43 |
| I-9 DIS | 10/08/13 | 3.08 | 0.97 | 0.23 | | Detect | | 3.23 | 1.13 | 1.51 | J+ | Detect | |
| I-9 MDNR DIS | 10/08/13 | -0.01 | 0.10 | 0.21 | U | Non-Detect | Non-Detect | 4.48 | 1.30 | 2.33 | | Detect | 32 |
| PZ-101-SS DIS | 10/08/13 | 17.4 | 4.09 | 0.18 | | Detect | | 0.99 | 0.67 | 1.23 | UJ+ | Non-Detect | |
| PZ-101-SS MDNR DIS | 10/08/13 | 23.62 | 2.15 | 0.37 | | Detect | 30 | NM | | | | NM | NM |
| PZ-102-SS DIS | 10/08/13 | 2.96 | 0.91 | 0.16 | | Detect | | 0.99 | 0.62 | 1.11 | UJ+ | Non-Detect | |
| PZ-102-SS MDNR DIS | 10/08/13 | 3.18 | 0.67 | 0.17 | | Detect | 7 | NM | | | | NM | NM |
| PZ-104-SD DIS | 10/07/13 | 6.29 | 2.11 | 0.45 | J | Detect | | 8.08 | 2.04 | 1.24 | J | Detect | |
| PZ-104-SD MDNR DIS | 10/07/13 | 5.26 | 1.01 | 0.20 | | Detect | 18 | 1.60 | 1.01 | 1.98 | J | Detect | 134 |
| PZ-113-AD DIS | 10/07/13 | 0.75 | 0.38 | 0.19 | J | Detect | | 6.2 | 1.57 | 0.95 | J+ | Detect | |
| PZ-113-AD MDNR DIS | 10/07/13 | 2.81 | 0.80 | 0.30 | | Detect | 116 | 7.71 | 1.25 | 2.00 | | Detect | 22 |
| S-5 DIS | 10/07/13 | 0.39 | 0.23 | 0.17 | J | Detect | | -0.1 | 1.26 | 2.69 | UJ | Non-Detect | |
| S-5 MDNR DIS | 10/07/13 | 1.62 | 0.91 | 0.91 | J | Detect | 122 | 2.05 | 1.38 | 2.73 | J | Detect | Non-Detect |
| S-82 DIS | 10/08/13 | 1.33 | 0.54 | 0.32 | | Detect | | 1.91 | 0.79 | 1.2 | J+ | Detect | |
| S-82 MDNR DIS | 10/08/13 | 1.18 | 0.50 | 0.23 | | Detect | 12 | NM | | | | NM | NM |

Notes: All results are in units of pCi/L; FD = Field duplicate; CSU = Combined Standard Uncertainty (2-sigma); MDA = Minimum Detectable Activity
Data Validation Qualifiers (Final Q) include: J = estimated result, J+ = estimated result which may be biased high, U = Non-detect at the reported value,
UJ+ = Non-Detect at the estimated reported value which may be biased high, and UJ- = Non-Detect at the estimated reported value which may be biased low.
NM = not measured

**Table 9: Summary of Detected Trace Metal Results - October 2013 Groundwater Sampling, West Lake Landfill OU-1**

| Sample ID | Sample Fraction | Sample Date | Alumi-num | Antimony | Arsenic | Barium | Chro-mium | Cobalt | Iron | Lead | Manga-nese | Mercury | Nickel | Vana-dium | Zinc |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| S-5 | DIS | 10/7/2013 | 1000 U | 50 U | 50 U | 390 | 50 U | 250 U | 9900 | 50 U | 90 | 0.20 U | 200 U | 250 U | 100 U |
| S-5 | TOT | 10/7/2013 | 1000 U | 50 U | 20 | 620 | 50 U | 250 U | 19000 | 14 | 160 | 0.20 U | 82 | 250 U | 61 |
| S-8 | DIS | 10/1/2013 | 1000 U | 50 U | 50 U | 330 | 50 U | 250 U | 250 U | 50 U | 550 | 0.20 U | 200 U | 250 U | 100 U |
| S-8 | TOT | 10/1/2013 | 1000 U | 50 U | 50 U | 340 | 50 U | 250 U | 630 | 50 U | 560 | 0.20 U | 200 U | 250 U | 100 U |
| S-10 | DIS | 10/1/2013 | 400 | 50 U | 26 | 110 U | 50 U | 250 U | 130000 | 10 | 7900 | 0.20 U | 200 U | 250 U | 100 U |
| S-10 | TOT | 10/1/2013 | 760 | 50 U | 28 | 85 | 50 U | 24 | 150000 | 13 | 9500 | 0.20 U | 200 U | 22 | 100 U |
| S-53 | DIS | 10/15/2013 | 1000 U | 21 | 50 U | 290 | 50 U | 250 U | 500 U | 50 U | 2000 | 0.20 U | 200 U | 250 U | 100 U |
| S-53 | TOT | 10/15/2013 | 13000 | 20 | 50 U | 500 | 19 | 52 | 17000 | 31 | 2400 | 0.20 U | 200 U | 24 | 110 |
| S-61 | DIS | 10/3/2013 | 1000 U | 50 U | 50 U | 220 | 50 U | 250 U | 500 U | 50 U | 570 | 0.20 U | 200 U | 250 U | 100 U |
| S-61 | TOT | 10/3/2013 | 8100 | 50 U | 50 U | 390 | 21 | 28 | 11000 | 39 | 770 | 0.20 U | 200 U | 250 U | 51 |
| S-82 | DIS | 10/8/2013 | 1000 U | 50 U | 230 | 910 | 18 | 25 J+ | 38000 | 8.0 | 1600 | 0.20 U | 200 U | 250 U | 100 U |
| S-82 | TOT | 10/8/2013 | 1000 U | 50 U | 230 | 930 | 50 U | 36 | 38000 J | 50 U | 1600 J | 0.20 U | 200 U | 250 U | 100 U |
| S-84 | DIS | 10/9/2013 | 1000 U | 50 U | 150 | 880 | 50 U | 29 | 72000 | 16 | 1900 | 0.20 U | 200 U | 250 U | 100 U |
| S-84 FD | DIS | 10/9/2013 | 1000 U | 50 U | 140 | 840 | 50 U | 250 U | 70000 | 16 U | 1900 | 0.20 U | 200 U | 250 U | 100 U |
| S-84 | TOT | 10/9/2013 | 4700 | 50 U | 170 | 1200 | 50 U | 38 | 95000 | 36 U | 2800 | 0.20 U | 200 U | 24 | 92 |
| S-84 FD | TOT | 10/9/2013 | 10000 | 50 U | 170 | 1300 | 27 | 42 | 97000 | 37 | 2700 | 0.20 U | 67 | 49 | 110 |
| I-4 | DIS | 10/7/2013 | 1000 U | 50 U | 50 U | 220 | 50 U | 250 U | 14000 | 50 U | 250 | 0.20 U | 200 U | 250 U | 100 U |
| I-4 | TOT | 10/7/2013 | 1000 U | 50 U | 14 | 300 | 50 U | 250 U | 19000 | 50 U | 360 | 0.20 U | 200 U | 250 U | 34 |
| I-9 | DIS | 10/8/2013 | 1000 U | 20 | 24 | 1700 | 50 U | 250 U | 37000 | 50 U | 1200 | 0.20 U | 200 U | 250 U | 100 U |
| I-9 FD | DIS | 10/8/2013 | 1000 U | 50 U | 21 | 1700 | 50 U | 250 U | 38000 | 7.5 | 1200 | 0.20 U | 200 U | 250 U | 100 U |
| I-9 | TOT | 10/8/2013 | 1000 U | 50 U | 26 | 1500 | 50 U | 250 U | 34000 J | 50 U | 1100 J | 0.20 U | 200 U | 250 U | 100 U |
| I-9 FD | TOT | 10/8/2013 | 1000 U | 50 U | 21 | 1600 | 50 U | 250 U | 34000 J | 10 | 1100 J | 0.20 U | 200 U | 250 U | 100 U |
| I-11 | DIS | 10/1/2013 | 1000 U | 50 U | 15 | 650 | 50 U | 250 U | 36000 | 50 U | 2200 | 0.20 U | 200 U | 250 U | 100 U |
| I-11 | TOT | 10/1/2013 | 1600 | 50 U | 29 | 670 | 50 U | 250 U | 43000 | 12 | 2300 | 0.20 U | 200 U | 250 U | 100 U |
| I-62 | DIS | 10/1/2013 | 1000 U | 50 U | 50 U | 420 | 50 U | 250 U | 7600 | 50 U | 550 | 0.20 U | 200 U | 250 U | 100 U |
| I-62 | TOT | 10/1/2013 | 1000 U | 50 U | 12 | 440 | 50 U | 250 U | 8300 | 8.0 | 580 | 0.20 U | 200 U | 250 U | 100 U |
| I-65 | DIS | 10/15/2013 | 1000 U | 50 U | 50 U | 180 | 50 U | 250 U | 500 U | 50 U | 100 | 0.20 U | 200 U | 250 U | 100 U |
| I-65 | TOT | 10/15/2013 | 620 | 50 U | 50 U | 210 | 50 U | 250 U | 870 | 50 U | 270 | 0.20 U | 200 U | 250 U | 100 U |
| I-66 | DIS | 10/9/2013 | 1000 U | 50 U | 50 U | 130 | 50 U | 250 U | 1400 | 7.5 | 4400 | 0.20 U | 200 U | 250 U | 100 U |
| I-66 | TOT | 10/9/2013 | 1000 U | 50 U | 50 U | 150 | 50 U | 250 U | 2200 | 11 U | 4900 | 0.20 U | 200 U | 250 U | 100 U |
| I-67 | DIS | 10/3/2013 | 1000 U | 50 U | 50 U | 300 | 50 U | 250 U | 7900 | 50 U | 1500 | 0.20 U | 200 U | 250 U | 100 U |
| I-67 FD | DIS | 10/3/2013 | 1000 U | 50 U | 50 U | 290 | 50 U | 250 U | 7800 | 7.5 | 1400 | 0.20 U | 200 U | 250 U | 100 U |
| I-67 | TOT | 10/3/2013 | 1000 U | 50 U | 50 U | 290 | 50 U | 250 U | 10000 | 50 U | 1400 | 0.20 U | 200 U | 250 U | 100 U |
| I-67 FD | TOT | 10/3/2013 | 1000 U | 50 U | 50 U | 300 | 50 U | 250 U | 11000 | 9.5 | 1400 | 0.20 U | 200 U | 250 U | 100 U |
| I-68 | DIS | 10/4/2013 | 1000 U | 50 U | 50 U | 450 | 50 U | 250 U | 490 | 9.0 | 2000 | 0.20 U | 200 U | 250 U | 100 U |
| I-68 | TOT | 10/4/2013 | 8400 | 50 U | 50 U | 530 | 30 | 29 | 8000 | 28 | 2100 | 0.077 | 200 U | 21 | 100 |
| I-73 | DIS | 10/3/2013 | 2000 U | 100 U | 200 | 4700 | 140 | 200 | 140000 | 22 | 1700 | 2.0 U | 710 | 53 | 830 |
| I-73 | TOT | 10/3/2013 | 4800 | 100 U | 210 | 4900 | 150 | 200 | 160000 | 84 | 1800 | 2.0 U | 750 | 89 | 3500 |
| D-3 | DIS | 10/7/2013 | 1000 U | 50 U | 50 U | 2500 | 50 U | 250 U | 34000 | 50 U | 550 | 0.20 U | 200 U | 250 U | 100 U |
| D-3 | TOT | 10/7/2013 | 1000 U | 50 U | 50 U | 2500 | 50 U | 250 U | 35000 | 8.0 | 570 | 0.20 U | 200 U | 250 U | 100 U |

**Table 9: Summary of Detected Trace Metal Results - October 2013 Groundwater Sampling, West Lake Landfill OU-1**

| Sample ID | Sample Fraction | Sample Date | Alumi-num | Antimony | Arsenic | Barium | Chro-mium | Cobalt | Iron | Lead | Manga-nese | Mercury | Nickel | Vana-dium | Zinc |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| D-6 | DIS | 10/8/2013 | 1000 U | 50 U | 50 U | 1500 | 50 U | 250 U | 19000 | 50 U | 560 | 0.20 U | 200 U | 250 U | 100 U |
| D-6 | TOT | 10/8/2013 | 1000 U | 50 U | 50 U | 1400 | 50 U | 250 U | 18000 J | 50 U | 530 J | 0.20 U | 200 U | 250 U | 100 U |
| D-12 | DIS | 10/1/2013 | 1000 U | 50 U | 50 U | 450 | 50 U | 250 U | 9200 | 8.5 | 1100 | 0.20 U | 200 U | 250 U | 100 U |
| D-12 | TOT | 10/1/2013 | 1000 U | 50 U | 50 U | 380 | 50 U | 250 U | 9400 | 50 U | 1100 | 0.20 U | 200 U | 250 U | 100 U |
| D-13 | DIS | 10/7/2013 | 1000 U | 50 U | 50 U | 650 | 50 U | 25 | 14000 | 50 U | 400 | 0.20 U | 200 U | 250 U | 100 U |
| D-13 | TOT | 10/7/2013 | 510 | 50 U | 50 U | 670 | 50 U | 250 U | 15000 | 8.5 | 430 | 0.20 U | 200 U | 250 U | 100 U |
| D-14 | DIS | 10/15/2013 | 1000 U | 50 U | 50 U | 560 | 50 U | 250 U | 6800 | 50 U | 950 | 0.20 U | 200 U | 250 U | 100 U |
| D-14 | TOT | 10/15/2013 | 800 | 50 U | 50 U | 700 | 50 U | 250 U | 17000 | 50 U | 1200 | 0.26 | 200 U | 250 U | 26 |
| D-81 | DIS | 10/3/2013 | 1000 U | 50 U | 50 U | 350 | 50 U | 250 U | 16000 | 50 U | 860 | 0.20 U | 200 U | 250 U | 100 U |
| D-81 | TOT | 10/3/2013 | 1000 U | 50 U | 50 U | 350 | 50 U | 250 U | 15000 | 50 U | 830 | 0.20 U | 200 U | 250 U | 100 U |
| D-83 | DIS | 10/8/2013 | 1000 U | 50 U | 50 U | 1900 | 50 U | 250 U | 18000 | 50 U | 440 | 0.20 U | 200 U | 250 U | 100 U |
| D-83 | TOT | 10/8/2013 | 1000 U | 50 U | 50 U | 1800 | 50 U | 250 U | 16000 J | 50 U | 430 J | 0.20 U | 200 U | 250 U | 100 U |
| D-85 | DIS | 10/9/2013 | 1000 U | 50 U | 43 | 1900 | 50 U | 250 U | 55000 | 11 U | 1000 | 0.20 U | 200 U | 250 U | 100 U |
| D-85 | TOT | 10/9/2013 | 15000 | 50 U | 51 | 2600 | 24 | 32 | 97000 | 63 | 2200 | 0.20 U | 82 | 50 | 170 |
| D-87 | DIS | 10/2/2013 | 1000 U | 50 U | 50 U | 1500 | 50 U | 34 | 34000 | 7.5 | 640 | 0.20 U | 200 U | 250 U | 100 U |
| D-87 FD | DIS | 10/2/2013 | 1000 U | 50 U | 50 U | 1500 | 50 U | 250 U | 35000 | 12 | 630 | 0.20 U | 200 U | 250 U | 100 U |
| D-87 | TOT | 10/2/2013 | 2300 | 50 U | 50 U | 1500 | 50 U | 250 U | 36000 | 14 | 670 | 0.20 U | 200 U | 250 U | 100 U |
| D-87 FD | TOT | 10/2/2013 | 2200 | 50 U | 50 U | 1500 | 50 U | 250 U | 37000 | 11 | 670 | 0.20 U | 200 U | 250 U | 26 |
| D-93 | DIS | 10/8/2013 | 1000 U | 50 U | 50 U | 1300 | 50 U | 250 U | 22000 | 50 U | 480 | 0.20 U | 200 U | 250 U | 100 U |
| D-93 | TOT | 10/8/2013 | 690 | 50 U | 50 U | 1100 | 50 U | 250 U | 23000 J | 11 | 580 J | 0.20 U | 200 U | 250 U | 100 U |
| LR-100 | DIS | 10/4/2013 | 1000 U | 50 U | 50 U | 470 | 50 U | 250 U | 23000 | 9.5 | 190 | 0.20 U | 200 U | 250 U | 100 U |
| LR-100 FD | DIS | 10/4/2013 | 1000 U | 50 U | 50 U | 460 | 50 U | 34 | 22000 | 50 U | 180 | 0.20 U | 200 U | 250 U | 100 U |
| LR-100 | TOT | 10/4/2013 | 1000 U | 50 U | 50 U | 460 | 16 | 21 | 23000 | 13 | 190 | 0.20 U | 200 U | 250 U | 100 U |
| LR-100 FD | TOT | 10/4/2013 | 1000 U | 50 U | 50 U | 460 | 50 U | 250 U | 23000 | 9.0 | 190 | 0.20 U | 200 U | 250 U | 100 U |
| LR-103 | DIS | 10/2/2013 | 1000 U | 50 U | 74 | 1100 | 50 U | 250 U | 38000 | 11 | 920 | 0.20 U | 200 U | 250 U | 100 U |
| LR-103 | TOT | 10/2/2013 | 1000 U | 50 U | 75 | 1100 | 50 U | 250 U | 40000 | 50 U | 950 | 0.20 U | 200 U | 250 U | 100 U |
| LR-104 | DIS | 10/2/2013 | 1000 U | 50 U | 50 U | 400 | 50 U | 250 U | 14000 | 50 U | 1200 | 0.20 U | 200 U | 250 U | 100 U |
| LR-104 | TOT | 10/2/2013 | 1000 U | 50 U | 50 U | 390 | 50 U | 250 U | 14000 | 9.5 | 1200 | 0.20 U | 200 U | 250 U | 100 U |
| MW-102 | DIS | 10/3/2013 | 1000 U | 50 U | 44 | 110 | 50 U | 27 | 500 U | 50 U | 1400 | 0.20 U | 200 U | 250 U | 100 U |
| MW-102 | TOT | 10/3/2013 | 6200 | 50 U | 130 | 550 | 17 | 99 | 45000 | 55 | 2500 | 0.20 U | 220 | 39 | 170 |
| MW-103 | DIS | 10/4/2013 | 1000 U | 50 U | 50 U | 180 | 50 U | 250 U | 1400 | 50 U | 1100 | 0.20 U | 200 U | 250 U | 100 U |
| MW-103 | TOT | 10/4/2013 | 15000 | 50 U | 50 U | 300 | 28 | 21 | 14000 | 31 | 1200 | 0.20 U | 200 U | 29 | 78 |
| MW-104 | DIS | 10/3/2013 | 1000 U | 50 U | 30 | 520 | 50 U | 250 U | 30000 | 50 U | 3400 | 0.20 U | 200 U | 250 U | 100 U |
| MW-104 | TOT | 10/3/2013 | 62000 | 50 U | 55 | 1600 | 91 | 50 | 110000 | 130 | 5300 | 0.13 | 150 | 180 | 430 |
| MW-1204 | DIS | 10/11/2013 | 2400 J | 100 UJ | 100 UJ | 4100 J | 220 J | 84 J | 130000 J | 100 UJ | 6400 J | 0.20 U | 400 UJ | 62 J | 200 UJ |
| MW-1204 | TOT | 10/11/2013 | 2700 J | 49 J | 100 UJ | 3900 J | 220 J | 500 UJ | 140000 J | 32 J | 7400 J | 0.20 U | 400 UJ | 61 UJ | 200 UJ |
| PZ-100-KS | DIS | 10/15/2013 | 1000 U | 50 U | 50 U | 250 U | 50 U | 250 U | 500 U | 50 U | 17 | 0.20 U | 200 U | 250 U | 100 U |
| PZ-100-KS | TOT | 10/15/2013 | 1000 U | 50 U | 50 U | 250 U | 50 U | 250 U | 520 | 50 U | 28 | 0.20 U | 200 U | 250 U | 100 U |
| PZ-100-SD | DIS | 10/8/2013 | 1000 U | 50 U | 50 U | 350 | 50 U | 250 U | 820 | 50 U | 73 | 0.20 U | 200 U | 250 U | 100 U |
| PZ-100-SD | TOT | 10/8/2013 | 1000 U | 50 U | 50 U | 320 | 50 U | 250 U | 640 J | 50 U | 63 J | 0.20 U | 200 U | 250 U | 100 U |

**Table 9: Summary of Detected Trace Metal Results - October 2013 Groundwater Sampling, West Lake Landfill OU-1**

| Sample ID | Sample Fraction | Sample Date | Alumi-num | Antimony | Arsenic | Barium | Chro-mium | Cobalt | Iron | Lead | Manga-nese | Mercury | Nickel | Vana-dium | Zinc |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| PZ-100-SS | DIS | 10/8/2013 | 1000 U | 50 U | 50 U | 69 | 50 U | 250 U | 500 U | 50 U | 75 U | 0.20 U | 200 U | 250 U | 100 U |
| PZ-100-SS | TOT | 10/8/2013 | 1000 U | 50 U | 50 U | 68 | 50 U | 250 U | 500 U | 50 U | 75 U | 0.20 U | 200 U | 250 U | 100 U |
| PZ-101-SS | DIS | 10/8/2013 | 1000 U | 50 U | 50 U | 620 | 50 U | 26 J+ | 1100 | 50 U | 85 | 0.20 U | 200 U | 250 U | 100 U |
| PZ-101-SS | TOT | 10/8/2013 | 1000 U | 50 U | 50 U | 580 | 50 U | 250 U | 1900 J | 50 U | 89 J | 0.20 U | 200 U | 250 U | 100 U |
| PZ-102R-SS | DIS | 10/8/2013 | 1000 U | 50 U | 50 U | 79 | 50 U | 250 U | 500 U | 50 U | 75 U | 0.20 U | 200 U | 250 U | 100 U |
| PZ-102R-SS | TOT | 10/8/2013 | 420 | 50 U | 50 U | 72 | 50 U | 250 U | 230 J | 50 U | 75 U | 0.20 U | 200 U | 250 U | 100 U |
| PZ-102-SS | DIS | 10/8/2013 | 1000 U | 50 U | 50 U | 350 | 50 U | 26 J+ | 870 | 50 U | 230 | 0.20 U | 200 U | 250 U | 100 U |
| PZ-102-SS | TOT | 10/8/2013 | 4600 | 50 U | 50 U | 340 | 50 U | 250 U | 4100 J | 8.5 | 260 J | 0.20 U | 200 U | 250 U | 100 U |
| PZ-103-SS | DIS | 10/4/2013 | 1000 U | 50 U | 50 U | 390 | 50 U | 250 U | 14000 | 7.5 | 330 | 0.20 U | 200 U | 250 U | 100 U |
| PZ-103-SS | TOT | 10/4/2013 | 2400 | 50 U | 50 U | 400 | 18 | 250 U | 18000 | 13 | 350 | 0.20 U | 200 U | 250 U | 44 |
| PZ-104-KS | DIS | 10/4/2013 | 1000 U | 50 U | 50 U | 51 | 50 U | 36 | 440 | 50 U | 75 U | 0.20 U | 200 U | 250 U | 100 U |
| PZ-104-KS | TOT | 10/4/2013 | 1000 U | 50 U | 50 U | 51 | 50 U | 250 U | 560 | 50 U | 75 U | 0.20 U | 200 U | 250 U | 100 U |
| PZ-104-SD | DIS | 10/7/2013 | 1000 U | 50 U | 12 | 670 | 50 U | 250 U | 8700 | 50 U | 170 | 0.20 U | 200 U | 250 U | 100 U |
| PZ-104-SD | TOT | 10/7/2013 | 1000 U | 50 U | 50 U | 480 | 50 U | 250 U | 6500 | 50 U | 130 | 0.20 U | 200 U | 250 U | 120 |
| PZ-104-SS | DIS | 10/9/2013 | 1000 U | 50 U | 50 U | 100 | 50 U | 35 | 1400 | 50 U | 40 | 0.20 U | 200 U | 250 U | 100 U |
| PZ-104-SS | TOT | 10/9/2013 | 1000 U | 50 U | 50 U | 110 | 50 U | 250 U | 1500 | 50 U | 41 | 0.20 U | 200 U | 250 U | 100 U |
| PZ-105-SS | DIS | 10/9/2013 | 1000 U | 50 U | 50 U | 160 | 50 U | 250 U | 500 U | 9.5 | 75 U | 0.20 U | 200 U | 250 U | 27 |
| PZ-105-SS | TOT | 10/9/2013 | 1000 U | 50 U | 50 U | 160 | 50 U | 250 U | 280 | 50 U | 75 U | 0.20 U | 200 U | 250 U | 29 |
| PZ-106-KS | DIS | 10/11/2013 | 1000 U | 50 U | 50 U | 46 | 50 U | 250 U | 240 | 50 U | 75 U | 0.20 U | 200 U | 250 U | 100 U |
| PZ-106-KS FD | DIS | 10/11/2013 | 1000 R | 50 R | 50 R | 620 R | 50 R | 250 R | 12000 R | 9.5 R | 1100 R | 0.20 U | 200 R | 250 R | 100 R |
| PZ-106-KS | TOT | 10/11/2013 | 1000 U | 50 U | 50 U | 45 | 50 U | 250 U | 270 | 50 U | 75 U | 0.20 U | 200 U | 250 U | 100 U |
| PZ-106-KS FD | TOT | 10/11/2013 | 1000 U | 50 U | 50 U | 45 | 50 U | 250 U | 260 | 50 U | 75 U | 0.20 U | 200 U | 250 U | 100 U |
| PZ-106-SD | DIS | 10/8/2013 | 1000 U | 50 U | 50 U | 100 | 50 U | 250 U | 570 | 50 U | 70 | 0.20 U | 200 U | 250 U | 100 U |
| PZ-106-SD | TOT | 10/8/2013 | 710 | 50 U | 50 U | 120 | 50 U | 250 U | 1900 J | 50 U | 63 J | 0.20 U | 200 U | 250 U | 100 U |
| PZ-106-SS | DIS | 10/7/2013 | 1000 U | 50 U | 50 U | 150 | 50 U | 250 U | 590 | 50 U | 20 | 0.20 U | 200 U | 250 U | 100 U |
| PZ-106-SS | TOT | 10/7/2013 | 1000 U | 50 U | 50 U | 150 | 50 U | 250 U | 520 | 50 U | 75 U | 0.20 U | 200 U | 250 U | 100 U |
| PZ-107-SS | DIS | 10/3/2013 | 1000 U | 50 U | 50 U | 720 | 18 | 250 U | 540 | 8.5 | 380 | 0.20 U | 200 U | 250 U | 26 |
| PZ-107-SS | TOT | 10/3/2013 | 3000 | 50 U | 50 U | 740 | 21 | 250 U | 4100 | 18 | 400 | 0.20 U | 200 U | 250 U | 50 |
| PZ-109-SS | DIS | 10/9/2013 | 1000 U | 50 U | 50 U | 69 | 50 U | 250 U | 500 U | 8.0 U | 75 U | 0.20 U | 200 U | 250 U | 29 |
| PZ-109-SS | TOT | 10/9/2013 | 1000 U | 50 U | 50 U | 63 | 50 U | 250 U | 500 U | 7.5 U | 75 U | 0.20 U | 200 U | 250 U | 33 |
| PZ-110-SS | DIS | 10/8/2013 | 1000 U | 50 U | 50 U | 320 | 50 U | 250 U | 7200 | 9.5 | 210 | 0.20 U | 200 U | 250 U | 100 U |
| PZ-110-SS | TOT | 10/8/2013 | 1000 U | 50 U | 50 U | 300 | 50 U | 250 U | 6500 J | 50 U | 190 J | 0.20 U | 200 U | 250 U | 100 U |
| PZ-111-KS | DIS | 10/3/2013 | 1000 U | 50 U | 50 U | 250 U | 50 U | 250 U | 500 U | 50 U | 75 U | 0.20 U | 200 U | 250 U | 100 U |
| PZ-111-KS | TOT | 10/3/2013 | 1000 U | 50 U | 50 U | 250 U | 50 U | 250 U | 150 | 50 U | 75 U | 0.20 U | 200 U | 250 U | 100 U |
| PZ-111-SD | DIS | 10/7/2013 | 1000 U | 50 U | 50 U | 110 | 50 U | 250 U | 500 U | 50 U | 75 U | 0.20 U | 200 U | 250 U | 100 U |
| PZ-111-SD | TOT | 10/7/2013 | 1000 U | 50 U | 50 U | 110 | 50 U | 250 U | 500 U | 50 U | 75 U | 0.20 U | 200 U | 250 U | 100 U |
| PZ-112-AS | DIS | 10/2/2013 | 1000 U | 50 U | 180 | 2100 | 50 U | 250 U | 39000 | 11 | 220 | 0.20 U | 200 U | 250 U | 100 U |
| PZ-112-AS | TOT | 10/2/2013 | 1000 U | 50 U | 190 | 2100 | 50 U | 250 U | 40000 | 11 | 230 | 0.20 U | 200 U | 250 U | 100 U |
| PZ-113-AD | DIS | 10/7/2013 | 1000 U | 50 U | 50 U | 2300 | 50 U | 30 | 36000 | 8.5 | 660 | 0.20 U | 200 U | 250 U | 100 U |
| PZ-113-AD FD | DIS | 10/7/2013 | 1000 U | 50 U | 50 U | 2300 | 50 U | 250 U | 36000 | 50 U | 650 | 0.20 U | 200 U | 250 U | 100 U |

**Table 9: Summary of Detected Trace Metal Results - October 2013 Groundwater Sampling, West Lake Landfill OU-1**

| Sample ID | Sample Fraction | Sample Date | Alumi-num | Antimony | Arsenic | Barium | Chro-mium | Cobalt | Iron | Lead | Manga-nese | Mercury | Nickel | Vana-dium | Zinc |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| PZ-113-AD | TOT | 10/7/2013 | 1000 U | 50 U | 50 U | 2300 | 50 U | 250 U | 36000 | 50 U | 670 | 0.20 U | 200 U | 250 U | 100 U |
| PZ-113-AD FD | TOT | 10/7/2013 | 1000 U | 50 U | 50 U | 2300 | 50 U | 250 U | 37000 | 7.5 | 680 | 0.20 U | 200 U | 250 U | 100 U |
| PZ-113-AS | DIS | 10/2/2013 | 1000 U | 50 U | 16 | 800 | 50 U | 25 | 11000 | 8.0 | 6300 | 0.20 U | 200 U | 250 U | 100 U |
| PZ-113-AS | TOT | 10/2/2013 | 1000 U | 50 U | 17 | 840 | 50 U | 250 U | 13000 | 8.0 | 6400 | 0.20 U | 200 U | 250 U | 100 U |
| PZ-113-SS | DIS | 10/3/2013 | 1000 U | 50 U | 50 U | 190 | 50 U | 250 U | 500 U | 50 U | 35 | 0.20 U | 200 U | 250 U | 100 U |
| PZ-113-SS | TOT | 10/3/2013 | 5900 | 50 U | 50 U | 220 | 24 | 250 U | 5300 | 10 | 94 | 0.20 U | 200 U | 250 U | 35 |
| PZ-114-AS | DIS | 10/8/2013 | 1000 U | 50 U | 240 | 460 | 21 | 26 J+ | 74000 | 15 | 1900 | 0.20 U | 200 U | 250 U | 100 U |
| PZ-114-AS | TOT | 10/8/2013 | 1000 U | 50 U | 250 | 450 | 50 U | 250 U | 72000 J | 12 | 1800 J | 0.20 U | 200 U | 250 U | 100 U |
| PZ-115-SS | DIS | 10/8/2013 | 1000 U | 50 U | 50 U | 340 | 50 U | 31 J+ | 1300 | 50 U | 51 | 0.20 U | 200 U | 250 U | 100 U |
| PZ-115-SS | TOT | 10/8/2013 | 1000 U | 50 U | 50 U | 330 | 50 U | 250 U | 1200 J | 50 U | 48 J | 0.20 U | 200 U | 250 U | 100 U |
| PZ-116-SS | DIS | 10/11/2013 | 1000 U | 50 U | 50 U | 70 | 50 U | 28 | 500 U | 50 U | 75 U | 0.20 U | 200 U | 250 U | 100 U |
| PZ-116-SS | TOT | 10/11/2013 | 1000 U | 50 U | 50 U | 76 | 50 U | 250 U | 500 U | 50 U | 75 U | 0.20 U | 200 U | 250 U | 30 |
| PZ-200-SS | DIS | 10/2/2013 | 1000 U | 50 U | 50 U | 790 | 50 U | 250 U | 9500 | 50 U | 5800 | 0.20 U | 200 U | 250 U | 100 U |
| PZ-200-SS | TOT | 10/2/2013 | 800 | 50 U | 50 U | 800 | 50 U | 41 | 12000 | 11 | 5900 | 0.20 U | 200 U | 250 U | 100 U |
| PZ-201A-SS | DIS | 10/9/2013 | 1000 U | 50 U | 50 U | 140 | 50 U | 250 U | 500 U | 50 U | 75 U | 0.20 U | 200 U | 250 U | 30 |
| PZ-201A-SS | TOT | 10/9/2013 | 1000 U | 50 U | 10 | 140 | 50 U | 250 U | 500 U | 11 U | 75 U | 0.20 U | 200 U | 250 U | 33 |
| PZ-202-SS | DIS | 10/11/2013 | 1000 U | 50 U | 50 U | 620 | 50 U | 29 | 11000 | 8.5 U | 1100 | 0.20 U | 200 U | 250 U | 100 U |
| PZ-202-SS | TOT | 10/11/2013 | 1000 U | 50 U | 50 U | 630 | 50 U | 36 | 12000 | 13 | 1200 | 0.20 U | 200 U | 250 U | 100 U |
| PZ-203-SS | DIS | 10/2/2013 | 1000 U | 50 U | 50 U | 88 | 50 U | 250 U | 270 | 50 U | 22 | 0.20 U | 200 U | 250 U | 100 U |
| PZ-203-SS | TOT | 10/2/2013 | 1000 U | 50 U | 50 U | 89 | 50 U | 250 U | 350 | 50 U | 23 | 0.20 U | 200 U | 250 U | 100 U |
| PZ-204A-SS | DIS | 10/8/2013 | 1000 U | 50 U | 17 | 300 | 17 | 25 J+ | 8600 | 50 U | 2000 | 0.20 U | 200 U | 250 U | 100 U |
| PZ-204A-SS | TOT | 10/8/2013 | 1400 | 50 U | 17 | 450 | 50 U | 26 | 9800 J | 15 | 2100 J | 0.20 U | 200 U | 250 U | 46 |
| PZ-204-SS | DIS | 10/8/2013 | 1000 U | 50 U | 50 U | 170 | 50 U | 250 U | 340 | 50 U | 110 | 0.20 U | 200 U | 250 U | 100 U |
| PZ-204-SS | TOT | 10/8/2013 | 1000 U | 50 U | 50 U | 140 | 50 U | 250 U | 810 J | 12 | 100 J | 0.20 U | 200 U | 250 U | 100 U |
| PZ-205-AS | DIS | 10/15/2013 | 1000 U | 22 | 19 | 1600 | 50 U | 250 U | 45000 | 50 U | 740 | 0.20 U | 200 U | 250 U | 100 U |
| PZ-205-AS | TOT | 10/15/2013 | 23000 | 26 | 30 | 1900 | 41 | 51 | 70000 | 48 | 1000 | 0.086 | 200 U | 42 | 99 |
| PZ-205-SS | DIS | 10/9/2013 | 1000 U | 50 U | 50 U | 140 | 50 U | 250 U | 500 U | 9.5 | 75 U | 0.20 U | 200 U | 250 U | 100 U |
| PZ-205-SS | TOT | 10/9/2013 | 1000 U | 50 U | 50 U | 150 | 50 U | 250 U | 500 U | 10 U | 75 U | 0.20 U | 200 U | 250 U | 100 U |
| PZ-206-SS | DIS | 10/7/2013 | 1000 U | 50 U | 50 U | 57 | 50 U | 250 U | 500 U | 50 U | 22 | 0.20 U | 200 U | 250 U | 100 U |
| PZ-206-SS | TOT | 10/7/2013 | 1900 | 50 U | 50 U | 92 | 50 U | 250 U | 3100 | 7.5 | 65 | 0.20 U | 200 U | 250 U | 100 U |
| PZ-207-AS | DIS | 10/4/2013 | 1000 U | 50 U | 50 U | 700 | 50 U | 24 | 22000 | 50 U | 69 | 0.20 U | 200 U | 250 U | 100 U |
| PZ-207-AS | TOT | 10/4/2013 | 1000 U | 50 U | 50 U | 690 | 17 | 250 U | 22000 | 10 | 66 | 0.11 | 200 U | 250 U | 41 |
| PZ-208-SS | DIS | 10/8/2013 | 1000 U | 50 U | 50 U | 170 | 50 U | 250 U | 500 U | 12 | 28 | 0.20 U | 200 U | 250 U | 100 U |
| PZ-208-SS | TOT | 10/8/2013 | 1800 | 50 U | 50 U | 220 | 50 U | 250 U | 2300 J | 50 U | 93 J | 0.20 U | 200 U | 250 U | 100 U |
| PZ-209-SD | DIS | 11/7/2013 | 1000 U | 50 U | 50 U | 32 | 50 U | 250 U | 500 U | 50 U | 39 | 0.20 U | 200 U | 250 U | 100 U |
| PZ-209-SD | TOT | 11/7/2013 | 1000 U | 50 U | 50 U | 38 | 50 U | 250 U | 500 U | 50 U | 46 | 0.20 U | 200 U | 250 U | 100 U |
| PZ-209-SS | DIS | 11/7/2013 | 1000 U | 50 U | 50 U | 160 | 50 U | 250 U | 500 U | 50 U | 180 | 0.20 U | 200 U | 250 U | 100 U |
| PZ-209-SS | TOT | 11/7/2013 | 1000 U | 50 U | 50 U | 160 | 50 U | 250 U | 500 U | 50 U | 160 | 0.20 U | 200 U | 250 U | 100 U |
| PZ-210-SD | DIS | 11/6/2013 | 8500 J+ | 50 U | 50 U | 140 | 23 | 30 | 2100 J+ | 11 | 51 | 0.20 U | 200 U | 250 U | 46 U |
| PZ-210-SD FD | DIS | 11/6/2013 | 23000 J+ | 50 U | 50 U | 220 | 28 | 26 | 5800 J+ | 25 | 63 | 0.20 U | 200 U | 250 U | 72 U |

**Table 9: Summary of Detected Trace Metal Results - October 2013 Groundwater Sampling, West Lake Landfill OU-1**

| Sample ID | Sample Fraction | Sample Date | Alumi-num | Antimony | Arsenic | Barium | Chro-mium | Cobalt | Iron | Lead | Manga-nese | Mercury | Nickel | Vana-dium | Zinc |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| PZ-210-SD | TOT | 11/6/2013 | 75000 | 50 U | 21 | 630 | 27 | 250 U | 20000 | 78 | 130 | 0.20 U | 74 | 250 U | 190 |
| PZ-210-SD FD | TOT | 11/6/2013 | 60000 | 50 U | 14 | 500 | 28 | 250 U | 16000 | 65 | 110 | 0.20 U | 68 | 250 U | 160 |
| PZ-210-SS | DIS | 11/7/2013 | 1000 U | 50 U | 50 U | 97 | 50 U | 250 U | 500 U | 8.0 | 83 | 0.20 U | 200 U | 250 U | 100 U |
| PZ-210-SS | TOT | 11/7/2013 | 480 | 50 U | 50 U | 63 | 50 U | 250 U | 240 | 50 U | 90 | 0.20 U | 200 U | 250 U | 30 |
| PZ-211-SD | DIS | 11/6/2013 | 42000 J+ | 50 U | 16 | 110 | 19 | 39 | 11000 J+ | 44 | 59 | 0.20 U | 200 U | 250 U | 50 U |
| PZ-211-SD | TOT | 11/6/2013 | 160000 | 50 U | 59 | 480 | 50 U | 250 U | 42000 | 170 | 240 | 0.062 | 200 U | 250 U | 190 |
| PZ-211-SS | DIS | 11/7/2013 | 1000 U | 50 U | 50 U | 63 | 50 U | 250 U | 500 U | 50 U | 21 | 0.20 U | 200 U | 250 U | 100 U |
| PZ-211-SS | TOT | 11/7/2013 | 1000 U | 50 U | 50 U | 64 | 50 U | 250 U | 500 U | 50 U | 22 | 0.20 U | 200 U | 250 U | 100 U |
| PZ-212-SD | DIS | 11/7/2013 | 1000 U | 50 U | 50 U | 140 | 50 U | 250 U | 500 U | 50 U | 280 | 0.20 U | 200 U | 250 U | 100 U |
| PZ-212-SD | TOT | 11/7/2013 | 1000 U | 50 U | 50 U | 140 | 50 U | 250 U | 500 U | 50 U | 280 | 0.20 U | 200 U | 250 U | 100 U |
| PZ-212-SS | DIS | 11/7/2013 | 1000 U | 50 U | 50 U | 140 | 50 U | 250 U | 500 U | 50 U | 28 | 0.20 U | 200 U | 250 U | 100 U |
| PZ-212-SS | TOT | 11/7/2013 | 770 | 50 U | 50 U | 150 | 50 U | 250 U | 700 | 50 U | 78 | 0.20 U | 200 U | 250 U | 100 U |
| PZ-302-AI | DIS | 10/3/2013 | 1000 U | 50 U | 50 U | 360 | 50 U | 250 U | 1700 | 9.5 | 250 | 0.20 U | 200 U | 250 U | 100 U |
| PZ-302-AI | TOT | 10/3/2013 | 1000 U | 50 U | 50 U | 350 | 50 U | 26 | 1800 | 50 U | 250 | 0.20 U | 200 U | 250 U | 100 U |
| PZ-302-AS | DIS | 10/8/2013 | 1000 U | 50 U | 140 | 620 | 17 | 26 | 77000 | 8.5 | 4800 | 0.20 U | 200 U | 250 U | 100 U |
| PZ-302-AS | TOT | 10/8/2013 | 4300 J+ | 50 U | 200 | 800 | 50 U | 250 U | 83000 J | 18 | 4900 J | 0.20 U | 96 | 250 U | 55 |
| PZ-303-AS | DIS | 10/4/2013 | 1000 U | 50 U | 190 | 810 | 50 U | 21 | 88000 | 9.0 | 3800 | 0.20 U | 200 U | 250 U | 100 U |
| PZ-303-AS | TOT | 10/4/2013 | 1000 U | 50 U | 200 | 940 | 24 | 250 U | 92000 | 29 | 3600 | 0.20 U | 200 U | 250 U | 100 U |
| PZ-304-AI | DIS | 10/1/2013 | 1000 U | 50 U | 50 U | 1600 | 50 U | 250 U | 19000 | 50 U | 1000 | 0.20 U | 200 U | 250 U | 100 U |
| PZ-304-AI FD | DIS | 10/1/2013 | 1000 U | 50 U | 50 U | 1600 | 50 U | 250 U | 19000 | 50 U | 1000 | 0.20 U | 200 U | 250 U | 100 U |
| PZ-304-AI | TOT | 10/1/2013 | 1000 U | 50 U | 50 U | 1600 | 50 U | 250 U | 19000 | 7.5 | 1000 | 0.20 U | 200 U | 250 U | 100 U |
| PZ-304-AI FD | TOT | 10/1/2013 | 1000 U | 50 U | 50 U | 1600 | 50 U | 250 U | 19000 | 9.5 | 1000 | 0.20 U | 200 U | 250 U | 100 U |
| PZ-304-AS | DIS | 10/1/2013 | 1000 U | 50 U | 210 | 2400 | 50 U | 250 U | 31000 | 50 U | 130 J+ | 0.20 U | 200 U | 250 U | 100 U |
| PZ-304-AS | TOT | 10/1/2013 | 1000 U | 50 U | 210 | 2300 | 50 U | 250 U | 30000 | 13 | 120 | 0.20 U | 200 U | 24 | 100 U |
| PZ-305-AI | DIS | 10/2/2013 | 1000 U | 50 U | 50 U | 710 | 50 U | 250 U | 40000 | 8.0 | 3300 | 0.20 U | 200 U | 250 U | 100 U |
| PZ-305-AI | TOT | 10/2/2013 | 1000 U | 50 U | 25 | 640 | 50 U | 250 U | 45000 | 13 | 3500 | 0.20 U | 200 U | 250 U | 100 U |

Notes:
All values are in units of micrograms per liter (µg/L)
Sample Fractions: DIS = Dissolved (filtered sample); TOT = Total (unfiltered sample)
FD - Field duplicate sample
Data Validation Qualifiers (Final Q) include:
U = non-detect at the reported value
J = estimated result
J+ = estimated result which may be biased high
J- = estimated result which may be biased low
UJ = non-detect at the estimated reported value
UJ- = non-detect at the estimated reported value which may be biased low

## Table 10: Summary of Most Frequently Detected Volatile Organic Compounds - October 2013 Groundwater Sampling

| Sample ID | Sample Date | Benzene | Ethyl Benzene | M, P- Xylenes | O-Xylene | Total Xylenes | Isopropyl-benzene (Cumene) | MTBE | Chloro-benzene | 1,4-Dichloro-benzene | cis-1,2-Dichloro-ethene | Toluene | Vinyl Chloride |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| S-5 | 10/7/2013 | 3.9 | 5.0 U | 6.4 | 4.8 | 11 | 2.4 | 0.63 | 2.3 | 8.2 | 5.0 U | 1.0 | 5.0 U |
| S-8 | 10/1/2013 | 5.0 U | 5.0 U | 5.0 U | 5.0 U | 10 U | 5.0 U | 5.0 U | 5.0 U | 5.0 U | 5.0 U | 5.0 U | 5.0 U |
| S-10 | 10/1/2013 | 3.4 | 5.0 U | 5.0 U | 5.0 U | 10 U | 5.0 U | 5.0 U | 8.9 | 1.3 | 4.1 | 5.0 U | 2.1 |
| S-53 | 10/15/2013 | 0.67 | 5.0 UJ- | 5.0 U | 5.0 UJ- | 10 U | 5.0 U | 5.0 U | 5.0 U | 5.0 U | 5.0 U | 5.0 U | 5.0 U |
| S-61 | 10/3/2013 | 5.0 U | 5.0 U | 5.0 U | 5.0 U | 10 U | 5.0 U | 5.0 U | 5.0 U | 5.0 U | 0.59 | 5.0 U | 5.0 U |
| S-82 | 10/8/2013 | 5.0 U | 5.0 U | 5.0 U | 5.0 U | 10 U | 5.0 U | 5.0 U | 1.2 | 5.0 U | 1.1 | 5.0 U | 5.0 U |
| S-84 | 10/9/2013 | 2.8 | 5.0 U | 5.0 U | 5.0 U | 10 U | 5.0 U | 5.0 U | 13 | 5.0 U | 0.45 | 5.0 U | 5.0 U |
| S-84 FD | 10/9/2013 | 3.5 | 5.0 U | 5.0 U | 5.0 U | 10 U | 5.0 U | 5.0 U | 12 | 5.0 U | 5.0 U | 5.0 U | 5.0 U |
| I-4 | 10/7/2013 | 5.6 | 5.0 U | 24 | 14 | 38 | 3.3 | 0.64 | 6.4 | 7.3 | 5.0 U | 5.7 | 5.0 U |
| I-9 | 10/8/2013 | 5.0 U | 5.0 U | 5.0 U | 5.0 U | 10 U | 5.0 U | 5.0 U | 5.0 U | 5.0 U | 5.0 U | 5.0 U | 5.0 U |
| I-9 FD | 10/8/2013 | 5.0 U | 5.0 U | 5.0 U | 5.0 U | 10 U | 5.0 U | 5.0 U | 5.0 U | 5.0 U | 5.0 U | 5.0 U | 5.0 U |
| I-11 | 10/1/2013 | 5.0 U | 5.0 U | 5.0 U | 5.0 U | 10 U | 5.0 U | 5.0 U | 1.3 | 5.0 U | 2.1 | 5.0 U | 5.0 U |
| I-62 | 10/1/2013 | 5.0 U | 5.0 U | 5.0 U | 5.0 U | 10 U | 5.0 U | 5.0 U | 5.0 U | 5.0 U | 5.0 U | 5.0 U | 5.0 U |
| I-65 | 10/15/2013 | 5.0 U | 5.0 UJ- | 5.0 U | 5.0 UJ- | 10 U | 5.0 U | 5.0 U | 5.0 U | 5.0 U | 5.0 U | 5.0 U | 5.0 U |
| I-66 | 10/9/2013 | 5.0 U | 5.0 U | 5.0 U | 5.0 U | 10 U | 5.0 U | 5.0 U | 5.0 U | 5.0 U | 5.0 U | 5.0 U | 5.0 U |
| I-67 | 10/3/2013 | 5.0 U | 5.0 U | 5.0 U | 5.0 U | 10 U | 5.0 U | 5.0 U | 5.0 U | 5.0 U | 5.0 U | 5.0 U | 5.0 U |
| I-67 FD | 10/3/2013 | 5.0 U | 5.0 U | 5.0 U | 5.0 U | 10 U | 5.0 U | 5.0 U | 5.0 U | 5.0 U | 0.85 | 5.0 U | 5.0 U |
| I-68 | 10/4/2013 | 5.0 U | 5.0 U | 5.0 U | 5.0 U | 10 U | 5.0 U | 5.0 U | 5.0 U | 5.0 U | 5.0 U | 5.0 U | 5.0 U |
| I-73 | 10/3/2013 | 130 | 15 | 20 | 9.2 | 29 | 9.8 | 2.5 | 63 | 5.0 U | 1.1 | 40 | 5.0 U |
| D-3 | 10/7/2013 | 5.0 U | 5.0 U | 5.0 U | 5.0 U | 10 U | 5.0 U | 0.55 | 2.1 | 5.0 U | 5.0 U | 5.0 U | 5.0 U |
| D-6 | 10/8/2013 | 5.0 U | 5.0 U | 5.0 U | 5.0 U | 10 U | 5.0 U | 3.3 | 5.0 U | 5.0 U | 0.52 | 5.0 U | 5.0 U |
| D-12 | 10/1/2013 | 5.0 U | 5.0 U | 5.0 U | 5.0 U | 10 U | 5.0 U | 5.0 U | 5.0 U | 5.0 U | 0.56 | 5.0 U | 5.0 U |
| D-13 | 10/7/2013 | 5.0 U | 5.0 U | 5.0 U | 5.0 U | 10 U | 5.0 U | 8.5 | 5.0 U | 5.0 U | 5.0 U | 5.0 U | 5.0 U |
| D-14 | 10/15/2013 | 15 | 2.9 J- | 5.0 | 2.5 J- | 7.5 | 3.7 | 0.70 | 65 | 16 | 5.0 U | 4.4 | 0.84 |
| D-81 | 10/3/2013 | 5.0 U | 5.0 U | 5.0 U | 5.0 U | 10 U | 5.0 U | 5.0 U | 5.0 U | 5.0 U | 5.0 U | 5.0 U | 5.0 U |
| D-83 | 10/8/2013 | 5.0 U | 5.0 U | 5.0 U | 5.0 U | 10 U | 5.0 U | 1.6 | 2.3 | 5.0 U | 5.0 U | 5.0 U | 5.0 U |
| D-85 | 10/9/2013 | 0.45 | 5.0 U | 5.0 U | 5.0 U | 10 U | 5.0 U | 5.0 U | 59 | 5.0 U | 5.0 U | 5.0 U | 5.0 U |
| D-87 | 10/2/2013 | 5.0 U | 5.0 U | 5.0 U | 5.0 U | 10 U | 5.0 U | 5.0 U | 5.0 U | 5.0 U | 5.0 U | 5.0 U | 5.0 U |
| D-87 FD | 10/2/2013 | 5.0 U | 5.0 U | 5.0 U | 5.0 U | 10 U | 5.0 U | 5.0 U | 5.0 U | 5.0 U | 0.75 | 5.0 U | 5.0 U |
| D-93 | 10/8/2013 | 2.7 | 5.0 U | 5.0 U | 5.0 U | 10 U | 5.0 U | 5.0 U | 5.0 U | 5.0 U | 53 | 5.0 U | 31 |
| LR-100 | 10/4/2013 | 6.9 | 5.0 U | 0.91 | 0.35 | 1.3 | 17 | 5.0 U | 63 | 5.6 | 5.0 U | 5.0 U | 5.0 U |
| LR-100 FD | 10/4/2013 | 7.7 | 5.0 U | 0.99 | 0.36 | 1.4 | 18 | 5.0 U | 65 | 6.1 | 5.0 U | 5.0 U | 5.0 U |
| LR-103 | 10/2/2013 | 5.0 U | 5.0 U | 5.0 U | 5.0 U | 10 U | 5.0 U | 5.0 U | 5.0 U | 5.0 U | 5.0 U | 5.0 U | 5.0 U |
| LR-104 | 10/2/2013 | 5.0 U | 5.0 U | 5.0 U | 5.0 U | 10 U | 5.0 U | 5.0 U | 5.0 U | 5.0 U | 0.57 | 5.0 U | 5.0 U |
| MW-102 | 10/3/2013 | 5.0 U | 5.0 U | 5.0 U | 5.0 U | 10 U | 5.0 U | 5.0 U | 5.0 U | 5.0 U | 5.0 U | 5.0 U | 5.0 U |
| MW-103 | 10/4/2013 | 5.0 U | 5.0 U | 5.0 U | 5.0 U | 10 U | 5.0 U | 5.0 U | 5.0 U | 5.0 U | 5.0 U | 5.0 U | 5.0 U |
| MW-104 | 10/3/2013 | 5.0 U | 5.0 U | 5.0 U | 5.0 U | 10 U | 5.0 U | 5.0 U | 5.0 U | 5.0 U | 5.0 U | 5.0 U | 5.0 U |
| MW-1204 | 10/11/2013 | 53 | 500 U | 500 U | 500 U | 1000 U | 500 U | 500 U | 500 U | 500 U | 500 U | 2400 | 500 U |
| PZ-100-KS | 10/15/2013 | 5.0 U | 5.0 UJ- | 5.0 U | 5.0 UJ- | 10 U | 5.0 U | 5.0 U | 5.0 U | 5.0 U | 5.0 U | 5.0 U | 5.0 U |

## Table 10: Summary of Most Frequently Detected Volatile Organic Compounds - October 2013 Groundwater Sampling

| Sample ID | Sample Date | Benzene | Ethyl Benzene | M, P- Xylenes | O-Xylene | Total Xylenes | Isopropyl-benzene (Cumene) | MTBE | Chloro-benzene | 1,4-Dichloro-benzene | cis-1,2-Dichloro-ethene | Toluene | Vinyl Chloride |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| S-5 | 10/7/2013 | 3.9 | 5.0 U | 6.4 | 4.8 | 11 | 2.4 | 0.63 | 2.3 | 8.2 | 5.0 U | 1.0 | 5.0 U |
| S-8 | 10/1/2013 | 5.0 U | 5.0 U | 5.0 U | 5.0 U | 10 U | 5.0 U | 5.0 U | 5.0 U | 5.0 U | 5.0 U | 5.0 U | 5.0 U |
| S-10 | 10/1/2013 | 3.4 | 5.0 U | 5.0 U | 5.0 U | 10 U | 5.0 U | 5.0 U | 8.9 | 1.3 | 4.1 | 5.0 U | 2.1 |
| S-53 | 10/15/2013 | 0.67 | 5.0 UJ- | 5.0 U | 5.0 UJ- | 10 U | 5.0 U | 5.0 U | 5.0 U | 5.0 U | 5.0 U | 5.0 U | 5.0 U |
| S-61 | 10/3/2013 | 5.0 U | 5.0 U | 5.0 U | 5.0 U | 10 U | 5.0 U | 5.0 U | 5.0 U | 5.0 U | 0.59 | 5.0 U | 5.0 U |
| S-82 | 10/8/2013 | 5.0 U | 5.0 U | 5.0 U | 5.0 U | 10 U | 5.0 U | 5.0 U | 1.2 | 5.0 U | 1.1 | 5.0 U | 5.0 U |
| S-84 | 10/9/2013 | 2.8 | 5.0 U | 5.0 U | 5.0 U | 10 U | 5.0 U | 5.0 U | 13 | 5.0 U | 0.45 | 5.0 U | 5.0 U |
| S-84 FD | 10/9/2013 | 3.5 | 5.0 U | 5.0 U | 5.0 U | 10 U | 5.0 U | 5.0 U | 12 | 5.0 U | 5.0 U | 5.0 U | 5.0 U |
| I-4 | 10/7/2013 | 5.6 | 5.0 U | 24 | 14 | 38 | 3.3 | 0.64 | 6.4 | 7.3 | 5.0 U | 5.7 | 5.0 U |
| I-9 | 10/8/2013 | 5.0 U | 5.0 U | 5.0 U | 5.0 U | 10 U | 5.0 U | 5.0 U | 5.0 U | 5.0 U | 5.0 U | 5.0 U | 5.0 U |
| I-9 FD | 10/8/2013 | 5.0 U | 5.0 U | 5.0 U | 5.0 U | 10 U | 5.0 U | 5.0 U | 5.0 U | 5.0 U | 5.0 U | 5.0 U | 5.0 U |
| I-11 | 10/1/2013 | 5.0 U | 5.0 U | 5.0 U | 5.0 U | 10 U | 5.0 U | 5.0 U | 1.3 | 5.0 U | 2.1 | 5.0 U | 5.0 U |
| I-62 | 10/1/2013 | 5.0 U | 5.0 U | 5.0 U | 5.0 U | 10 U | 5.0 U | 5.0 U | 5.0 U | 5.0 U | 5.0 U | 5.0 U | 5.0 U |
| I-65 | 10/15/2013 | 5.0 U | 5.0 UJ- | 5.0 U | 5.0 UJ- | 10 U | 5.0 U | 5.0 U | 5.0 U | 5.0 U | 5.0 U | 5.0 U | 5.0 U |
| I-66 | 10/9/2013 | 5.0 U | 5.0 U | 5.0 U | 5.0 U | 10 U | 5.0 U | 5.0 U | 5.0 U | 5.0 U | 5.0 U | 5.0 U | 5.0 U |
| I-67 | 10/3/2013 | 5.0 U | 5.0 U | 5.0 U | 5.0 U | 10 U | 5.0 U | 5.0 U | 5.0 U | 5.0 U | 5.0 U | 5.0 U | 5.0 U |
| I-67 FD | 10/3/2013 | 5.0 U | 5.0 U | 5.0 U | 5.0 U | 10 U | 5.0 U | 5.0 U | 5.0 U | 5.0 U | 0.85 | 5.0 U | 5.0 U |
| I-68 | 10/4/2013 | 5.0 U | 5.0 U | 5.0 U | 5.0 U | 10 U | 5.0 U | 5.0 U | 5.0 U | 5.0 U | 5.0 U | 5.0 U | 5.0 U |
| I-73 | 10/3/2013 | 130 | 15 | 20 | 9.2 | 29 | 9.8 | 2.5 | 63 | 5.0 U | 1.1 | 40 | 5.0 U |
| D-3 | 10/7/2013 | 5.0 U | 5.0 U | 5.0 U | 5.0 U | 10 U | 5.0 U | 0.55 | 2.1 | 5.0 U | 5.0 U | 5.0 U | 5.0 U |
| D-6 | 10/8/2013 | 5.0 U | 5.0 U | 5.0 U | 5.0 U | 10 U | 5.0 U | 3.3 | 5.0 U | 5.0 U | 0.52 | 5.0 U | 5.0 U |
| D-12 | 10/1/2013 | 5.0 U | 5.0 U | 5.0 U | 5.0 U | 10 U | 5.0 U | 5.0 U | 5.0 U | 5.0 U | 0.56 | 5.0 U | 5.0 U |
| D-13 | 10/7/2013 | 5.0 U | 5.0 U | 5.0 U | 5.0 U | 10 U | 5.0 U | 8.5 | 5.0 U | 5.0 U | 5.0 U | 5.0 U | 5.0 U |
| D-14 | 10/15/2013 | 15 | 2.9 J- | 5.0 | 2.5 J- | 7.5 | 3.7 | 0.70 | 65 | 16 | 5.0 U | 4.4 | 0.84 |
| PZ-100-SD | 10/8/2013 | 5.0 U | 5.0 U | 5.0 U | 5.0 U | 10 U | 5.0 U | 5.0 U | 5.0 U | 5.0 U | 5.0 U | 5.0 U | 5.0 U |
| PZ-101-SS | 10/8/2013 | 0.74 | 5.0 U | 5.0 U | 5.0 U | 10 U | 5.0 U | 5.0 U | 5.7 | 1.1 | 5.0 U | 5.0 U | 5.0 U |
| PZ-102R-SS | 10/8/2013 | 5.0 U | 5.0 U | 5.0 U | 5.0 U | 10 U | 5.0 U | 5.0 U | 5.0 U | 5.0 U | 5.0 U | 5.0 U | 5.0 U |
| PZ-102-SS | 10/8/2013 | 5.0 U | 5.0 U | 5.0 U | 5.0 U | 10 U | 5.0 U | 5.0 U | 5.0 U | 5.0 U | 5.0 U | 5.0 U | 5.0 U |
| PZ-103-SS | 10/4/2013 | 77 | 6.6 | 12 | 6.9 | 19 | 1.1 | 5.0 U | 5.0 U | 12 | 5.0 U | 13 | 5.0 U |
| PZ-104-KS | 10/4/2013 | 5.0 U | 5.0 U | 5.0 U | 5.0 U | 10 U | 5.0 U | 5.0 U | 5.0 U | 5.0 U | 5.0 U | 5.0 U | 5.0 U |
| PZ-104-SD | 10/7/2013 | 640 | 17 | 29 | 9.0 | 38 | 100 U | 100 U | 100 U | 100 U | 100 U | 200 | 100 U |
| PZ-104-SS | 10/9/2013 | 2000 | 31 | 49 | 26 | 75 | 3.5 | 6.9 | 5.0 U | 8.0 | 5.0 U | 150 | 5.0 U |
| PZ-105-SS | 10/9/2013 | 5.0 U | 5.0 U | 5.0 U | 5.0 U | 10 U | 5.0 U | 5.0 U | 5.0 U | 5.0 U | 5.0 U | 5.0 U | 5.0 U |
| PZ-106-KS | 10/11/2013 | 5.0 U | 5.0 U | 5.0 U | 5.0 U | 10 U | 5.0 U | 5.0 U | 5.0 U | 5.0 U | 5.0 U | 5.0 U | 5.0 U |
| PZ-106-KS FD | 10/11/2013 | 5.0 U | 5.0 U | 5.0 U | 5.0 U | 10 U | 5.0 U | 5.0 U | 5.0 U | 5.0 U | 5.0 U | 5.0 U | 5.0 U |
| PZ-106-SD | 10/8/2013 | 5.0 U | 5.0 U | 5.0 U | 5.0 U | 10 U | 5.0 U | 5.0 U | 5.0 U | 5.0 U | 5.0 U | 5.0 U | 5.0 U |
| PZ-106-SS | 10/7/2013 | 5.0 U | 5.0 U | 5.0 U | 5.0 U | 10 U | 5.0 U | 5.0 U | 5.0 U | 5.0 U | 5.0 U | 5.0 U | 5.0 U |
| PZ-107-SS | 10/3/2013 | 4.1 | 5.0 U | 5.0 U | 5.0 U | 10 U | 5.0 U | 0.73 | 5.0 U | 5.0 U | 5.0 U | 5.0 U | 5.0 U |
| PZ-109-SS | 10/9/2013 | 5.0 U | 5.0 U | 5.0 U | 5.0 U | 10 U | 5.0 U | 5.0 U | 5.0 U | 5.0 U | 5.0 U | 5.0 U | 5.0 U |

### Table 10: Summary of Most Frequently Detected Volatile Organic Compounds - October 2013 Groundwater Sampling

| Sample ID | Sample Date | Benzene | Ethyl Benzene | M, P- Xylenes | O-Xylene | Total Xylenes | Isopropyl-benzene (Cumene) | MTBE | Chloro-benzene | 1,4-Dichloro-benzene | cis-1,2-Dichloro-ethene | Toluene | Vinyl Chloride |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| S-5 | 10/7/2013 | 3.9 | 5.0 U | 6.4 | 4.8 | 11 | 2.4 | 0.63 | 2.3 | 8.2 | 5.0 U | 1.0 | 5.0 U |
| S-8 | 10/1/2013 | 5.0 U | 5.0 U | 5.0 U | 5.0 U | 10 U | 5.0 U | 5.0 U | 5.0 U | 5.0 U | 5.0 U | 5.0 U | 5.0 U |
| S-10 | 10/1/2013 | 3.4 | 5.0 U | 5.0 U | 5.0 U | 10 U | 5.0 U | 5.0 U | 8.9 | 1.3 | 4.1 | 5.0 U | 2.1 |
| S-53 | 10/15/2013 | 0.67 | 5.0 UJ- | 5.0 U | 5.0 UJ- | 10 U | 5.0 U | 5.0 U | 5.0 U | 5.0 U | 5.0 U | 5.0 U | 5.0 U |
| S-61 | 10/3/2013 | 5.0 U | 5.0 U | 5.0 U | 5.0 U | 10 U | 5.0 U | 5.0 U | 5.0 U | 5.0 U | 0.59 | 5.0 U | 5.0 U |
| S-82 | 10/8/2013 | 5.0 U | 5.0 U | 5.0 U | 5.0 U | 10 U | 5.0 U | 5.0 U | 1.2 | 5.0 U | 1.1 | 5.0 U | 5.0 U |
| S-84 | 10/9/2013 | 2.8 | 5.0 U | 5.0 U | 5.0 U | 10 U | 5.0 U | 5.0 U | 13 | 5.0 U | 0.45 | 5.0 U | 5.0 U |
| S-84 FD | 10/9/2013 | 3.5 | 5.0 U | 5.0 U | 5.0 U | 10 U | 5.0 U | 5.0 U | 12 | 5.0 U | 5.0 U | 5.0 U | 5.0 U |
| I-4 | 10/7/2013 | 5.6 | 5.0 U | 24 | 14 | 38 | 3.3 | 0.64 | 6.4 | 7.3 | 5.0 U | 5.7 | 5.0 U |
| I-9 | 10/8/2013 | 5.0 U | 5.0 U | 5.0 U | 5.0 U | 10 U | 5.0 U | 5.0 U | 5.0 U | 5.0 U | 5.0 U | 5.0 U | 5.0 U |
| I-9 FD | 10/8/2013 | 5.0 U | 5.0 U | 5.0 U | 5.0 U | 10 U | 5.0 U | 5.0 U | 5.0 U | 5.0 U | 5.0 U | 5.0 U | 5.0 U |
| I-11 | 10/1/2013 | 5.0 U | 5.0 U | 5.0 U | 5.0 U | 10 U | 5.0 U | 5.0 U | 1.3 | 5.0 U | 2.1 | 5.0 U | 5.0 U |
| I-62 | 10/1/2013 | 5.0 U | 5.0 U | 5.0 U | 5.0 U | 10 U | 5.0 U | 5.0 U | 5.0 U | 5.0 U | 5.0 U | 5.0 U | 5.0 U |
| I-65 | 10/15/2013 | 5.0 U | 5.0 UJ- | 5.0 U | 5.0 UJ- | 10 U | 5.0 U | 5.0 U | 5.0 U | 5.0 U | 5.0 U | 5.0 U | 5.0 U |
| I-66 | 10/9/2013 | 5.0 U | 5.0 U | 5.0 U | 5.0 U | 10 U | 5.0 U | 5.0 U | 5.0 U | 5.0 U | 5.0 U | 5.0 U | 5.0 U |
| I-67 | 10/3/2013 | 5.0 U | 5.0 U | 5.0 U | 5.0 U | 10 U | 5.0 U | 5.0 U | 5.0 U | 5.0 U | 5.0 U | 5.0 U | 5.0 U |
| I-67 FD | 10/3/2013 | 5.0 U | 5.0 U | 5.0 U | 5.0 U | 10 U | 5.0 U | 5.0 U | 5.0 U | 5.0 U | 0.85 | 5.0 U | 5.0 U |
| I-68 | 10/4/2013 | 5.0 U | 5.0 U | 5.0 U | 5.0 U | 10 U | 5.0 U | 5.0 U | 5.0 U | 5.0 U | 5.0 U | 5.0 U | 5.0 U |
| I-73 | 10/3/2013 | 130 | 15 | 20 | 9.2 | 29 | 9.8 | 2.5 | 63 | 5.0 U | 1.1 | 40 | 5.0 U |
| D-3 | 10/7/2013 | 5.0 U | 5.0 U | 5.0 U | 5.0 U | 10 U | 5.0 U | 0.55 | 2.1 | 5.0 U | 5.0 U | 5.0 U | 5.0 U |
| D-6 | 10/8/2013 | 5.0 U | 5.0 U | 5.0 U | 5.0 U | 10 U | 5.0 U | 3.3 | 5.0 U | 5.0 U | 0.52 | 5.0 U | 5.0 U |
| D-12 | 10/1/2013 | 5.0 U | 5.0 U | 5.0 U | 5.0 U | 10 U | 5.0 U | 5.0 U | 5.0 U | 5.0 U | 0.56 | 5.0 U | 5.0 U |
| D-13 | 10/7/2013 | 5.0 U | 5.0 U | 5.0 U | 5.0 U | 10 U | 5.0 U | 8.5 | 5.0 U | 5.0 U | 5.0 U | 5.0 U | 5.0 U |
| D-14 | 10/15/2013 | 15 | 2.9 J- | 5.0 | 2.5 J- | 7.5 | 3.7 | 0.70 | 65 | 16 | 5.0 U | 4.4 | 0.84 |
| PZ-10D-SS | 10/8/2013 | 5.0 U | 5.0 U | 5.0 U | 5.0 U | 10 U | 5.0 U | 5.0 U | 5.0 U | 5.0 U | 5.0 U | 5.0 U | 5.0 U |
| PZ-110-SS | 10/8/2013 | 5.0 U | 5.0 U | 5.0 U | 5.0 U | 10 U | 5.0 U | 5.0 U | 5.0 U | 5.0 U | 2.4 | 5.0 U | 5.0 U |
| PZ-111-KS | 10/3/2013 | 5.0 U | 5.0 U | 5.0 U | 5.0 U | 10 U | 5.0 U | 5.0 U | 5.0 U | 5.0 U | 5.0 U | 5.0 U | 5.0 U |
| PZ-111-SD | 10/7/2013 | 5.0 U | 5.0 U | 5.0 U | 5.0 U | 10 U | 5.0 U | 5.0 U | 5.0 U | 5.0 U | 5.0 U | 5.0 U | 5.0 U |
| PZ-112-AS | 10/2/2013 | 38 | 1.1 | 0.77 | 0.47 | 1.2 | 2.3 | 5.0 U | 3500 | 22 | 5.0 U | 5.0 U | 5.0 U |
| PZ-113-AD | 10/7/2013 | 5.0 U | 5.0 U | 5.0 U | 5.0 U | 10 U | 5.0 U | 5.0 U | 5.0 U | 5.0 U | 5.0 U | 5.0 U | 5.0 U |
| PZ-113-AD FD | 10/7/2013 | 5.0 U | 5.0 U | 5.0 U | 5.0 U | 10 U | 5.0 U | 5.0 U | 5.0 U | 5.0 U | 5.0 U | 5.0 U | 5.0 U |
| PZ-113-AS | 10/2/2013 | 5.0 U | 5.0 U | 5.0 U | 5.0 U | 10 U | 5.0 U | 2.0 | 5.0 U | 5.0 U | 5.0 U | 5.0 U | 5.0 U |
| PZ-113-SS | 10/3/2013 | 5.0 U | 5.0 U | 5.0 U | 5.0 U | 10 U | 5.0 U | 5.0 U | 5.0 U | 5.0 U | 5.0 U | 5.0 U | 5.0 U |
| PZ-114-AS | 10/8/2013 | 3.4 | 5.0 U | 5.0 U | 5.0 U | 10 U | 5.0 U | 5.0 U | 61 | 6.0 | 5.0 U | 5.0 U | 5.0 U |
| PZ-115-SS | 10/8/2013 | 5.0 U | 5.0 U | 5.0 U | 5.0 U | 10 U | 5.0 U | 5.0 U | 5.0 U | 5.0 U | 5.0 U | 5.0 U | 5.0 U |
| PZ-116-SS | 10/11/2013 | 5.0 U | 5.0 U | 5.0 U | 5.0 U | 10 U | 5.0 U | 5.0 U | 5.0 U | 5.0 U | 5.0 U | 5.0 U | 5.0 U |
| PZ-200-SS | 10/2/2013 | 0.85 | 5.0 U | 5.0 U | 5.0 U | 10 U | 5.0 U | 5.0 U | 5.0 U | 5.0 U | 5.0 U | 5.0 U | 5.0 U |
| PZ-201A-SS | 10/9/2013 | 2.7 | 5.0 U | 5.0 U | 0.56 | 10 U | 5.0 U | 5.0 U | 5.0 U | 5.0 U | 5.0 U | 5.0 U | 5.0 U |
| PZ-202-SS | 10/11/2013 | 20 | 5.0 U | 5.0 U | 5.0 U | 10 U | 5.0 U | 3.1 | 5.0 U | 5.0 U | 5.0 U | 5.0 U | 5.0 U |

**Table 10: Summary of Most Frequently Detected Volatile Organic Compounds - October 2013 Groundwater Sampling**

| Sample ID | Sample Date | Benzene | Ethyl Benzene | M, P- Xylenes | O-Xylene | Total Xylenes | Isopropyl-benzene (Cumene) | MTBE | Chloro-benzene | 1,4-Dichloro-benzene | cis-1,2-Dichloro-ethene | Toluene | Vinyl Chloride |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| S-5 | 10/7/2013 | 3.9 | 5.0 U | 6.4 | 4.8 | 11 | 2.4 | 0.63 | 2.3 | 8.2 | 5.0 U | 1.0 | 5.0 U |
| S-8 | 10/1/2013 | 5.0 U | 5.0 U | 5.0 U | 5.0 U | 10 U | 5.0 U | 5.0 U | 5.0 U | 5.0 U | 5.0 U | 5.0 U | 5.0 U |
| S-10 | 10/1/2013 | 3.4 | 5.0 U | 5.0 U | 5.0 U | 10 U | 5.0 U | 5.0 U | 8.9 | 1.3 | 4.1 | 5.0 U | 2.1 |
| S-53 | 10/15/2013 | 0.67 | 5.0 UJ- | 5.0 U | 5.0 UJ- | 10 U | 5.0 U | 5.0 U | 5.0 U | 5.0 U | 5.0 U | 5.0 U | 5.0 U |
| S-61 | 10/3/2013 | 5.0 U | 5.0 U | 5.0 U | 5.0 U | 10 U | 5.0 U | 5.0 U | 5.0 U | 5.0 U | 0.59 | 5.0 U | 5.0 U |
| S-82 | 10/8/2013 | 5.0 U | 5.0 U | 5.0 U | 5.0 U | 10 U | 5.0 U | 5.0 U | 1.2 | 5.0 U | 1.1 | 5.0 U | 5.0 U |
| S-84 | 10/9/2013 | 2.8 | 5.0 U | 5.0 U | 5.0 U | 10 U | 5.0 U | 5.0 U | 13 | 5.0 U | 0.45 | 5.0 U | 5.0 U |
| S-84 FD | 10/9/2013 | 3.5 | 5.0 U | 5.0 U | 5.0 U | 10 U | 5.0 U | 5.0 U | 12 | 5.0 U | 5.0 U | 5.0 U | 5.0 U |
| I-4 | 10/7/2013 | 5.6 | 5.0 U | 24 | 14 | 38 | 3.3 | 0.64 | 6.4 | 7.3 | 5.0 U | 5.7 | 5.0 U |
| I-9 | 10/8/2013 | 5.0 U | 5.0 U | 5.0 U | 5.0 U | 10 U | 5.0 U | 5.0 U | 5.0 U | 5.0 U | 5.0 U | 5.0 U | 5.0 U |
| I-9 FD | 10/8/2013 | 5.0 U | 5.0 U | 5.0 U | 5.0 U | 10 U | 5.0 U | 5.0 U | 5.0 U | 5.0 U | 5.0 U | 5.0 U | 5.0 U |
| I-11 | 10/1/2013 | 5.0 U | 5.0 U | 5.0 U | 5.0 U | 10 U | 5.0 U | 5.0 U | 1.3 | 5.0 U | 2.1 | 5.0 U | 5.0 U |
| I-62 | 10/1/2013 | 5.0 U | 5.0 U | 5.0 U | 5.0 U | 10 U | 5.0 U | 5.0 U | 5.0 U | 5.0 U | 5.0 U | 5.0 U | 5.0 U |
| I-65 | 10/15/2013 | 5.0 U | 5.0 UJ- | 5.0 U | 5.0 UJ- | 10 U | 5.0 U | 5.0 U | 5.0 U | 5.0 U | 5.0 U | 5.0 U | 5.0 U |
| I-66 | 10/9/2013 | 5.0 U | 5.0 U | 5.0 U | 5.0 U | 10 U | 5.0 U | 5.0 U | 5.0 U | 5.0 U | 5.0 U | 5.0 U | 5.0 U |
| I-67 | 10/3/2013 | 5.0 U | 5.0 U | 5.0 U | 5.0 U | 10 U | 5.0 U | 5.0 U | 5.0 U | 5.0 U | 5.0 U | 5.0 U | 5.0 U |
| I-67 FD | 10/3/2013 | 5.0 U | 5.0 U | 5.0 U | 5.0 U | 10 U | 5.0 U | 5.0 U | 5.0 U | 5.0 U | 0.85 | 5.0 U | 5.0 U |
| I-68 | 10/4/2013 | 5.0 U | 5.0 U | 5.0 U | 5.0 U | 10 U | 5.0 U | 5.0 U | 5.0 U | 5.0 U | 5.0 U | 5.0 U | 5.0 U |
| I-73 | 10/3/2013 | 130 | 15 | 20 | 9.2 | 29 | 9.8 | 2.5 | 63 | 5.0 U | 1.1 | 40 | 5.0 U |
| D-3 | 10/7/2013 | 5.0 U | 5.0 U | 5.0 U | 5.0 U | 10 U | 5.0 U | 0.55 | 2.1 | 5.0 U | 5.0 U | 5.0 U | 5.0 U |
| D-6 | 10/8/2013 | 5.0 U | 5.0 U | 5.0 U | 5.0 U | 10 U | 5.0 U | 3.3 | 5.0 U | 5.0 U | 0.52 | 5.0 U | 5.0 U |
| D-12 | 10/1/2013 | 5.0 U | 5.0 U | 5.0 U | 5.0 U | 10 U | 5.0 U | 5.0 U | 5.0 U | 5.0 U | 0.56 | 5.0 U | 5.0 U |
| D-13 | 10/7/2013 | 5.0 U | 5.0 U | 5.0 U | 5.0 U | 10 U | 5.0 U | 8.5 | 5.0 U | 5.0 U | 5.0 U | 5.0 U | 5.0 U |
| D-14 | 10/15/2013 | 15 | 2.9 J- | 5.0 | 2.5 J- | 7.5 | 3.7 | 0.70 | 65 | 16 | 5.0 U | 4.4 | 0.84 |
| PZ-203-SS | 10/2/2013 | 5.0 U | 5.0 U | 5.0 U | 5.0 U | 10 U | 5.0 U | 5.0 U | 5.0 U | 5.0 U | 5.0 U | 5.0 U | 5.0 U |
| PZ-204A-SS | 10/8/2013 | 20 | 5.0 U | 5.0 U | 5.0 U | 10 U | 5.0 U | 0.62 | 1.6 | 5.0 U | 5.0 U | 5.0 U | 5.0 U |
| PZ-204-SS | 10/8/2013 | 5.0 U | 5.0 U | 5.0 U | 5.0 U | 10 U | 5.0 U | 5.0 U | 5.0 U | 5.0 U | 5.0 U | 5.0 U | 5.0 U |
| PZ-205-AS | 10/15/2013 | 1500 | 140 J- | 480 | 140 J- | 460 | 35 | 10 | 80 | 8.7 | 5.0 U | 870 | 5.0 U |
| PZ-205-SS | 10/9/2013 | 5.0 U | 5.0 U | 5.0 U | 5.0 U | 10 U | 5.0 U | 5.0 U | 5.0 U | 5.0 U | 5.0 U | 5.0 U | 5.0 U |
| PZ-206-SS | 10/7/2013 | 5.0 U | 5.0 U | 5.0 U | 5.0 U | 10 U | 5.0 U | 5.0 U | 5.0 U | 5.0 U | 5.0 U | 5.0 U | 5.0 U |
| PZ-207-AS | 10/4/2013 | 1.5 | 5.0 U | 5.0 U | 5.0 U | 10 U | 4.6 | 0.88 | 17 | 3.8 | 5.0 U | 5.0 U | 5.0 U |
| PZ-208-SS | 10/8/2013 | 5.0 U | 5.0 U | 5.0 U | 5.0 U | 10 U | 5.0 U | 5.0 U | 5.0 U | 5.0 U | 5.0 U | 5.0 U | 5.0 U |
| PZ-209-SD | 11/7/2013 | 5.0 U | 5.0 U | 5.0 U | 5.0 U | 10 U | 5.0 U | 5.0 U | 5.0 U | 5.0 U | 5.0 U | 5.0 U | 5.0 U |
| PZ-209-SS | 11/7/2013 | 5.0 U | 5.0 U | 5.0 U | 5.0 U | 10 U | 5.0 U | 5.0 U | 5.0 U | 5.0 U | 5.0 U | 5.0 U | 5.0 U |
| PZ-210-SD | 11/6/2013 | 38 | 0.48 | 0.70 | 0.43 | 1.1 | 5.0 U | 0.83 | 5.0 U | 5.0 U | 5.0 U | 3.8 | 5.0 U |
| PZ-210-SD FD | 11/6/2013 | 38 | 0.44 | 0.67 | 0.38 | 1.1 | 5.0 U | 0.93 | 5.0 U | 5.0 U | 5.0 U | 4.0 | 5.0 U |
| PZ-210-SS | 11/7/2013 | 0.54 | 5.0 U | 5.0 U | 5.0 U | 10 U | 5.0 U | 5.0 U | 5.0 U | 5.0 U | 5.0 U | 5.0 U | 5.0 U |
| PZ-211-SD | 11/6/2013 | 5.0 U | 5.0 U | 5.0 U | 5.0 U | 10 U | 5.0 U | 5.0 U | 5.0 U | 5.0 U | 5.0 U | 5.0 U | 5.0 U |
| PZ-211-SS | 11/7/2013 | 2.0 | 5.0 U | 5.0 U | 5.0 U | 10 U | 5.0 U | 5.0 U | 5.0 U | 5.0 U | 5.0 U | 5.0 U | 5.0 U |

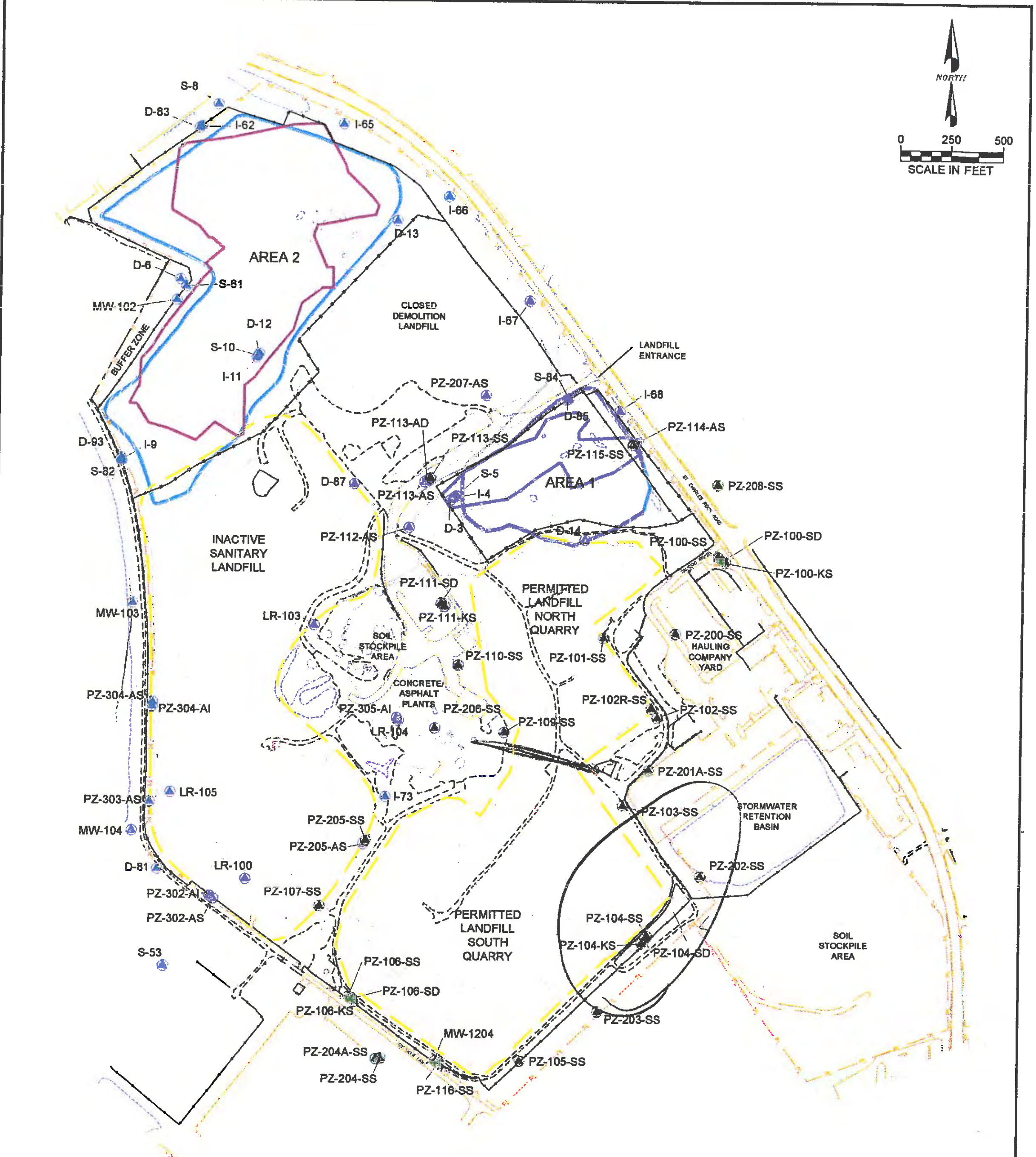
**Table 10: Summary of Most Frequently Detected Volatile Organic Compounds - October 2013 Groundwater Sampling**

| Sample ID | Sample Date | Benzene | Ethyl Benzene | M, P- Xylenes | O-Xylene | Total Xylenes | Isopropyl-benzene (Cumene) | MTBE | Chloro-benzene | 1,4-Dichloro-benzene | cis-1,2-Dichloro-ethene | Toluene | Vinyl Chloride |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| S-5 | 10/7/2013 | 3.9 | 5.0 U | 6.4 | 4.8 | 11 | 2.4 | 0.63 | 2.3 | 8.2 | 5.0 U | 1.0 | 5.0 U |
| S-8 | 10/1/2013 | 5.0 U | 5.0 U | 5.0 U | 5.0 U | 10 U | 5.0 U | 5.0 U | 5.0 U | 5.0 U | 5.0 U | 5.0 U | 5.0 U |
| S-10 | 10/1/2013 | 3.4 | 5.0 U | 5.0 U | 5.0 U | 10 U | 5.0 U | 5.0 U | 8.9 | 1.3 | 4.1 | 5.0 U | 2.1 |
| S-53 | 10/15/2013 | 0.67 | 5.0 UJ- | 5.0 U | 5.0 UJ- | 10 U | 5.0 U | 5.0 U | 5.0 U | 5.0 U | 5.0 U | 5.0 U | 5.0 U |
| S-61 | 10/3/2013 | 5.0 U | 5.0 U | 5.0 U | 5.0 U | 10 U | 5.0 U | 5.0 U | 5.0 U | 5.0 U | 0.59 | 5.0 U | 5.0 U |
| S-82 | 10/8/2013 | 5.0 U | 5.0 U | 5.0 U | 5.0 U | 10 U | 5.0 U | 5.0 U | 1.2 | 5.0 U | 1.1 | 5.0 U | 5.0 U |
| S-84 | 10/9/2013 | 2.8 | 5.0 U | 5.0 U | 5.0 U | 10 U | 5.0 U | 5.0 U | 13 | 5.0 U | 0.45 | 5.0 U | 5.0 U |
| S-84 FD | 10/9/2013 | 3.5 | 5.0 U | 5.0 U | 5.0 U | 10 U | 5.0 U | 5.0 U | 12 | 5.0 U | 5.0 U | 5.0 U | 5.0 U |
| I-4 | 10/7/2013 | 5.6 | 5.0 U | 24 | 14 | 38 | 3.3 | 0.64 | 6.4 | 7.3 | 5.0 U | 5.7 | 5.0 U |
| I-9 | 10/8/2013 | 5.0 U | 5.0 U | 5.0 U | 5.0 U | 10 U | 5.0 U | 5.0 U | 5.0 U | 5.0 U | 5.0 U | 5.0 U | 5.0 U |
| I-9 FD | 10/8/2013 | 5.0 U | 5.0 U | 5.0 U | 5.0 U | 10 U | 5.0 U | 5.0 U | 5.0 U | 5.0 U | 5.0 U | 5.0 U | 5.0 U |
| I-11 | 10/1/2013 | 5.0 U | 5.0 U | 5.0 U | 5.0 U | 10 U | 5.0 U | 5.0 U | 1.3 | 5.0 U | 2.1 | 5.0 U | 5.0 U |
| I-62 | 10/1/2013 | 5.0 U | 5.0 U | 5.0 U | 5.0 U | 10 U | 5.0 U | 5.0 U | 5.0 U | 5.0 U | 5.0 U | 5.0 U | 5.0 U |
| I-65 | 10/15/2013 | 5.0 U | 5.0 UJ- | 5.0 U | 5.0 UJ- | 10 U | 5.0 U | 5.0 U | 5.0 U | 5.0 U | 5.0 U | 5.0 U | 5.0 U |
| I-66 | 10/9/2013 | 5.0 U | 5.0 U | 5.0 U | 5.0 U | 10 U | 5.0 U | 5.0 U | 5.0 U | 5.0 U | 5.0 U | 5.0 U | 5.0 U |
| I-67 | 10/3/2013 | 5.0 U | 5.0 U | 5.0 U | 5.0 U | 10 U | 5.0 U | 5.0 U | 5.0 U | 5.0 U | 5.0 U | 5.0 U | 5.0 U |
| I-67 FD | 10/3/2013 | 5.0 U | 5.0 U | 5.0 U | 5.0 U | 10 U | 5.0 U | 5.0 U | 5.0 U | 5.0 U | 0.85 | 5.0 U | 5.0 U |
| I-68 | 10/4/2013 | 5.0 U | 5.0 U | 5.0 U | 5.0 U | 10 U | 5.0 U | 5.0 U | 5.0 U | 5.0 U | 5.0 U | 5.0 U | 5.0 U |
| I-73 | 10/3/2013 | 130 | 15 | 20 | 9.2 | 29 | 9.8 | 2.5 | 63 | 5.0 U | 1.1 | 40 | 5.0 U |
| D-3 | 10/7/2013 | 5.0 U | 5.0 U | 5.0 U | 5.0 U | 10 U | 5.0 U | 0.55 | 2.1 | 5.0 U | 5.0 U | 5.0 U | 5.0 U |
| D-6 | 10/8/2013 | 5.0 U | 5.0 U | 5.0 U | 5.0 U | 10 U | 5.0 U | 3.3 | 5.0 U | 5.0 U | 0.52 | 5.0 U | 5.0 U |
| D-12 | 10/1/2013 | 5.0 U | 5.0 U | 5.0 U | 5.0 U | 10 U | 5.0 U | 5.0 U | 5.0 U | 5.0 U | 0.56 | 5.0 U | 5.0 U |
| D-13 | 10/7/2013 | 5.0 U | 5.0 U | 5.0 U | 5.0 U | 10 U | 5.0 U | 8.5 | 5.0 U | 5.0 U | 5.0 U | 5.0 U | 5.0 U |
| D-14 | 10/15/2013 | 15 | 2.9 J- | 5.0 | 2.5 J- | 7.5 | 3.7 | 0.70 | 65 | 16 | 5.0 U | 4.4 | 0.84 |
| PZ-212-SD | 11/7/2013 | 5.0 U | 5.0 U | 5.0 U | 5.0 U | 10 U | 5.0 U | 5.0 U | 5.0 U | 5.0 U | 5.0 U | 5.0 U | 5.0 U |
| PZ-212-SS | 11/7/2013 | 5.0 U | 5.0 U | 5.0 U | 5.0 U | 10 U | 5.0 U | 5.0 U | 5.0 U | 5.0 U | 5.0 U | 5.0 U | 5.0 U |
| PZ-302-AI | 10/3/2013 | 5.0 U | 5.0 U | 5.0 U | 5.0 U | 10 U | 5.0 U | 5.0 U | 5.0 U | 5.0 U | 5.0 U | 5.0 U | 5.0 U |
| PZ-302-AS | 10/8/2013 | 80 | 0.40 | 0.59 | 5.0 U | 10 U | 1.3 | 5.0 U | 52 | 4.9 | 5.0 U | 2.7 | 5.0 U |
| PZ-303-AS | 10/4/2013 | 40 | 16 | 190 | 190 | 380 | 5.0 U | 0.63 | 5.0 U | 5.0 U | 6.4 | 280 | 1.9 |
| PZ-304-AI | 10/1/2013 | 1.7 | 5.0 U | 5.0 U | 5.0 U | 10 U | 0.48 | 5.0 U | 16 | 2.4 | 5.0 U | 5.0 U | 5.0 U |
| PZ-304-AI FD | 10/1/2013 | 1.7 | 5.0 U | 5.0 U | 5.0 U | 10 U | 0.45 | 5.0 U | 16 | 2.4 | 5.0 U | 5.0 U | 5.0 U |
| PZ-304-AS | 10/1/2013 | 9.7 | 5.0 U | 5.0 U | 5.0 U | 10 U | 0.61 | 5.0 U | 58 | 14 | 0.63 | 5.0 U | 5.0 U |
| PZ-305-AI | 10/2/2013 | 1.1 | 5.0 U | 5.0 U | 5.0 U | 10 U | 5.0 U | 5.0 U | 5.4 | 5.0 U | 5.0 U | 5.0 U | 5.0 U |

Notes: All values are in units of micrograms per liter (µg/L).
FD = Field duplicate sample.
Data Validation Qualifiers (Final Q) include:
U = non-detect at the reported value
J = estimated result. J- = estimated result which may be biased low
UJ = non-detect at the estimated reported value

# Figures

M:\CLIENTS\EMSI\WESTLAKE\2013\10-2013\FIG1-WL-BASE-10-2013.DWG-LAYOUT1 01/22/2014 12:34PM




## LEGEND

- Alluvium Groundwater Well
- Bedrock Groundwater Well
- Operable Unit-1 Area as Defined By ROD
- Estimated Extent of Radiologically Impacted Material
- Existing 10' Contours
- Building or Structure
- Property Line
- Fence
- Paved Road
- Unpaved Road

| Generalized Stratagraphic Column | | | | | |
|---|---|---|---|---|---|
| System | Series | Group | Formation | Thickness (ft) | Dominant Lithology |
| Quaternary | Holocene | | Alluvium | 0-150 | Sand, gravel, silt, and clay. |
| | Pleistocene | | Loess<br>Glacial Till | 1-110<br>0-55 | Silt<br>Pebbly clay and silt. |
| Pennsylvanian | Missourian | Pleasanton | Undifferentiated | 0-75 | Shale, siltstones, "dirty" sandstones, coal beds and thin limestone beds. |
| | Desmoinesian | Marmaton | Undifferentiated | 0-90 | |
| | | Cherokee | Undifferentiated | 0-200 | |
| | Atokan | | Cheltenham Formation | unknown | |
| Mississippian | Meramecian | | Ste. Genevieve Formation | 0-160 | Argillaceous to arenaceous limestone. |
| | | | St Louis Limestone | 0-180 | |
| | | | Salem Formation | 0-180 | |
| | | | Warsaw Formation | 0-110 | Shale in upper portion, limestone in lower portions. |
| | Osagean | | Burlington-Keokuk Formation | 0-240 | Cherty limestone. |
| | | | Fern Glen Formation | 0-105 | Red limestone and shale |

## WELL FORMATION DESIGNATIONS

LR or MW: Undifferentiated
S or AS: Alluvial Shallow Well
I or AI: Alluvial Intermediate Well
D or AD: Alluvial Deep Well
SS: St. Louis Formation Well
SD: Salem Formation Well
KS: Keokuk Formation Well

## NOTES:

1. Horizontal Coordinates Based on State Plane Missouri East Zone NAD 27
2. Elevations Based on U.S.G.S. Datum.
3. Existing Grade Contours are from the Aerial Survey Completed by the Sanborn Mapping Company on July 20, 2011.
4. Base Map Prepared by Aquaterra Environmental Solutions, Inc.

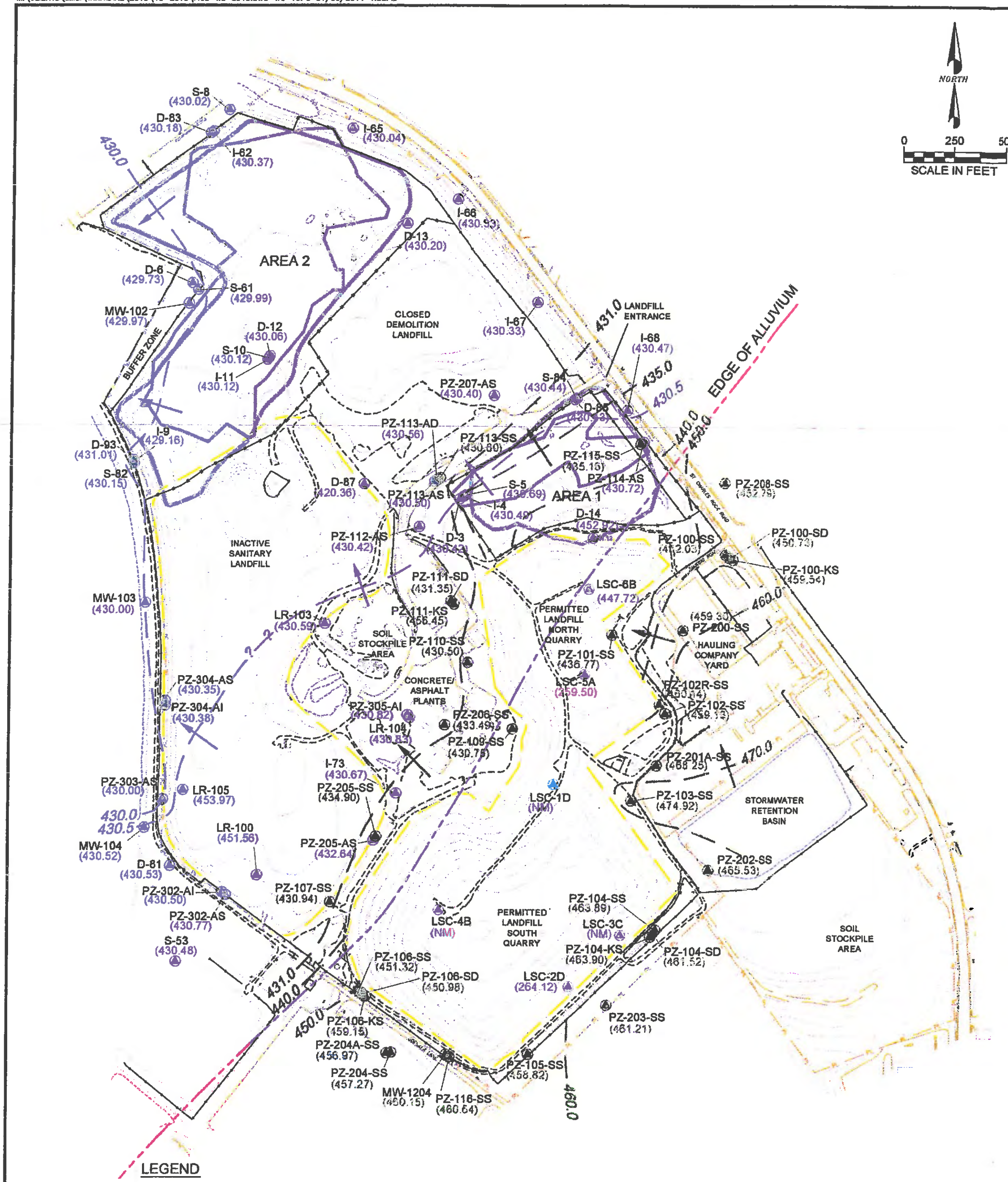
Figure 1

Base Map

West Lake Landfill Operable Unit-1

EMSI Engineering Management Support, Inc.

M:\CLIENTS\EMSI\WESTLAKE\2013\10-2013\FIG2-WL-G913.DWG-WO-TOPO 01/30/2014 4:58PM




## LEGEND

| | |
|---|---|
| | Leachate Collection Sump |
| | Alluvium Groundwater Well |
| | Bedrock Groundwater Well |
| | Operable Unit-1 Area as Defined By ROD |
| | Estimated Extent of Radiologically Impacted Material |
| | Paved Road |
| | Unpaved Road |
| 440 | Groundwater Elevation Contour (FAMSL) - Alluvium |
| 440 | Groundwater Elevation Contour (FAMSL) - St. Louis Fm |
| (279.02) | Leachate Groundwater Elevation (FAMSL) |
| (429.82) | Alluvium Groundwater Elevation (FAMSL) |
| (458.64) | St. Louis Fm Groundwater Elevation (FAMSL) |
| * | Groundwater Elevation not used for contouring |
| | Groundwater Flow Direction - Alluvium |
| | Groundwater Flow Direction - St. Louis Fm |
| (FAMSL) | Feet above mean sea level |

## WELL FORMATION DESIGNATIONS

LR or MW: Undifferentiated
S or AS: Alluvial Shallow Well
I or AI: Alluvial Intermediate Well
D or AD: Alluvial Deep Well
SS: St. Louis Formation Well
SD: Salem Formation Well
KS: Keokuk Formation Well

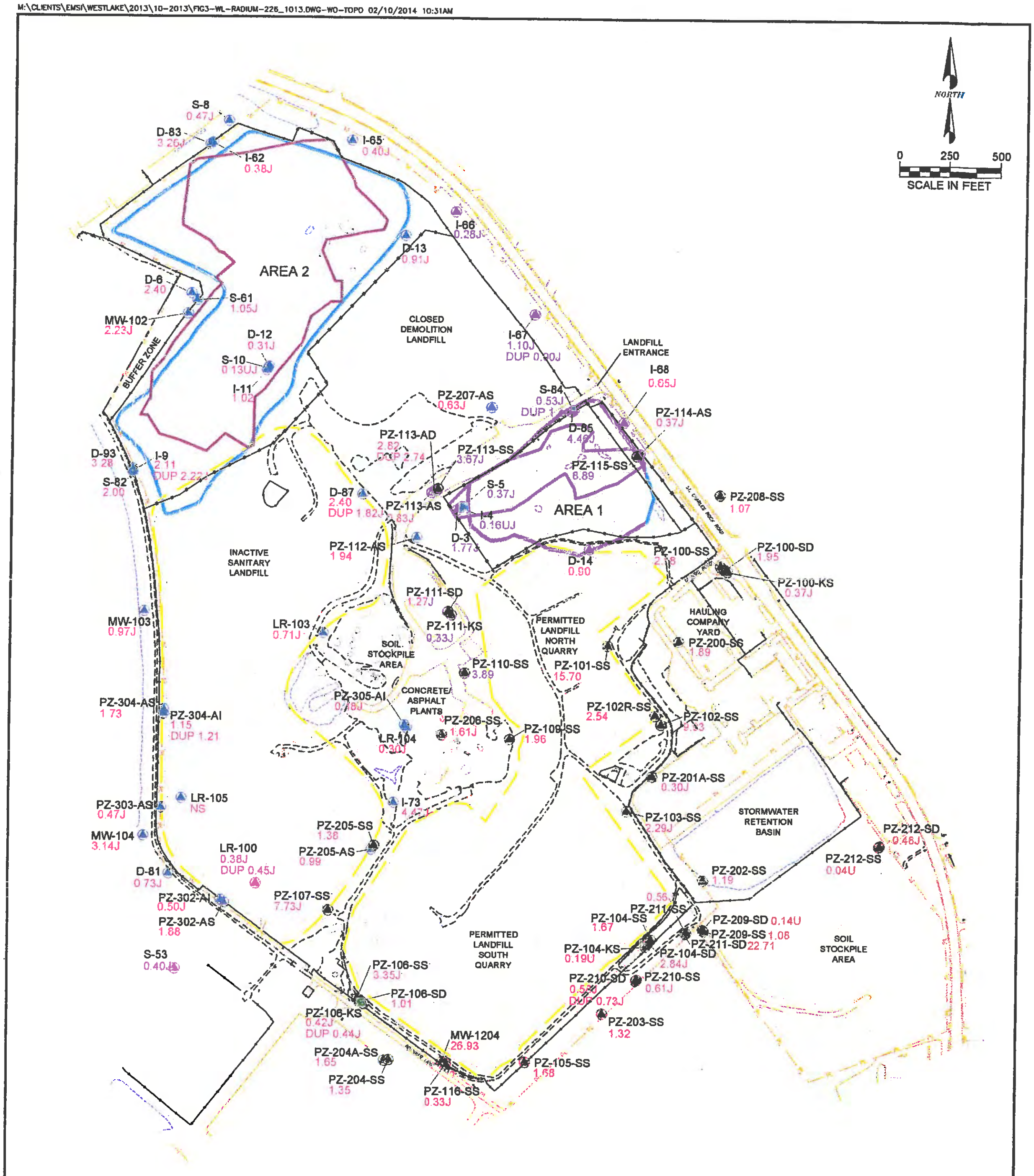
## NOTES:

1. Horizontal Coordinates Based on State Plane Missouri East Zone NAD 27
2. Elevations Based on U.S.G.S. Datum.
3. Existing Grade Contours are from the Aerial Survey Completed by the Sanborn Mapping Company on July 20, 2011.
4. Base Map Prepared by Aquaterra Environmental Solutions, Inc.

Figure 2
Alluvial Groundwater Table and
St. Louis FM. Potentiometric Elevation Map
September 30, 2013
West Lake Landfill Operable Unit-1

EMSI Engineering Management Support, Inc.

M:\CLIENTS\EMSI\WESTLAKE\2013\10-2013\FIG3-WL-RADIUM-226_1013.DWG-WO-TOPO 02/10/2014 10:31AM




## LEGEND

- Alluvium Groundwater Well
- Bedrock Groundwater Well
- Operable Unit-1 Area as Defined By ROD
- Estimated Extent of Radiologically Impacted Material
- Paved Road
- Unpaved Road

## RADIUM EXPLANATION

.092 Radium-226 (pCi/L)
NS Not Sampled

Data Validation Qualifiers:

U = Non-detect at the reported value
UJ = Non-Detect at the estimated reported value
UJ+ = Non-Detect at the estimated reported value which may be biased high
UJ- = Non-Detect at the estimated reported value which may be biased low
J = Estimated result
J+ = Esitmated result which may be biased high

## WELL FORMATION DESIGNATIONS

LR or MW: Undifferentiated
S or AS: Alluvial Shallow Well
I or AI: Alluvial Intermediate Well
D or AD: Alluvial Deep Well
SS: St. Louis Formation Well
SD: Salem Formation Well
KS: Keokuk Formation Well

## NOTES:

1. Horizontal Coordinates Based on State Plane Missouri East Zone NAD 27
2. Elevations Based on U.S.G.S. Datum.
3. Existing Grade Contours are from the Aerial Survey Completed by the Sanborn Mapping Company on July 20, 2011.
4. Base Map Prepared by Aquaterra Environmental Solutions, Inc.

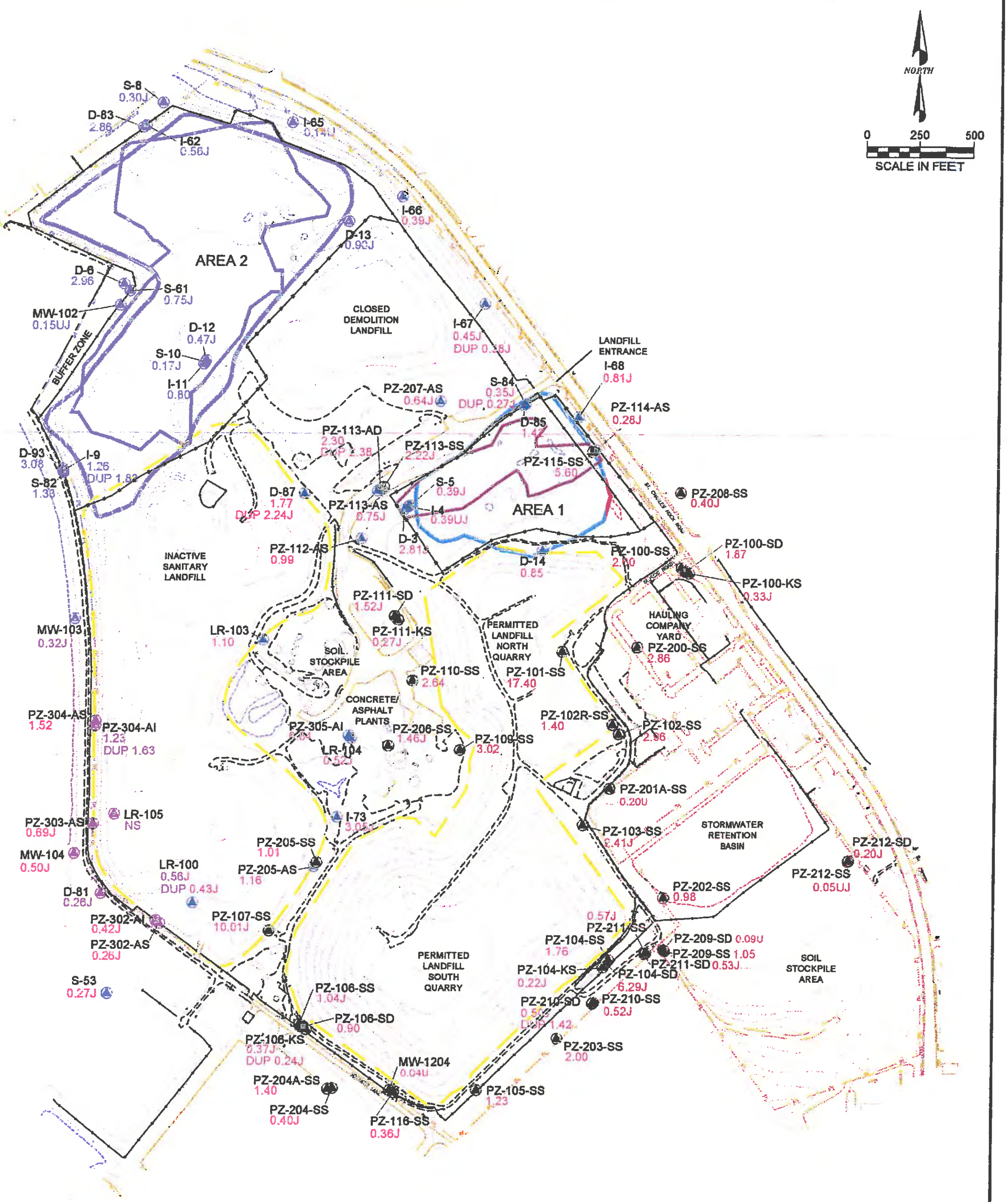
Figure 3

Total Radium-226 in Groundwater
October - November 2013

West Lake Landfill Operable Unit-1

EMSI Engineering Management Support, Inc.

M:\CLIENTS\EMSI\WESTLAKE\2013\10-2013\FIG4-WL-RADIUM-DISSOLVED-226_1013.DWG-W-TOPO (2) 02/10/2014 10:37AM




## LEGEND

- Alluvium Groundwater Well
- Bedrock Groundwater Well
- Operable Unit-1 Area as Defined By ROD
- Estimated Extent of Radiologically Impacted Material
- Paved Road
- Unpaved Road

## WELL FORMATION DESIGNATIONS

LR or MW: Undifferentiated
S or AS: Alluvial Shallow Well
I or AI: Alluvial Intermediate Well
D or AD: Alluvial Deep Well
SS: St. Louis Formation Well
SD: Salem Formation Well
KS: Keokuk Formation Well

## NOTES:

1. Horizontal Coordinates Based on State Plane Missouri East Zone NAD 27
2. Elevations Based on U.S.G.S. Datum.
3. Existing Grade Contours are from the Aerial Survey Completed by the Sanborn Mapping Company on July 20, 2011.
4. Base Map Prepared by Aquaterra Environmental Solutions, Inc.

## RADIUM EXPLANATION

.092 Radium-226 (pCi/L)
NS Not Sampled

Data Validation Qualifiers:

U = Non-detect at the reported value
UJ = Non-Detect at the estimated reported value
UJ+ = Non-Detect at the estimated reported value which may be biased high
UJ- = Non-Detect at the estimated reported value which may be biased low
J = Estimated result
J+ = Esitmated result which may be biased high

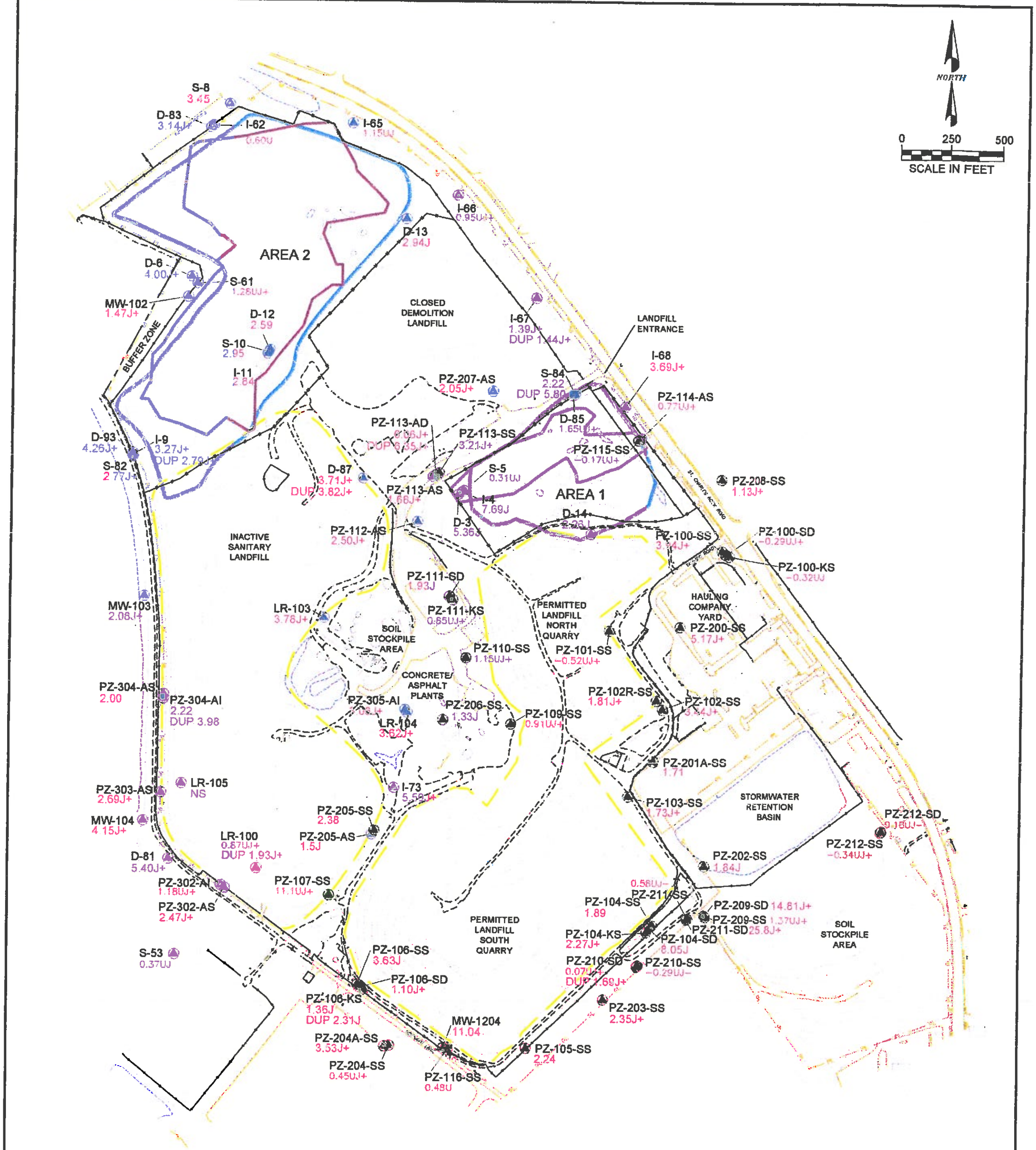
Figure 4

Dissolved Radium-226 in Groundwater
October - November 2013

West Lake Landfill Operable Unit-1

EMSI Engineering Management Support, Inc.

M:\CLIENTS\EMSI\WESTLAKE\2013\10-2013\FIG5-WL-RADIUM-228_1013.DWG-WO-TOPO 02/10/2014 10:41AM




## LEGEND

- Alluvium Groundwater Well
- Bedrock Groundwater Well
- Operable Unit-1 Area as Defined By ROD
- Estimated Extent of Radiologically Impacted Material
- Paved Road
- Unpaved Road

## RADIUM EXPLANATION

| | |
|---|---|
| 0.82 | Radium-228 (pCi/L) |
| NS | Not Sampled |

Data Validation Qualifiers:

U = Non-detect at the reported value
UJ = Non-Detect at the estimated reported value
UJ+ = Non-Detect at the estimated reported value which may be biased high
UJ- = Non-Detect at the estimated reported value which may be biased low
J = Estimated result
J+ = Esitmated result which may be biased high

## WELL FORMATION DESIGNATIONS

LR or MW: Undifferentiated
S or AS: Alluvial Shallow Well
I or AI: Alluvial Intermediate Well
D or AD: Alluvial Deep Well
SS: St. Louis Formation Well
SD: Salem Formation Well
KS: Keokuk Formation Well

## NOTES:

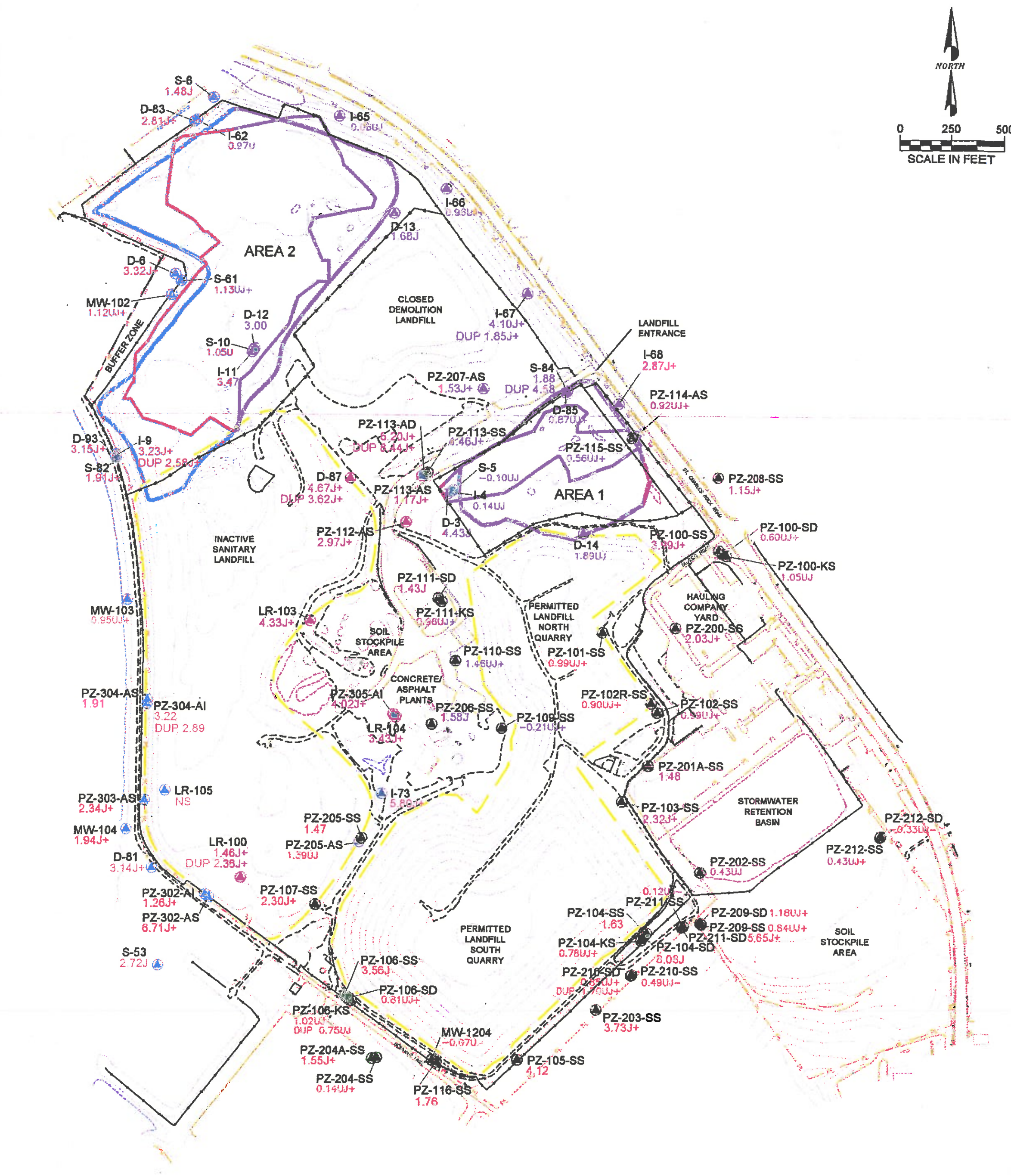
1. Horizontal Coordinates Based on State Plane Missouri East Zone NAD 27
2. Elevations Based on U.S.G.S. Datum.
3. Existing Grade Contours are from the Aerial Survey Completed by the Sanborn Mapping Company on July 20, 2011.
4. Base Map Prepared by Aquaterra Environmental Solutions, Inc.

Figure 5

Total Radium-228 in Groundwater
October - November 2013

West Lake Landfill Operable Unit-1

EMSI Engineering Management Support, Inc.




## LEGEND

- Alluvium Groundwater Well
- Bedrock Groundwater Well
- Operable Unit-1 Area as Defined By ROD
- Estimated Extent of Radiologically Impacted Material
- Paved Road
- Unpaved Road

## RADIUM EXPLANATION

.092 Radium-228 (pCi/L)
NS Not Sampled

Data Validation Qualifiers:

U = Non-detect at the reported value
UJ = Non-Detect at the estimated reported value
UJ+ = Non-Detect at the estimated reported value which may be biased high
UJ- = Non-Detect at the estimated reported value which may be biased low
J = Estimated result
J+ = Esitmated result which may be biased high

## WELL FORMATION DESIGNATIONS

LR or MW: Undifferentiated
S or AS: Alluvial Shallow Well
I or AI: Alluvial Intermediate Well
D or AD: Alluvial Deep Well
SS: St. Louis Formation Well
SD: Salem Formation Well
KS: Keokuk Formation Well

## NOTES:

1. Horizontal Coordinates Based on State Plane Missouri East Zone NAD 27
2. Elevations Based on U.S.G.S. Datum.
3. Existing Grade Contours are from the Aerial Survey Completed by the Sanborn Mapping Company on July 20, 2011.
4. Base Map Prepared by Aquaterra Environmental Solutions, Inc.

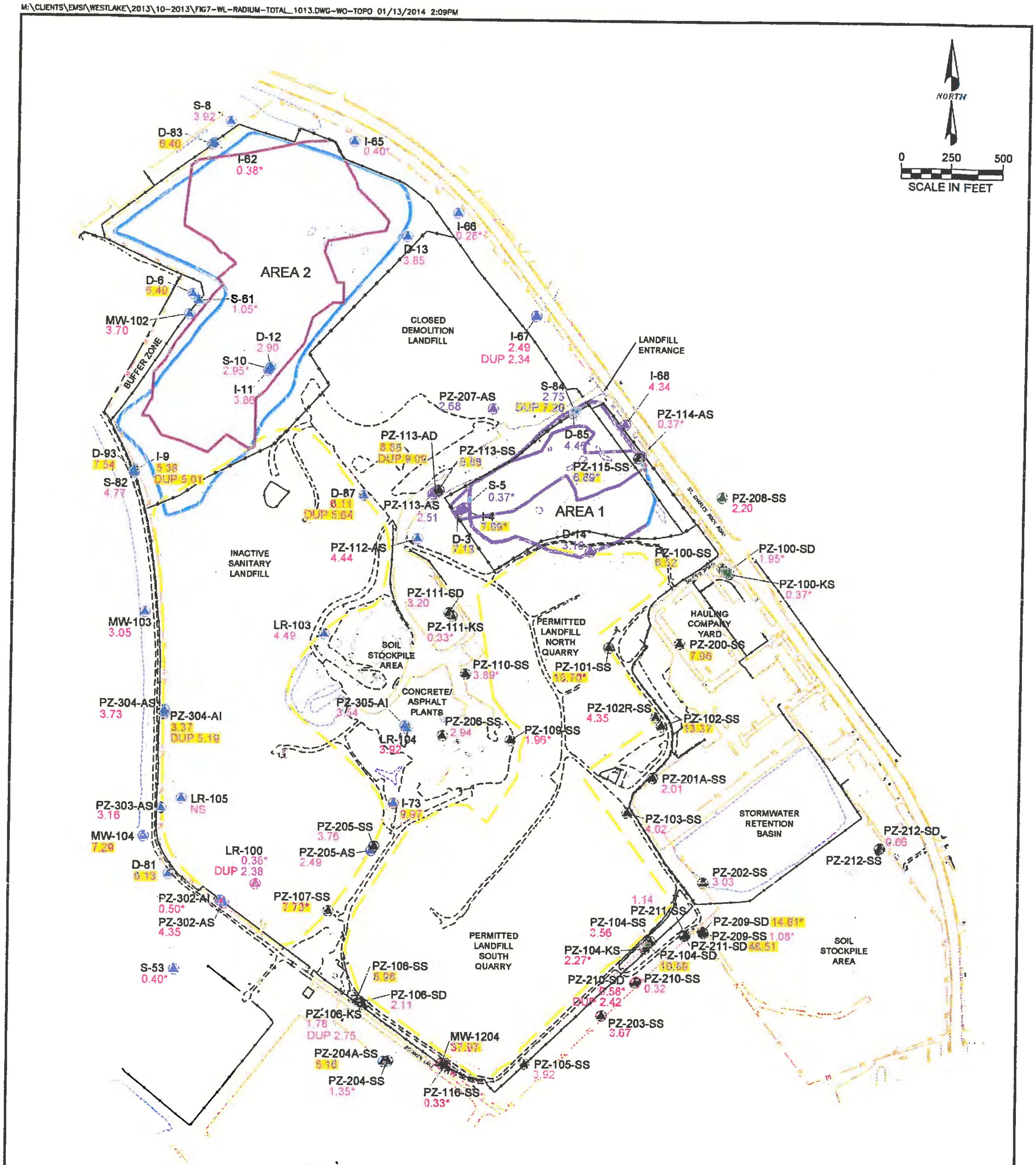
Figure 6

Dissolved Radium-228 in Groundwater
October - November 2013

West Lake Landfill Operable Unit-1

EMSI Engineering Management Support, Inc.

M:\CLIENTS\EMSI\WESTLAKE\2013\10-2013\FIG7-WL-RADIUM-TOTAL_1013.DWG-WO-TOPO 01/13/2014 2:09PM




## LEGEND

- Alluvium Groundwater Well
- Bedrock Groundwater Well
- Operable Unit-1 Area as Defined By ROD
- Estimated Extent of Radiologically Impacted Material
- Paved Road
- Unpaved Road

## RADIUM EXPLANATION

- 1.72 — Total Radium result that is less than the Maximum Contaminant Level of 5 pCi/L for combined Radium-226 and Radium-228
- 4.50* — Combined Ra-226 and Ra-228 results unless one of results was non-detect, in which case only the detected result is shown and the value is flagged with a *
- 5.10 — Total Radium greater than the Maximum Contaminant Level of 5 pCi/L for combined Radium-226 and Radium-228
- Both Radium-226 and Radium-228 were non-detect
- NS — Not Sampled

## WELL FORMATION DESIGNATIONS

LR or MW: Undifferentiated
S or AS: Alluvial Shallow Well
I or AI: Alluvial Intermediate Well
D or AD: Alluvial Deep Well
SS: St. Louis Formation Well
SD: Salem Formation Well
KS: Keokuk Formation Well

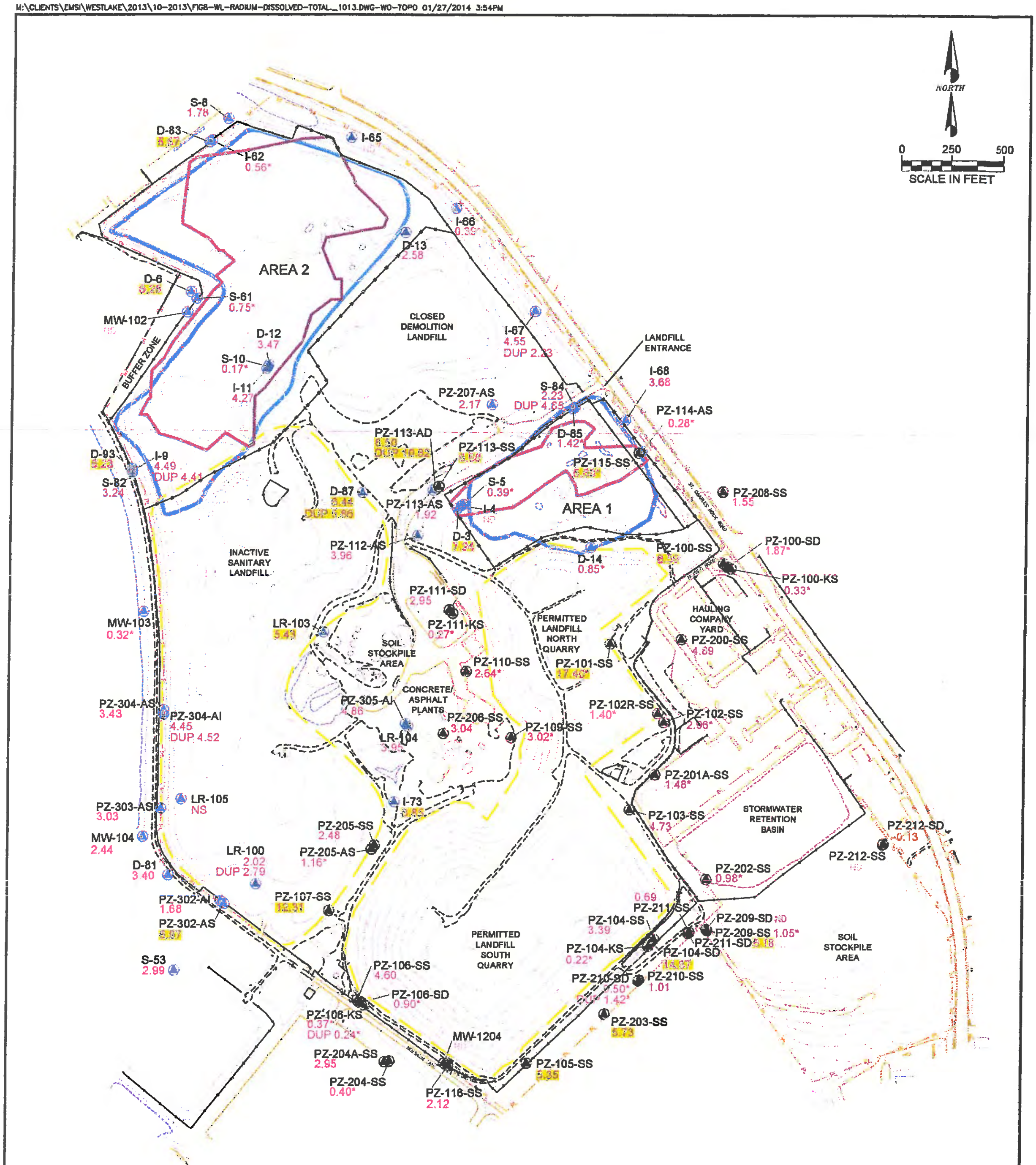
## NOTES:

1. Horizontal Coordinates Based on State Plane Missouri East Zone NAD 27
2. Elevations Based on U.S.G.S. Datum.
3. Existing Grade Contours are from the Aerial Survey Completed by the Sanborn Mapping Company on July 20, 2011.
4. Base Map Prepared by Aquaterra Environmental Solutions, Inc.

Figure 7
Combined
Total Radium-226 + Total Radium-228
in Groundwater
October - November 2013
West Lake Landfill Operable Unit-1

EMSI Engineering Management Support, Inc.

M:\CLIENTS\EMSI\WESTLAKE\2013\10-2013\FIG8-WL-RADIUM-DISSOLVED-TOTAL_1013.DWG-WO-TOPO 01/27/2014 3:54PM




## LEGEND

- Alluvium Groundwater Well
- Bedrock Groundwater Well
- Operable Unit-1 Area as Defined By ROD
- Estimated Extent of Radiologically Impacted Material
- Paved Road
- Unpaved Road

## RADIUM EXPLANATION

.092 Total Dissolved Radium that is less than the Maximum Contaminant Level of 5 pCi/L for combined Radium-226 and Radium-228

1.08* Combined Ra-226 and Ra-228 results unless one of results was non-detect, in which case only the detected result is shown and the value is flagged with a *

5.26 Total Dissolved Radium greater than the Maximum Contaminant Level of 5 pCi/L for combined Radium-226 and Radium-228

ND Both Radium-226 and Radium-228 were non-detect

NS Not Sampled

## WELL FORMATION DESIGNATIONS

LR or MW: Undifferentiated
S or AS: Alluvial Shallow Well
I or AI: Alluvial Intermediate Well
D or AD: Alluvial Deep Well
SS: St. Louis Formation Well
SD: Salem Formation Well
KS: Keokuk Formation Well

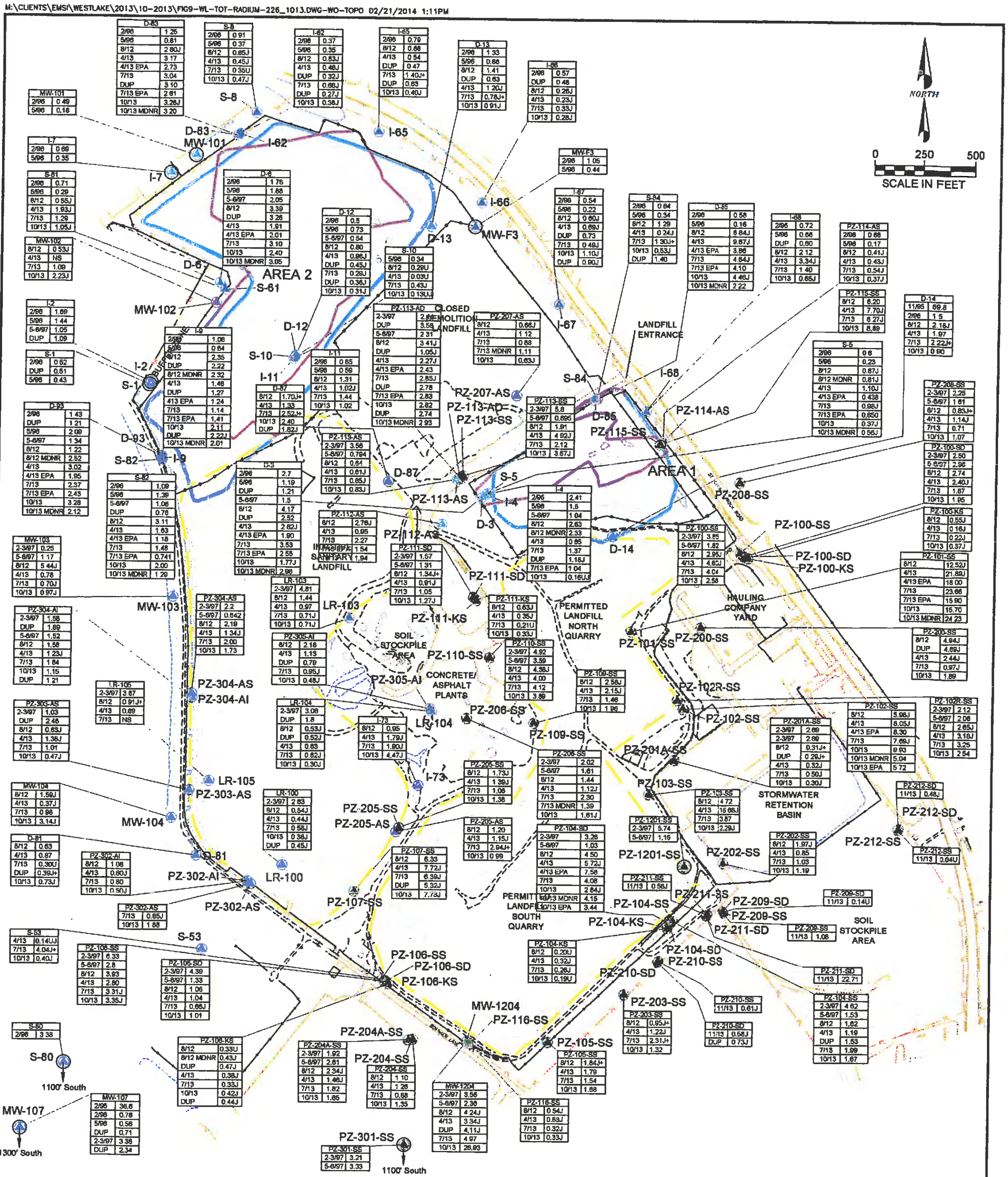
## NOTES:

1. Horizontal Coordinates Based on State Plane Missouri East Zone NAD 27
2. Elevations Based on U.S.G.S. Datum.
3. Existing Grade Contours are from the Aerial Survey Completed by the Sanbom Mapping Company on July 20, 2011.
4. Base Map Prepared by Aquaterra Environmental Solutions, Inc.

Figure 8
Combined
Dissolved Radium-226 + Dissolved Radium-228
in Groundwater
October - November 2013
West Lake Landfill Operable Unit-1

EMSI. Engineering Management Support, Inc.

M:\CLIENTS\EMSI\WESTLAKE\2013\10-2013\FIG9-WL-TOT-RADIUM-226_1013.DWG-WO-TOPO 02/21/2014 1:11PM




## LEGEND

- Alluvium Groundwater Well
- Bedrock Groundwater Well
- RI/FS Groundwater Well That No Longer Exists
- Operable Unit-1 Area as Defined By ROD
- Estimated Extent of Radiologically Impacted Material
- Paved Road
- Unpaved Road

## WELL FORMATION DESIGNATIONS

LR or MW: Undifferentiated
S or AS: Alluvial Shallow Well
I or AI: Alluvial Intermediate Well
D or AD: Alluvial Deep Well
SS: St. Louis Formation Well
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## Data Validation Qualifiers:

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UJ+ = Non-Detect at the estimated reported value which may be biased high
UJ- = Non-Detect at the estimated reported value which may be biased low
J = Estimated result
J+ = esitmated result which may be biased high

## RADIUM EXPLANATION

Well Number

| MW-1204 | |
|---|---|
| 2-3/97 | 3.56 |

Date Sampled — Total Radium-226 Concentration in (pCi/L)

EMSI has concluded that D-14 results are not vaild due to extreme variations between filtered and unfiltered results and extreme variations among sampling events.

OU-1 Wells Sampled 11/95, 2/96, 5/96, 5/97, 3/04, 5/04, 8/12, 4/13 and 7/13
OU-2 Wells Sampled 2-3/97 and 5-6/97, 8/12, 4/13 and 7/13

Data from either OU-1 RI (EMSI, 2000), OU-2 RI (Herst & Associates, 2000), or 2004 Data for OU-1 FS Effort.

## NOTES:

1. Horizontal Coordinates Based on State Plane Missouri East Zone NAD 27
2. Elevations Based on U.S.G.S. Datum.
3. Existing Grade Contours are from the Aerial Survey Completed by the Sanborn Mapping Company on July 20, 2011.
4. Base Map Prepared by Aquaterra Environmental Solutions, Inc.

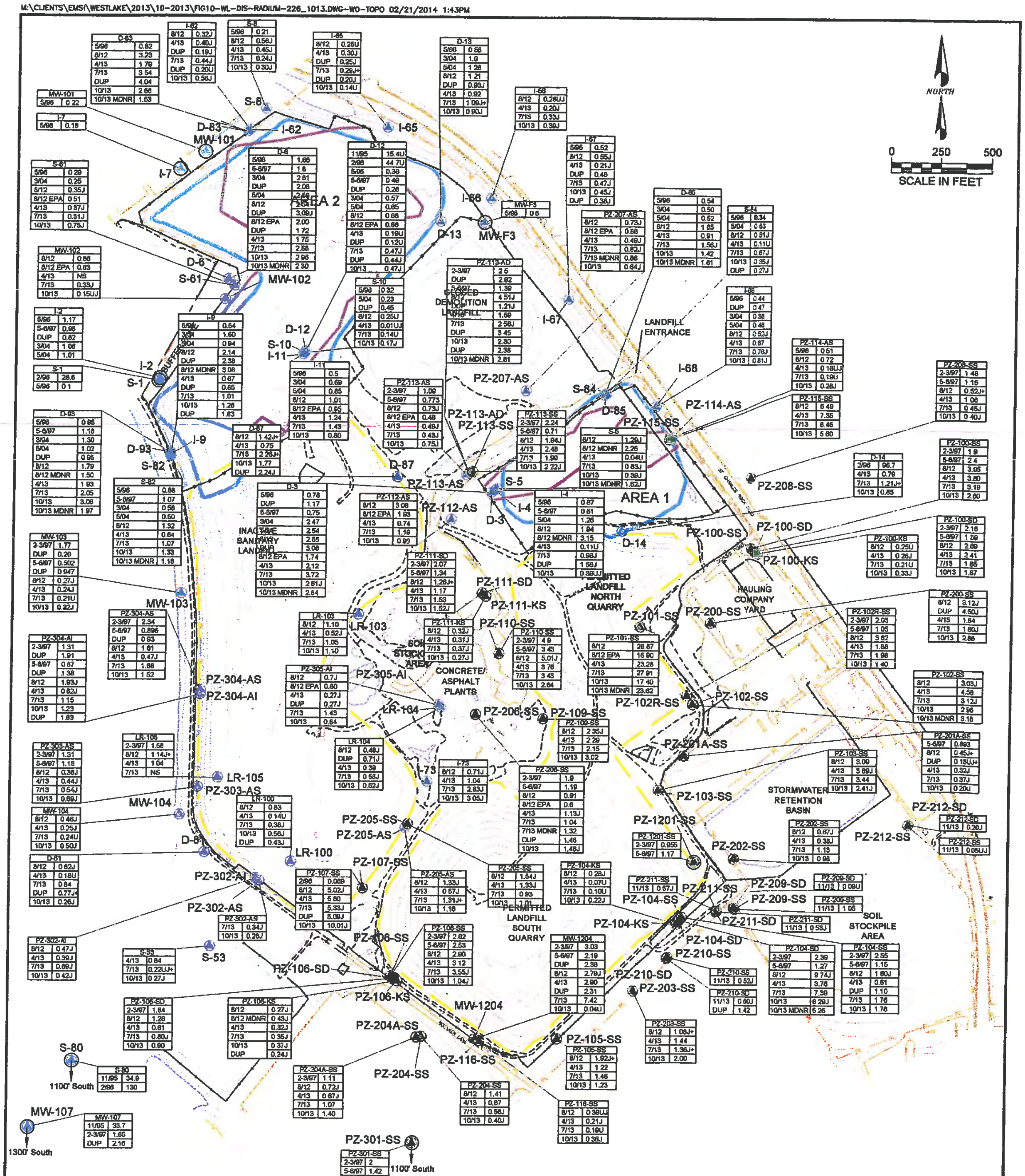
**Figure 9**

**2013, 2012 and RI/FS Results for Total Radium-226 in Groundwater**

West Lake Landfill Operable Unit-1

EMSI Engineering Management Support, Inc.

M:\CLIENTS\EMSI\WESTLAKE\2013\10-2013\FIG10-WL-DIS-RADIUM-226_1013.DWG-WO-TOPO 02/21/2014 1:43PM




## LEGEND

- Alluvium Groundwater Well
- Bedrock Groundwater Well
- RI/FS Groundwater Well That No Longer Exists
- Operable Unit-1 Area as Defined By ROD
- Estimated Extent of Radiologically Impacted Material
- Paved Road
- Unpaved Road

## WELL FORMATION DESIGNATIONS

LR or MW: Undifferentiated
S or AS: Alluvial Shallow Well
I or AI: Alluvial Intermediate Well
D or AD: Alluvial Deep Well
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## Data Validation Qualifiers:

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UJ+ = Non-Detect at the estimated reported value which may be biased high
UJ- = Non-Detect at the estimated reported value which may be biased low
J = Estimated result
J+ = esitmated result which may be biased high

## RADIUM EXPLANATION

Well Number — MW-1204
Date Sampled — 2-3/97 | 3.03 — Dissolved Radium-226 Concentration in (pCi/L)

EMSI has concluded that D-14 results are not valid due to extreme variations between filtered and unfiltered results and extreme variations among sampling events.

OU-1 Wells Sampled 11/95, 2/96, 5/96, 5/97, 3/04, 5/04, 8/12, 4/13 and 7/13
OU-2 Wells Sampled 2-3/97 and 5-6/97, 8/12, 4/13 and 7/13

Data from either OU-1 RI (EMSI, 2000), OU-2 RI (Herst & Associates, 2000), or 2004 Data for OU-1 FS Effort.

## NOTES:

1. Horizontal Coordinates Based on State Plane Missouri East Zone NAD 27
2. Elevations Based on U.S.G.S. Datum.
3. Existing Grade Contours are from the Aerial Survey Completed by the Sanborn Mapping Company on July 20, 2011.
4. Base Map Prepared by Aquaterra Environmental Solutions, Inc.

Figure 10

2013, 2012 and RI/FS Results for Dissolved Radium-226 in Groundwater

West Lake Landfill Operable Unit-1

EMSI Engineering Management Support, Inc.

## APPENDIX B

## BARRIER TREATMENT - TECHNICAL AND COST INFORMATION BY REGENESIS

REGENESIS

August 14, 2015

**To:** Kenny Hemmen – Geotechnology, Inc.
*Via email*

**From:** Ryan Moore; Great Lakes District Manager, 219-286-4838
Cc: Doug Davis, Central Region Technical Manager, 614-447-0492

**Proposal #:** 53072

**Subject:** **Feasibility for Treatment of a dissolved benzene plume, West Lake Landfill Operable Unit, Bridgeton, MO**

---

REGENESIS appreciates the opportunity to provide Geotechnology, Inc. (Geotechnology) this document outlining feasibility-level solutions and cost evaluations for treatment of a benzene groundwater plume at the West Lake Landfill site (the Site) in Bridgeton, MO Below we discuss the target treatment zone (TTZs) considered for remediation, applicability of REGENESIS technologies to address the contaminant and provide preliminary cost estimates for treatment using these technologies. Please note the following attachments.

1) Site Map
2) PlumeStop Technical Packet
3) REGENESIS Remediation Services Scope of Services

## DEFINITION OF TARGET TREATMENT ZONES

The Site groundwater is impacted with benzene. Per Geotechnology's suggestion, an approximate TTZ of a 4,600 feet (ft) long barrier with a vertical treatment interval of 20 to 100 ft below ground surface (bgs) into a sandy alluvium aquifer has been identified for this feasibility cost evaluation. The Site and proposed barrier location is depicted on the attached map.

For feasibility purposes a groundwater benzene concentration of 1 mg/L was used as representative values for the design and costing models. We understand that the remedial objective for benzene in groundwater 5 micrograms per liter (µg/L).

## TECHNOLOGY FEASIBILITY AND COST ESTIMATES

We have evaluated the contaminant for dissolved plume for applicability to our *in-situ* sorption and enhanced bioremediation technology, PlumeStop™ Liquid Activated Carbon™ (PlumeStop). We also provide budgetary estimates for implementation of PlumeStop at the site. The estimates is inclusive of all products, labor, application equipment (such as a GeoProbe® rigs and injection trailers), tax, and freight to complete the work assuming REGENESIS Remediation Services (RRS) execution of the work.

Dissolved Plume – *In-Situ* Sorption and Enhanced Bioremediation

The use of Enhanced Bioremediation is a viable method for treatment of benzene. At REGENESIS we have specific expertise in the use enhanced bioremediation to rapidly and effectively treat benzene across a wide range of site hydrogeologic conditions and dissolved phase concentrations. These include utilization of our technologies, ORC, ORC Advanced, ORC Advanced Pellets, RegenOx, PersulfOx, and RegenOx PetroCleanze. We now couple this expertise and these technologies with our latest groundwater treatment technology, PlumeStop.

PlumeStop is an innovative groundwater remediation technology designed to address the challenges of excessive time and end-point uncertainty in groundwater remediation. PlumeStop is composed of very fine particles of activated carbon (1-2μm) suspended in water through the use of unique organic polymer dispersion chemistry. Once in the subsurface, the material behaves as a colloidal biomatrix binding to the aquifer matrix, rapidly removing contaminants from groundwater, and expediting permanent contaminant biodegradation.

This unique remediation technology accomplishes treatment with the use of highly dispersible, fast-acting, sorption-based technology which captures and concentrates dissolved-phase contaminants within its matrix-like structure. Once contaminants are sorbed onto the regenerative matrix, biodegradation processes achieve complete remediation at an accelerated rate, which yields in accelerated biodegradation. The result is that benzene and other contamination such as petroleum hydrocarbons, chlorinated solvents, pesticides, and herbicides in groundwater can be reduced below or, near non-detect levels within days to weeks. More information on PlumeStop can be found in our Attached PlumeStop technical packet.

**REGENESIS Feasibility Costing Estimate for PlumeStop treatment-** $30 – $40 per cubic yard treated
Treatment Volume: 69,000 sf x 80 ft = 5,520,000 ft3 = 204,444 cubic yards
Total Estimated Cost = $6.1M – $8.2M

The estimates is inclusive of all products, labor, application equipment (such as a GeoProbe® rigs and injection trailers), tax, and freight to complete the work.

**PILOT TESTING**

We recommend field-scale pilot testing of this technology prior to full scale implementation. Depending on the scope of a pilot test, the pilot testing cost (from REGENESIS) most commonly is in the range of $20,000 to $40,000 for turn-key application services. In addition, significant cost savings may be realized through a robust vertical profiling and delineation of the dissolved phase contaminant plume (if this has not already been completed). REGENEISI can assist with this effort as this project moves forward.

**PAY FOR PERFORMANCE**

REGENESIS is confident in our ability to effectively treat chlorinated solvents and as such, are willing to offer performance-based contracting alternatives for remediation at this Site.

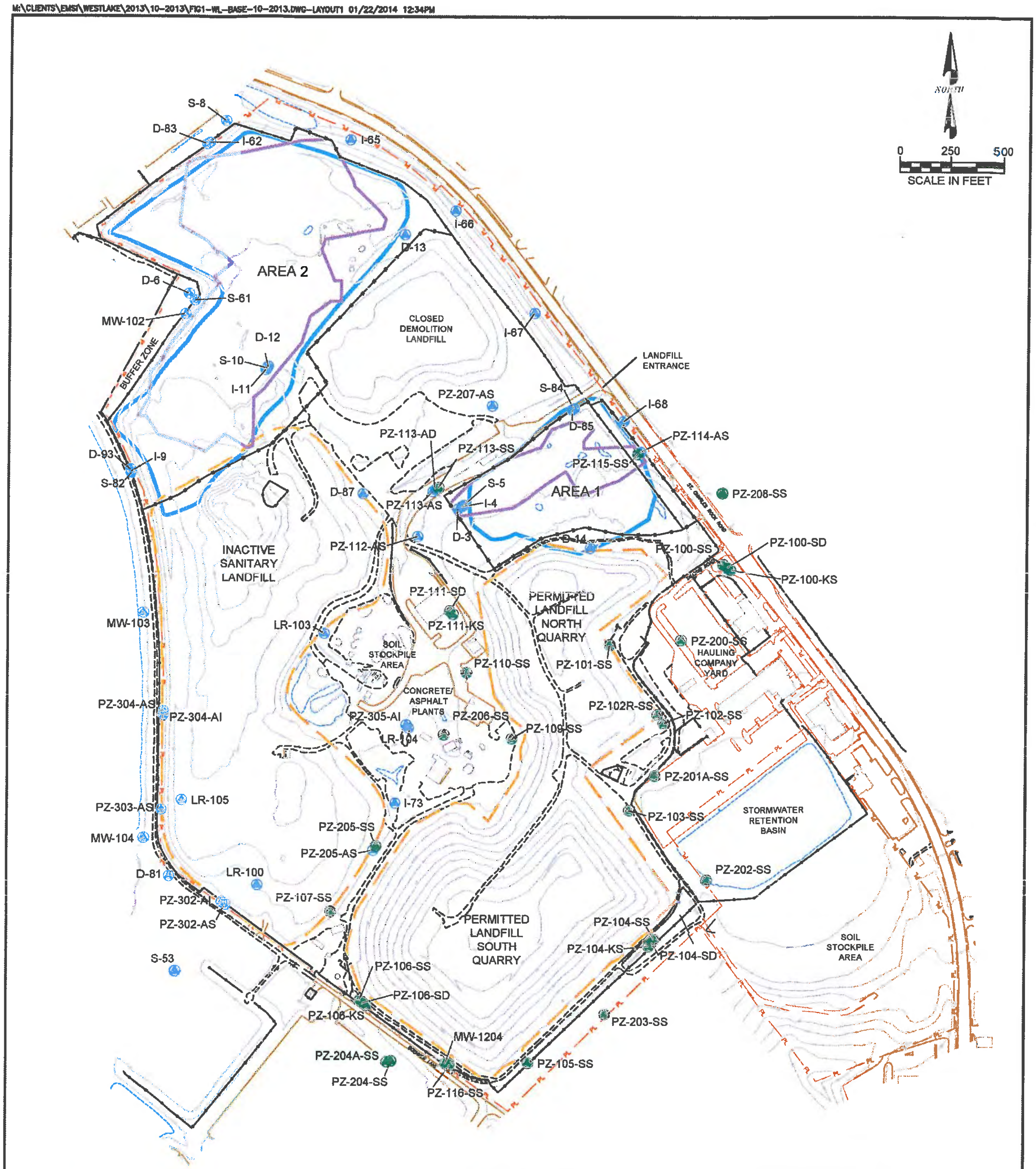
**CLOSING**

We sincerely appreciate the opportunity to present this feasibility proposal. When you want to move forward with a more specific design and cost proposal, we would like to set up a mutually convenient time to meet with you in person to address details about the site, including needed technical information for the design/proposal process and answer any questions you may have. We look forward to working with you further on this project.

**REGENESIS**

Doug Davis
Central Region Technical Service Manager

Ryan Moore, CHMM
Great Lakes District Manager




## LEGEND

- Alluvium Groundwater Well
- Bedrock Groundwater Well
- Operable Unit-1 Area as Defined By ROD
- Estimated Extent of Radiologically Impacted Material
- Existing 10' Contours
- Building or Structure
- Property Line
- Fence
- Paved Road
- Unpaved Road

## WELL FORMATION DESIGNATIONS

LR or MW: Undifferentiated
S or AS: Alluvial Shallow Well
I or AI: Alluvial Intermediate Well
D or AD: Alluvial Deep Well
SS: St. Louis Formation Well
SD: Salem Formation Well
KS: Keokuk Formation Well

## NOTES:

1. Horizontal Coordinates Based on State Plane Missouri East Zone NAD 27
2. Elevations Based on U.S.G.S. Datum.
3. Existing Grade Contours are from the Aerial Survey Completed by the Sanborn Mapping Company on July 20, 2011.
4. Base Map Prepared by Aquaterra Environmental Solutions, Inc.

**Generalized Stratagraphic Column**

| System | Series | Group | Formation | Thickness (ft) | Dominant Lithology |
|---|---|---|---|---|---|
| Quaternary | Holocene | | Alluvium | 0-150 | Sand, gravel, silt, and clay |
| | Pleistocene | | Loess<br>Glacial Till | 1-110<br>0-[illegible] | Silt<br>Pebbly clay and silt |
| Pennsylvanian | Missourian | Pleasanton | Undifferentiated | 0-75 | Shales, siltstones, "dirty" sandstones, coal beds and thin limestone beds. |
| | Desmoinesian | Marmaton | Undifferentiated | 0-90 | |
| | | Cherokee | Undifferentiated | 0-200 | |
| | Atokan | | Cheltenham Formation | unknown | |
| Mississippian | Meramecian | | Ste. Genevieve Formation | 0-160 | Argillaceous to arenaceous limestone |
| | | | St. Louis Limestone | 0-180 | |
| | | | Salem Formation | 0-180 | |
| | | | Warsaw Formation | 0-110 | Shales in upper portion, limestone in lower portions |
| | Osagean | | Burlington-Keokuk Formation | 0-240 | Cherty limestone. |
| | | | Fern Glen Formation | 0-105 | Red limestone and shale. |

Figure 1

Base Map

West Lake Landfill Operable Unit-1

EMSI Engineering Management Support, Inc.

REGENESIS

# PlumeStop Liquid Activated Carbon™ Technical Information

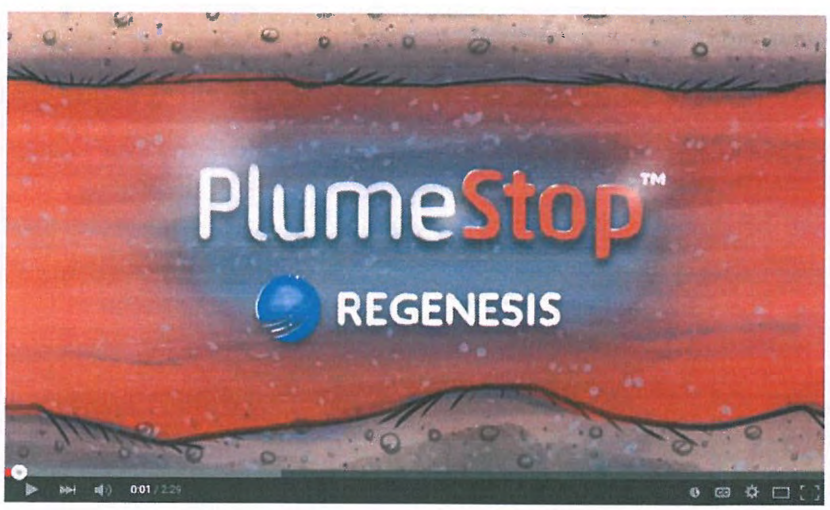
Thank you for your interest in REGENESIS and in our PlumeStop™ Liquid Activated Carbon™ technology (PlumeStop). We have assembled this information package to assist in your technical evaluation of this technology. Below we introduce the PlumeStop technology, describe the benefits of a PlumeStop treatment approach and provide an outline of a PlumeStop project including the standard services offered in support thereof.

**PlumeStop™ Liquid Activated Carbon™– What Is It?**

PlumeStop™ Liquid Activated Carbon™ is an innovative groundwater remediation technology designed to address the challenges of excessive time and end-point uncertainty in groundwater remediation. PlumeStop is composed of very fine particles of activated carbon (1-2µm) suspended in water through the use of unique organic polymer dispersion chemistry. Once in the subsurface, the material behaves as a colloidal biomatrix binding to the aquifer matrix, rapidly removing contaminants from groundwater, and expediting permanent contaminant biodegradation.

This unique remediation technology accomplishes treatment with the use of highly dispersible, fast-acting, sorption-based technology which captures and concentrates dissolved-phase contaminants within its matrix-like structure. Once contaminants are sorbed onto the regenerative matrix, biodegradation processes achieve complete remediation at an accelerated rate.

An animated video of the technology can be found here:



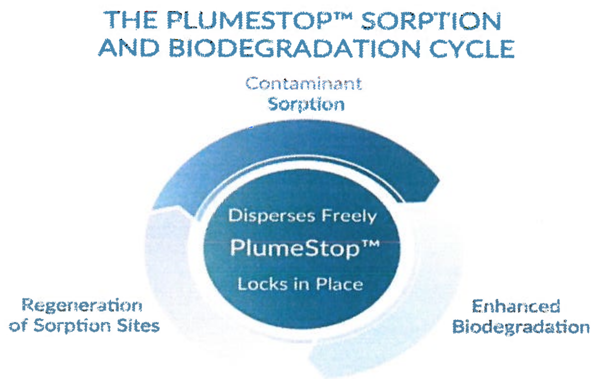

An Animated Overview of the PlumeStop™ Remediation Technology

REGENESIS ~ 1011 Calle Sombra ~ San Clemente, CA 92673 ~ TELEPHONE: 949-366-8000

www.regenesis.com

## The Four PlumeStop Treatment Mechanisms:

**Dispersion, Sorption, Biodegradation and Regeneration**




### 1.) Dispersion within the Subsurface

PlumeStop is a liquid activated carbon™ material which consists of a very fine suspension of charged particles which resists clumping and has a water-like viscosity. As a result, PlumeStop is easily applied into the subsurface through gravity-feed or low-pressure injection.

To get more details on this topic read Technical Bulletin 1.1 PlumeStop Distribution Through Soil

### 2.) Rapid Sorption of Dissolved-Phase Contaminants

Upon reagent injection, target contaminants partition out of the aqueous phase and sorb onto the liquid activated carbon™ matrix, thereby removing mobile contaminants from the immediate risk pathway. Concentration of the contaminants in this manner, in a matrix conducive to degrader colonization and activity, results in a direct increase in the overall instantaneous rate of contaminant destruction.

To get more details on this topic read the white paper PlumeStop™ Colloidal Biomatrix: Securing Rapid Contaminant Reduction and Accelerated Bioremediation using a Dispersive Injectable Reagent

### 3.) Biodegradation of Contaminants within the Matrix

Once in place and with contaminants partitioned onto its surface, PlumeStop is colonized by contaminant-degrading bacteria. The net result is a substantial increase in the rate and extent of contaminant destruction.

To get more details on this topic read Technical Bulletin 3.1 PlumeStop Enhanced Biodegradation

### 4.) Regeneration of Sorption Sites for Long-Term Treatment

Enhanced biodegradation of contaminants within the biomatrix regenerates or frees up sorption sites allowing contaminants to further partition out of the groundwater. This allows a single application of PlumeStop to remain functional for an extended/ indefinite period of time.

To get more details on this topic read [Technical Bulletin 4.1 PlumeStop In Situ Regeneration]

**Chronology of a PlumeStop Project**

Below we provide the common steps of a PlumeStop project and an estimate of the timing to complete each step.

Step 1 - Data Evaluation, Design and Initial Proposal

Relevant data providing details of the problem to be remedied are submitted to REGENESIS. We review the data and work with you to develop a preliminary design and cost estimate proposal for PlumeStop treatment (as appropriate) along with a recommendation for any design verification sampling, pilot or bench testing to be completed (as needed).

*Timing* – typically proposals are submitted within 10 business days following receipt of a complete data package.

Step 2 –Design Verification, Pilot Testing (As needed) or Bench Testing (As Needed)

Often it is necessary to confirm design assumptions with a design verification step. Design verification usually involves: 1) a baseline groundwater sampling event from existing monitoring well network and, 2) the collection of soil cores from within the target treatment zone to visually assess the soils for permeable and no-permeable zones and, to confirm the vertical injection interval to be treated. In some cases, soil samples may be submitted to confirm concentration ranges within the target interval.

Commonly field-scale pilot tests are proposed to demonstrate proof of concept and/or to set performance expectations. Pilot test can be wide-ranging in terms of scope but often typically assess short-term performance of a PlumeStop application encompassing one or more test wells. If required, REGENESIS can work with you on developing a pilot test proposal and cost estimate to suit the project's needs.

Occasionally bench testing services are provided by our Research and Development laboratory to determine PlumeStop efficacy. These are very site-specific and typically involve non-common contaminants or suites of contaminants and/or non-typical site conditions.

*Timing* - Varies according to the services completed. Typically, several weeks are needed to complete this step from the notification to proceed.

Step 3 – Design Update

Following design confirmation, pilot or bench testing, any required updates to our proposal are submitted for your authorization.

*Timing* – Usually less than 5 business days are required to submit a revised proposal once we have received the information gained as part of Step 2.

Step 4 - PlumeStop Field Application

Once the PlumeStop treatment approach is authorized, REGENESIS Remediation Services (RRS) will coordinate the application and mobilize to the site to complete the work. RRS employs state-of-the-art injection delivery systems manned by professionally-trained scientists with specific expertise in all aspects of the PlumeStop technology. In the field, the RRS project team will conduct real-time biogeochemical distribution monitoring of PlumeStop while tracking and recording key parameters related to the application such as injection pressure, flow rates and volumes applied over the prescribed injection interval. These details are recorded and presented in an Application Summary Report to document the application.

*Timing* – The majority of field projects require less than 15 days in the field to complete. Larger projects with higher delivery volumes to attain may require longer.

Step 5 - PlumeStop Performance Monitoring and Project Closure

It is our desire to actively track and manage the performance aspects on each PlumeStop project. We encourage site project managers to share performance monitoring data with us so that we may assist with both understanding and communicating performance to project stakeholders. In most cases we provide these services at no additional cost to the project.

*Timing* – Significant reductions in contaminant concentrations often occur within days to weeks of a PlumeStop application. The time required to reach closure goals and demonstrate attainment of these goals is project specific. REGENESIS will work with you to assist in your efforts to attain project closure through use of the PlumeStop technology.

REGENESIS

PROJECT PROFILE

# PlumeStop™ Pilot Study: Former Electronics Facility in Indiana

***Rapid Treatment of Mixed Chlorinated Solvents in Groundwater to Non-Detect***

## Project Highlights

- 99.9% reduction in two months
- Combined remedy application reduced mixed VOC plume to non-detect within nine months (<5µg/L)
- Treatment areas being monitored for closure
- PlumeStop results are being evaluated for potential larger scale application

*PlumeStop field performance was evaluated at a former electronics facility in Indiana.*

## Project Summary

A pilot study evaluation of PlumeStop performance was conducted on a section of a mixed chlorinated solvent plume (cVOC) comprising trichloroethene (TCE - 1,390 µg/L) and 1,1,2-trichlorotethane (TCA, 3,550 µg/L) at a former electronics facility in Indiana. PlumeStop was applied in conjunction with the controlled-release electron donor, Hydrogen Release Compound (HRC®).

Post-treatment solvent concentrations in groundwater were reduced by 92% by the first sampling round (two weeks), 99% by the second sampling round (one month) and 99.9% by the third sampling round (two months). No cVOCs were detected above analytical thresholds (<5µg/L) after three months (study period nine months). Source area treatment activities are being monitored for closure and the results of the PlumeStop pilot test are being evaluated as a potential larger scale plume treatment option.

**Site Type:** Industrial

**Contaminant of Concern:** cVOCs

**Concentration:** 5,000 ug/L

**Remediation Approach:** Sorption-Enhanced In Situ Anaerobic Bioremediation

**Soil Type:** Silt/Sand

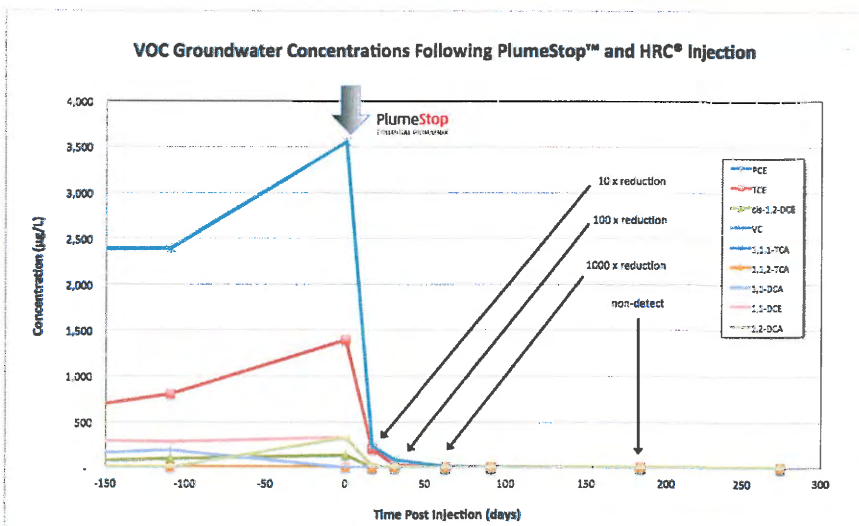
**Technology Used:** PlumeStop, HRC

## Remediation Approach

PlumeStop was applied perpendicularly to the groundwater flow using 10 direct-push injections around a central monitoring point. Approximately 180 pounds of HRC was applied into three injection points.

## Technology Description

PlumeStop is an innovative in situ remediation technology designed to rapidly reduce contaminant concentrations, stop migrating plumes, eliminate contaminant rebound, achieve stringent clean-up standards and treat back-diffusing contaminants. Plumestop provides a unique colloidal biomatrix platform which rapidly sorbs contaminants out of the dissolved-phase. Once contaminants are concentrated within the PlumeStop biomatrix, they can be completely biodegraded in place using compatible Regenesis bioremediation products.




HRC is a controlled release, electron donor material, that when hydrated is specifically designed to produce a controlled release of soluble lactate. The newly available lactic acid is highly efficient for the production of dissolved hydrogen to fuel anaerobic biodegradation processes in soil and groundwater.

REGENESIS

## CASE STUDY

# PlumeStop™ Application: Former Dry Cleaner in Marina, California

***Rapid Solvent Treatment to Non-Detect – Degradation Lines of Evidence***

## Project Highlights

- Depletion of groundwater solvent concentrations to non-detect within 19 days.
- 258 days post-treatment shows PCE <0.5 μg/L.
- Daughter products remain at non-detect post-application.
- Multiple lines of evidence for post-sorption solvent degradation.
- No generation of methane / competition from methanogens.

Combined remedies, including a PlumeStop application, decreased PCE levels to non-detect within 19 days.

## Remediation Approach

A PlumeStop performance evaluation was conducted on chlorinated solvent groundwater contamination at a former dry cleaner site. PlumeStop was applied in conjunction with the slow-release electron donor, Hydrogen Release Compound (HRC®) and the microbial bioaugmentation dechlorinator inoculum, BioDechlor INOCULUM Plus (BDI® Plus) for the treatment of residual PCE (550 μg/L). The application was conducted around a single well. Conditions prior to the test were aerobic (ORP +254 mV; DO 44%). Multiple parameters were monitored from groundwater samples to explore lines or evidence of solvent fate / degradation.

## Results

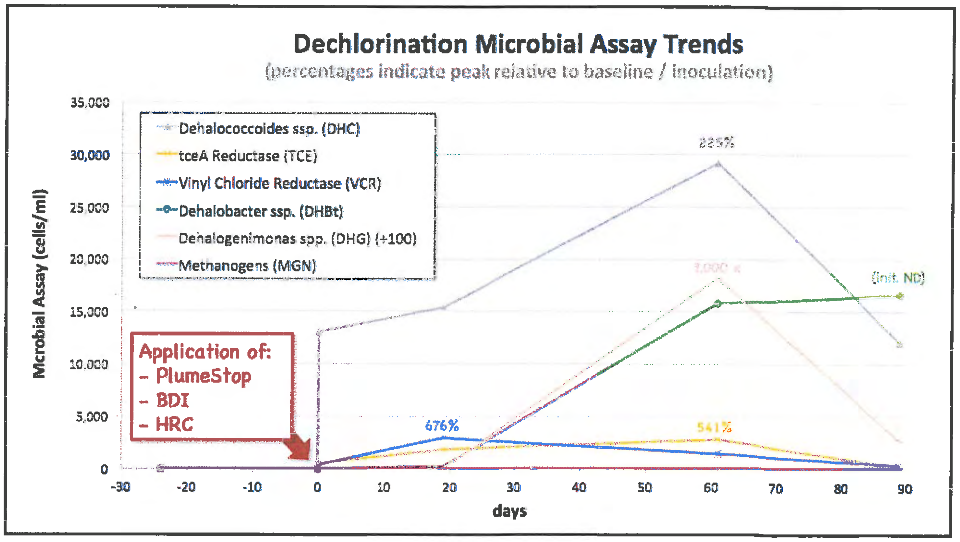
Post-treatment solvent concentrations in groundwater were reduced by over 99% to non-detect (<5μg/L) by the first sampling round (nineteen days). Microbial quantitative array data revealed marked increases in reductive dechlorinator species from baseline conditions in the months following reagent application (several hundred percent or more). (Baseline taken as immediately post-inoculation for species included in BDI). Moreover, functional enzymes for dechlorination of PCE through to ethene similarly increased over the same period (i.e. including specific genes for the degradation of TCE, DCE and vinyl chloride). Through this time, groundwater concentrations of PCE and daughter products remained below detection limits.

### Contaminant Concentrations Trends Pre- and Post-Application

| Analyte | | Baseline (-24 Days) | 19 Days | 33 Days | 61 Days | 89 Days | 160 Days | 258 Days |
|---|---|---|---|---|---|---|---|---|
| PCE | μg/L | 550 | <5 | <5 | <0.5 | <0.5 | <0.5 | <0.5 |
| Dissolved Oxygen | % | 44.5 | 6.5 | 5.1 | n/a | 0.5 | 0.5 | 0.5 |
| RedOx (ORP) | mV | 254 | -177 | -157 | n/a | -117 | -186 | -112 |
| Nitrate (as N) | μg/L | 6.6 | 5.1 | 3 | 0.7 | 3 | <0.5 | <0.5 |
| Dissolved Iron | μg/L | 0.77 | 0.56 | 5.1 | 6.5 | 4 | 6.5 | 8.2 |
| Sulfate | μg/L | 42 | 83 | 41 | 18 | 25 | <5.0 | 9 |
| Alkalinity | μg/L | 62 | 250 | 260 | 170 | 130 | 2200 | 250 |
| Carbon Dioxide | μg/L | 11 | 11 | 9 | 36 | 15 | 41 | 28 |
| Methane | μg/L | <0.001 | 0.0072 | 0.0011 | 0.12 | 0.16 | 0.56 | 2.1 |

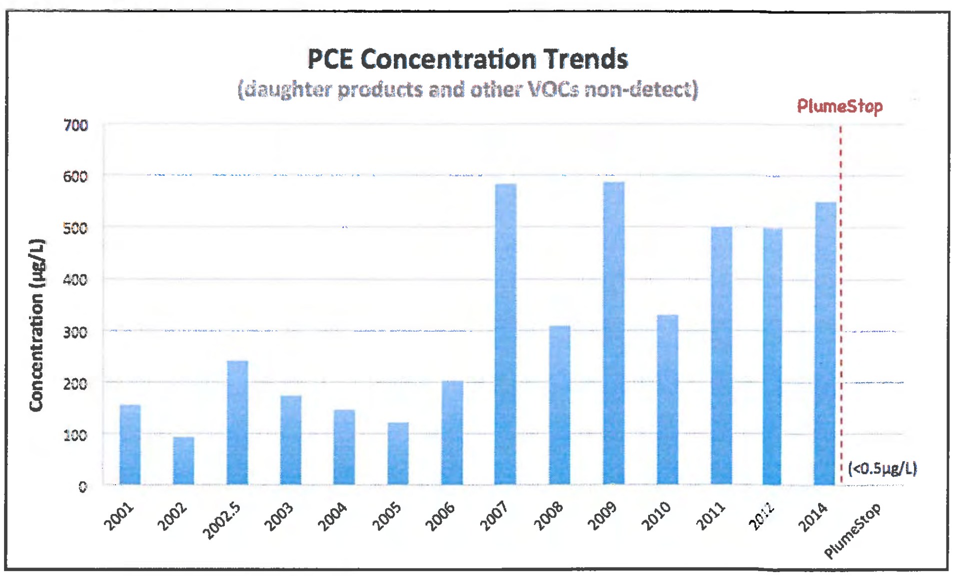
Electron donor status and redox potential post-application quickly stabilized at near-optimal conditions ( 150mV +/- 30 mV), with rapid decreases in competing electron acceptors observed within the first sampling intervals, albeit with some interplay with available iron, possibly reflecting an electron-shuttle dynamic with iron naturally present within the formation. The redox remained below methanogen activity thresholds – methanogen numbers did not share the trends observed in dehalorespirers, and in fact were detected above quantitation thresholds (2 – 30 cells /ml) in one sampling event only, at significantly lower cell counts than Dehalococcoides (94 vs. 12,200 cells/ml).

## Discussion




The continued expansion and proliferation of an active dechlorinating microflora in the months following inoculation are indicative of solvent biodegradation through this time. The fact that no solvent was present above detection limits in groundwater through the same period would indicate the degradation to be proceeding ostensibly from the sorbed-phase (i.e. PlumeStop/water interface). This would be consistent with the PlumeStop bio-matrix hypothesis. It is also of note that the dechlorinator numbers and activity peaked at approximately sixty days and declined thereafter. Although the data set is limited, this trend would be consistent with the presumed depletion of the solvent through degradation, the starting concentration having been only 550 µg/L.

## Conclusions




Data provide lines of evidence for post-sorption degradation of the target solvents on the PlumeStop, and would further indicate that methanogenic conditions are not necessary for complete reductive dechlorination activity through to ethene. Moreover, all data were obtainable from groundwater samples presenting a straightforward means of performance tracking via wells using the lines of evidence approach.

REGENESIS

PROJECT PROFILE

# PlumeStop™ and Combined Remedies Reduce PCE One Month Post-Application

*Request for Site Closure Submitted for Wisconsin Industrial Dry Cleaning Facility*

## Project Highlights

- Multiple chlorinated solvent USTs located on-site with releases dating back to 1970s
- Combined remedy approach included in situ soil mixing and PlumeStop application into deep groundwater plume
- Contaminant concentrations reduced to remediation goals one month post-application
- Request for site closure submitted

**Site Type:** Industrial Dry Cleaning

**Contaminant of Concern:** PCE

**Remediation Approach:** In Situ Chemical Oxidation, Sorption, Biodegradation, Bioaugmentation

**Treatment Area:** 16,000-Square-Feet

**Soil Type:** Clay

**Technology Used:** PlumeStop, RegenOx, HRC, BDI Plus

## Project Summary

An industrial dry cleaning facility in West Allis, Wisconsin was equipped with multiple underground storage tanks (USTs) which stored the degreasing agent perchloroethylene (PCE). The UST releases date back to the 1970s and created a treatment area of approximately 4,500 square feet. An in-situ, combined remedies treatment approach was implemented on-site using a range of reagents including PlumeStop™, RegenOx®, Hydrogen Release Compound (HRC®) and BioDechlor INOCULUM Plus (BDI® Plus). As this site was planned for future development, the remediation approach was designed to achieve site closure by removing the residual source in the vadose zone and treating the deep groundwater plume.

## Remediation Approach

Starting in the residual source area, RegenOx in situ chemical oxidation (ISCO) was applied via soil mixing down to a depth of 7 feet below ground surface. The ISCO program was designed to treat a total of 140 tons of PCE-impacted clay soil with initial concentrations measuring 169 mg/kg and a remediation goal of < 14 mg/kg.

To address the deep groundwater plume with PCE concentrations as high as 13,800 ppb, fast-acting, PlumeStop was applied through a series of deep injection wells approximately 80 to 95 feet below ground surface. The use of PlumeStop allows remediation practitioners to quickly-reduce concentrations over a wide-area with the long-term assurance of biodegradation. HRC and BDI Plus were co-applied with PlumeStop (a common and recommended practice) to enhance the biodegradation process. Concentrations were reduced to the remediation goal one month post-application. A request for closure has been submitted.

## Technology Description

RegenOx is an advanced chemical oxidation technology that destroys contaminants through powerful, yet controlled chemical reactions and not through biological means. This product maximizes in situ performance while using a solid alkaline oxidant that employs a sodium percarbonate complex with a multi-part catalytic formula.

PlumeStop is an innovative in situ remediation technology designed to rapidly reduce contaminant concentrations, stop migrating plumes, eliminate contaminant rebound, achieve stringent clean-up standards and treat back-diffusing contaminants. Plumestop provides a unique colloidal biomatrix platform which rapidly sorbs contaminants out of the dissolved-phase. Once contaminants are concentrated within the PlumeStop biomatrix, they can be completely biodegraded in place using compatible Regenesis bioremediation products.

HRC is a controlled release, electron donor material, that when hydrated is specifically designed to produce a controlled release of soluble lactate. The newly available lactic acid is highly efficient for the production of dissolved hydrogen to fuel anaerobic biodegradation processes in soil and groundwater.

Bio-Dechlor INOCULUM Plus is an enriched natural microbial consortium containing species of Dehalococcoides sp. (DHC). This microbial consortium has since been enriched to increase its ability to rapidly dechlorinate contaminants during in situ bioremediation processes.

REGENESIS

PROJECT PROFILE

# Combined Remedies at Brownfield Site Reduces TCE by 98% within 30 Days

## Rapid Treatment and Timely Project Execution Keeps Large Chicago Redevelopment on Track

## Project Highlights

- Downtown Chicago site planned for multi-million dollar redevelopment
- Manufacturing operations caused cVOC impacts in groundwater of up to 6500 ug/L
- Redevelopment schedule required effective treatment with timely implementation
- Monitoring wells indicated >98% reduction of TCE 30 days post treatment

Direct-injection of PlumeStop™

## Project Summary

This site, located in the heart of downtown Chicago, was impacted by chlorinated solvents used for a range of manufacturing activities that took place on site over many decades. The site was planned for redevelopment as an urban event center and sports arena. Regenesis Remediation Services (RRS) was contracted to treat the chlorinated solvents over an area of approximately 13,370 $ft^2$ in size and pave the way for redevelopment activities. An effective combination of PlumeStop™, Hydrogen Release Compound (HRC®) and a bioaugmentation culture BDI® Plus was planned for application to achieve the remediation targets.

Site Type: Former Industrial

Contaminant of Concern: cVOCs, TCE

Remediation Approach: Sorption, Biodegradation, and Bioaugmentation

Treatment Area: 13,370 sq. ft.

Soil Type: Silty Sand, Clay

Technology Used: PlumeStop, HRC, BDI Plus

## Remediation Approach

With the goal of reducing cVOC concentrations as high as 6500 ug/L in groundwater; PlumeStop, HRC, and BDI Plus were successfully applied by RRS within the defined treatment zones and intervals. A total of 54,400 lbs. of PlumeStop, 7,410 lbs. of HRC and 81 L of BDI Plus were injected through 138 direct-push injection points. The remediation chemistry was applied as either a 7.5% or 10% solution depending on the treatment zone. Execution and time was important on this project due to a rigid development schedule. The client needed a quick and permanent remedy to achieve stringent target levels. RRS was able to complete the work as scheduled during the winter to allow for a spring construction schedule.

At 30 days post-application, the two primary treatment performance wells observed 82% and 97% reduction in total cVOCs and >98% reduction of TCE. Additionally, at 30 days, DHC sp. count and functional genes of the anaerobic metabolic pathways increased significant from baseline measurements as determined by QuantArray® analysis. This suggests that not only is contaminant sorption occurring, but that biodegradation is happening as well. The project is ongoing, with monitoring results being collected monthly.

## Technology Description

PlumeStop™ Liquid Activated Carbon™ is composed of very fine particles of activated carbon (1-2µm) suspended in water through the use of unique organic polymer dispersion chemistry. Once in the subsurface, the material behaves as a colloidal biomatrix binding to the aquifer matrix, rapidly removing contaminants from groundwater, and expediting permanent contaminant biodegradation.

HRC® is a controlled release, electron donor material, that when hydrated is specifically designed to produce a controlled release of lactic acid. The newly available lactic acid is critical for the production of hydrogen to fuel anaerobic biodegradation processes in soil and groundwater.

Bio-Dechlor INOCULUM® Plus is an enriched natural microbial consortium containing species of Dehalococcoides sp. (DHC). This microbial consortium has since been enriched to increase its ability to rapidly dechlorinate contaminants during in situ bioremediation processes.

## Scope of Services

RRS is a dedicated team of scientists and engineers whose primary function is to provide environmental firms with specialized groundwater and soil remediation planning, design, and application services. Application services include:

- Hands-on field application management and supervision
- Knowledge and experience to make adjustments as necessary
- Real-time distribution and influence monitoring
- Detailed documentation and record keeping
- Partnership with experienced contractors to advance tooling
- Post application reporting and performance review
- Site Specific Health and Safety Plan
- Use of high resolution site characterization tools (available on request)

## Specialized Injection Equipment & Trailers

RRS prepares and applies our remedial technologies via state-of-the-art injection trailers. These fully enclosed self-sufficient injection trailers are configured for the purpose of handling and delivering our remediation technologies. Each trailer contains the following components:

- Complete drain conical mixing tanks
- Vortex/Cyclone mixers
- Application pumps
  - -Variable flow rates (up to 20 gpm)
  - -Variable pressures (up to 500 psi)
- Multiple fluid delivery lines
- Self-sufficient, dedicated power source
- Specialty injection tips
- Slip resistant and chemical resistant flooring
- In-line flow meters and pressure gauges
- Pressure bypass controls
- Emergency eyewash and First-Aid station

## Reporting Deliverables

During on-site activities, RRS documents noteworthy observations, real-time monitoring, and application delivery information. Application delivery information such as start/stop times, injection intervals, flow rates, pressures, total gallons, gallons per intervals, etc. are documented for each injection point. This information is then provided in a comprehensive application summary report which typically includes a written document detailing the remediation project, spreadsheet of information collected in the field, and a site map.

REGENESIS
REMEDIATION SERVICES
Technology-Based Solutions for the Environment

**RRS Assumptions and Qualifications**

- Client personnel will take delivery of the remediation chemistry prior to RRS mobilization and arrange for secure storage where the material will not be significantly affected by inclement weather. If material is stored off-site, Client personnel will coordinate the delivery of the material to the site.
- Product cost, freight and sales tax are included with the RRS pricing. Pricing valid for 90 days.
- Client will locate the product within 10 feet of the RRS injection trailer during application activities.
- RRS will collect project related refuse, empty treatment chemistry containers and used PPE on a daily basis to keep the site clean. This nonhazardous refuse will be placed in the Client's refuse container on-site for disposal.
- A high volume water source (e.g. hydrant) capable of producing at least 30 gpm will be available to RRS for the duration of the project within 300' of the project staging area, at no cost to RRS. RRS will supply 300 linear feet of 1.5 inch National Standard Thread fire hose.
- RRS will have access to the site for equipment operation and secure storage of materials and equipment.
- Client will provide field water quality meter similar to a YSI 556 with a down-hole sensor capable of reaching the water table and groundwater level meter while on-site for injection activities.
- Client is responsible for securing any permits prior to mobilizing to the site.
- Client is responsible for all soil, air and groundwater sampling and analysis.
- Client is responsible for transportation and disposal of any contaminated waste generated on-site during injection activities, though we do not anticipate generating any such waste during direct push injection activities.
- For safety reasons, access to the treatment area will be limited to RRS and Client personnel.
- The proposed quantity of reagents can be delivered to the treatment area without significant surfacing/short-circuiting via the prescribed number of injection points. RRS will take precautions to prevent surfacing, but if surfacing occurs, RRS is not responsible for any treatment chemistry infiltration into undesired locations.
- RRS will call in a public utility locate for the area in or near the injection zone. Private utility locates, if determined necessary, will be the responsibility of Client. RRS is not responsible for damage to any unknown or unmarked utilities. If as-built drawings are available for any on-site subsurface features, RRS request the right to review to confirm clearance for the advancement of DPT injection points.
- RRS personnel will have access to the site for work up to 12 hours per day Monday through Saturday.
- Proposal assumes probing and drilling will begin at ground surface. If hand augering, concrete coring or air knife services will be required, additional charges will apply.
- All injection point will be closed/backfilled with bentonite to ground surface by RRS. Additional costs associated with restoration of the ground surface have not been included. If restoration of the ground surface is needed, additional charges will apply.
- In generating this preliminary estimate, Regenesis relied upon professional judgment and site specific information provided by others. Using this information as input, we performed calculations based upon known chemical and geologic relationships to generate an estimate of the mass of product and subsurface placement required to affect remediation of the site.

PSA Environmental
LEE'S SUMMIT, MO.

*1625 Southeast Decker Street*
*Lee's Summit, Missouri 64081*

*Phone: (816) 525-7483 / Fax: (816) 525-7103*
*Email: bill.wilson@psaenvironmental.com Web: www.psaenvironmental.com*

August 17, 2015

To: Kenny Hemmen
At: Geotechnology, Inc.
Re: St. Louis, MO Site

From: William V. Wilson
At: PSA Environmental

| *DESCRIPTION* | *QNTY.* | *ITEM DESC.* | *UNIT PRICE* | *AMOUNT* |
|---|---|---|---|---|
| **Mobilization/Demobilization: Rig** | 494 | Round Trip Per Mile | $1.50 | $ 741.00 |
| **Support Truck Only** | 14 | Per Trip | $550.00 | $ 7,700.00 |
| **Per Diem: Crew of One (1)** | 120.0 | Per Day | $150.00 | $ 18,000.00 |
| **Geoprobe® 6620 Track Unit and All Tooling, Crew of One (1):** Includes: Advancement/Retraction of 1.5" Probe Rods | 120 | Per Day | $2,750.00 | $ 330,000.00 |
| *Per Day Rate Includes: Rig, Operator, DP800 Injection Pump and Hose, Two Sets of Rods String Tooling, Expendable Points and Bentonite Backfill.* | | | | |
| **MDNR Abandonment Report:** | 1 | Per Site Address | $70.00 | $ 70.00 |
| **Utility Locates:** | 1 | Per Site Address | $45.00 | $ 45.00 |
| **Additional Items @ No Charge:** *Includes: Power Decon System* *GPS System* | | | | |
| **ESTIMATED TOTAL** | | | | **$ 356,556.00** |

# APPENDIX C

## AIR STRIPPING TREATMENT COST INFORMATION
## QED ENVIRONMENTAL SYSTEMS

QED Environmental Systems

**Quote No:** T-01216, Aug 19, 2015

**Site Reference:** St. Louis Landfill

**Prepared For:**
Vince Epps
314-997-7440
v_epps@geotechnology.com

GEOTECHNOLOGY INC
11816 LACKLAND RD
SUITE 150
ST LOUIS, MO 63146-4263
USA

**Represented By:**
Bill Reetz, A-Better Earth
785-764-1674
bill@abetterearthllc.com

Prepared By:
Dave Fischer
800-624-2026
dfischer@qedenv.com

| QTY | PART NO. | DESCRIPTION | UM | UNIT PRICE | EXTENSION |
|---|---|---|---|---|---|
| 2 | EZ-96.4SS | EZ-96.4SS Tray air stripper assembly, 4 tray 10-1000 GPM. This EZ-Tray series 96 unit has a flow rate of 10-1000 GPM, 304 stainless steel trays and shell with integral sump. INCLUDES: 4 tray levels, see-through front hatch, polypropylene de-mister, liquid level sight gauge and sump pressure gauge. Note: This price does not include the blower. | EA | 134,995.00 | 269,990.00 |
| 2 | 807329 | Blower, pressure / mfg. New York Blower. Motor: 60 hp, 460 volt, 3-phase, TEFC. Inlet: 12" OD - discharge: 12" flange 150 lb. class. Standard on a EZ-96.X stainless steel. | EA | 8,700.00 | 17,400.00 |
| 2 | EZ-LOWP | Kit, blower low air pressure sump switch (explosion-proof). Includes: (1) EZPLOW pressure switch, tubing & fittings. | EA | 230.00 | 460.00 |
| 2 | BLKIT12 | Blower piping kit, 12" PVC SCH40 pipe & flange (150# class). Designed for EZ-48.x, EZ-72.x, and EZ-96.x stainless steel series air strippers. Blower to sump piping kit for QED skid mounted systems. | EA | 2,200.00 | 4,400.00 |
| 2 | EZ-HIGHLV | Sump high level float switch kit (non-exp). Includes: (1) 800065 warrick float switch & (1) cord strain relief. Note: Requires intrinsically-safe relay for explosive environments. QED p/n CPIS. | EA | 155.00 | 310.00 |
| 2 | T1000753 | Pump, transfer / mfg. Goulds - SSH series. 1000 GPM @ 75TDH, 30hp, 460V, 3-phase, TEFC. Pump material: 316L / Viton. Suction: 4" 150# flange - discharge: 6" 150# flange. | | 7,853.00 | 15,706.00 |
| 2 | 23SHIN | Feed pump plumbing kit, 500-1000 GPM system. Designed for QED skid mounted EZ-Tray air strippers. Feed pump to air stripper includes: 4" hose, fittings, pressure gauge, check valve, ball valve and sample port. | | 6,250.00 | 12,500.00 |

| | | | | | |
|---|---|---|---|---|---|
| 2 | EZ-DIS | Sump discharge pump float switch kit. Includes: (1) 800065 warrick float switch & (1) cord strain relief. Note: Requires intrinsically-safe relay for explosive environments. QED p/n CPIS. | EA | 155.00 | 310.00 |
| 2 | T1000753 | Pump, transfer / mfg. Goulds - SSH series. 1000 GPM @ 75TDH, 30hp, 460V, 3-phase, TEFC. Pump material: 316L / Viton. Suction: 4" 150# flange - discharge: 6" 150# flange. | | 7,853.00 | 15,706.00 |
| 2 | 23SHDS | Discharge pump plumbing kit, 500-1000 GPM system. Designed for QED skid mounted EZ-Tray air strippers. AS sump to discharge pump includes: 4" hose, fittings, pressure gauge, check valve, ball valve and sample port. | | 6,295.00 | 12,590.00 |
| 2 | SCPAS-96.X | CONTROL PANEL STANDARD DESIGN: Control panel is weatherproof (UL, NEMA 4 rating), with air stripper blower motor starter, HOA switch, green running light, red stripper sump high level alarm light, red low air pressure alarm light, circuit breakers and relays for controlling stripper and main disconnect. Unless otherwise indicated, the QED panel will control only the equip listed in this quote. NOTE: If site is Class I Division I or II, the control panel must be remote mount. | | 15,250.00 | 30,500.00 |
| 2 | 807303 | Skid, side mount platform for EZ-72.x & 96.x series air stripper ancillary equipment. Material: welded steel construction with forklift access holes. Finish: skid & chemically resistant polyurea coating. Designed for blower, (2) pumps, and control panel. | EA | 2,900.00 | 5,800.00 |
| 2 | EZ-L6 | LABOR, Assembly of QED Skid mounted Air Stripper systems. Standard on EZ-72.X, EZ-96.X Stainless Steel Air Strippers. | | 1,825.00 | 3,650.00 |
| 2 | 95167 | O & I EZ TRAY BOX | EA | 0.00 | 0.00 |
| | | | | **TOTAL** | **389,322.00** |

**OPTIONAL ITEMS:**

| | | | | |
|---|---|---|---|---|
| 2 | HD96 | Hinged Door Option for 96 Series Air Strippers *Hinged door are track mounted to air stripper shell and feature a swing out design.* | 7,800.00 | 15,600.00 |
| 2 | ST96.4 | EZ-96.4 SS Air Stripper Split Tray Option | 7,200.00 | 14,400.00 |

| | | | | | |
|---|---|---|---|---|---|
| | | *Split tray components reduce tray weight to below 35lbs and component length to ~3ft. This facilitates easier handling and maintenance of the air stripper trays.* | | | |
| 2 | 807385 | GRAVITY DRAIN 10 SKID ASSY<br>*Liquid discharge flow regulator vessels. 304 L stainless steel construction. Flanged connection from air stripper sump to vessel / flange out from vessel. Stabilizes sump volume and sump pressure.* | EA | 4,610.00 | 9,220.00 |

**TERMS & CONDITIONS:** Payment Terms: NET 30

Estimated Shipping Time: 8 - 12 weeks after receipt of Purchase Order and subsequent customer approval of engineering submittal package, unless custom equipment is included in the order. Final delivery date will be determined upon return of technical submittal package. A copy of your purchase order with a 30% deposit is required upon placing order. Balance owed is due within 30 days of invoice date. A service charge of 1% per month will be applied on all past due invoices. Pricing is valid for 30 days and all prices are in U.S dollars. Unless shown as separate line item (s), total price shown DOES NOT include applicable sales tax or shipping & handling charges. Applicable sales taxes, shipping & handling charges will be added to the invoice. Estimates available upon request. All shipments are FOB Dexter, MI, USA. Handling & off-loading of the air stripper unit is the responsibility of the buyer upon delivery. After seller accepts, NO order may be cancelled without Seller's written authorization and consent. Cancellation, if approved, is subject to reasonable restocking and / or handling fee. All products will be returned freight prepaid to Seller's facility.

Accepted by: ______________________ Title: ______________________

Print Name: ______________________ Company: ______________________

PO Number: ______________________ Date: ______________________

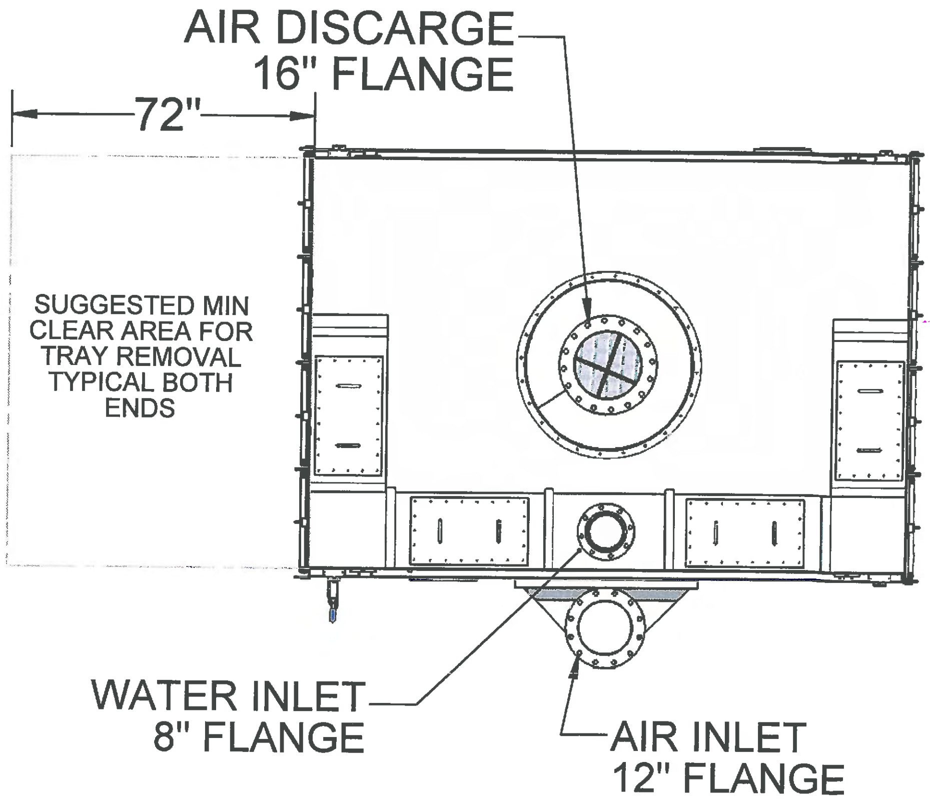
[ ] Check box if this order is necessary to your (or another contractors) contract with the federal government.

When placing orders, please make paperwork out to: QED Environmental Systems, Inc.

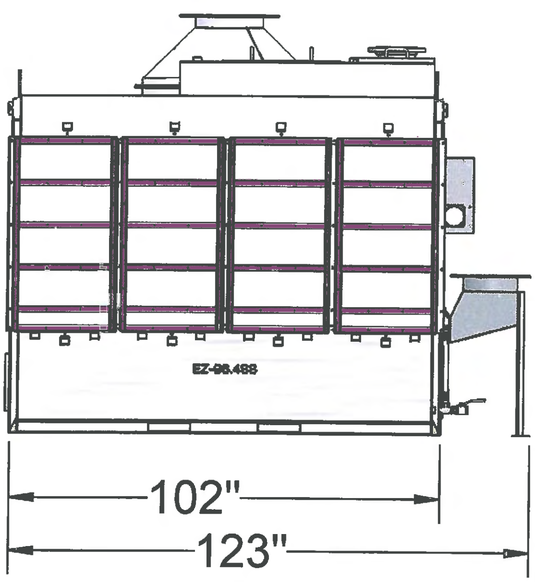
Mailing Address:
PO Box 3726
Ann Arbor, MI, 48106

Remit To Address:
PO Box 935668
Atlanta, GA 31193-5668

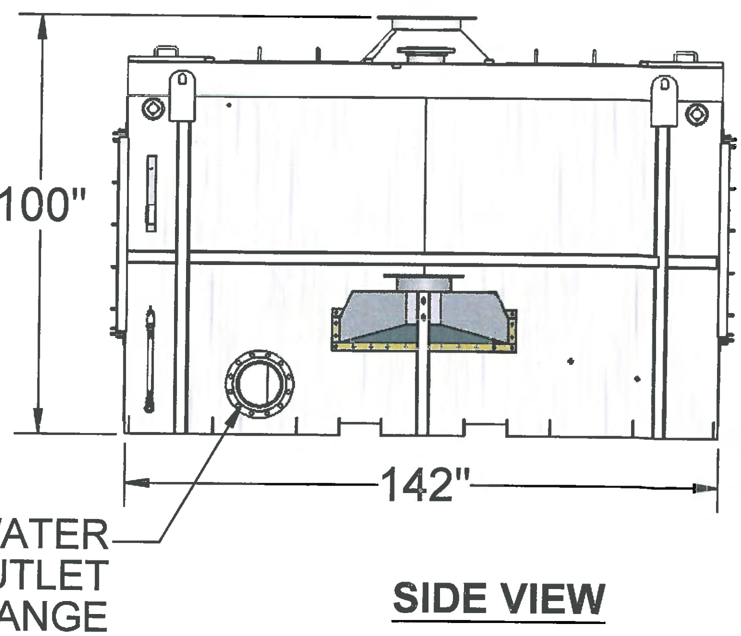
TOTAL BEING APPROVED $389,322.00




**PLAN VIEW**




**FRONT VIEW**




**SIDE VIEW**

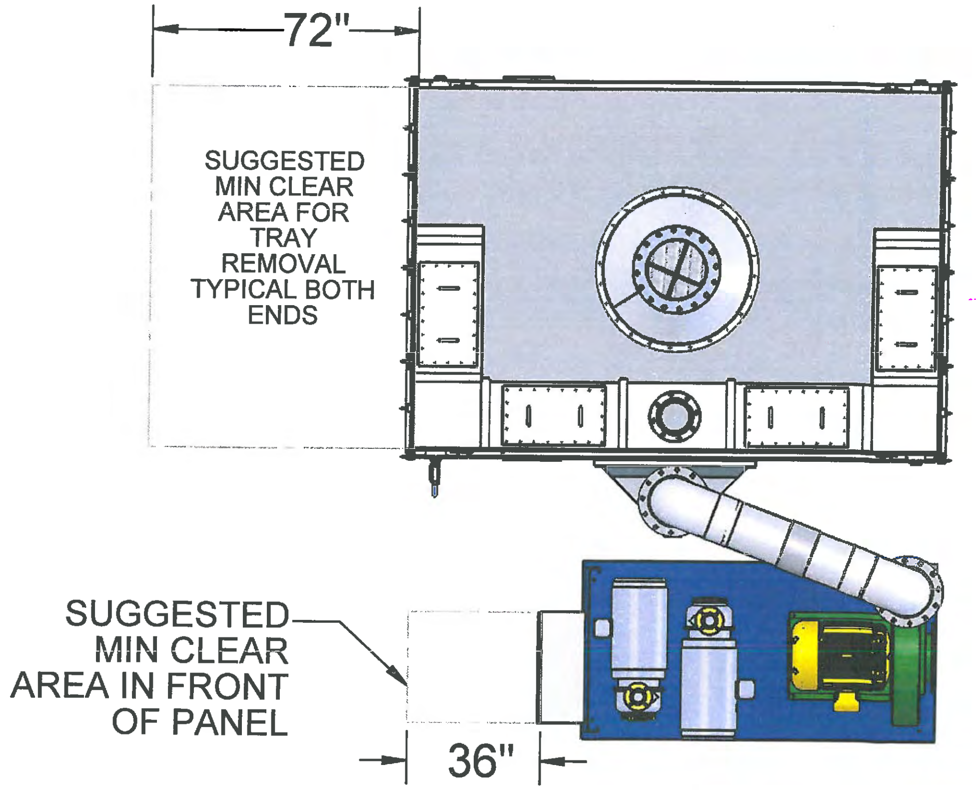
# EZ-96.4SS (AIR STRIPPER ONLY)

FOR MORE SPECIFICATIONS CLICK ON:

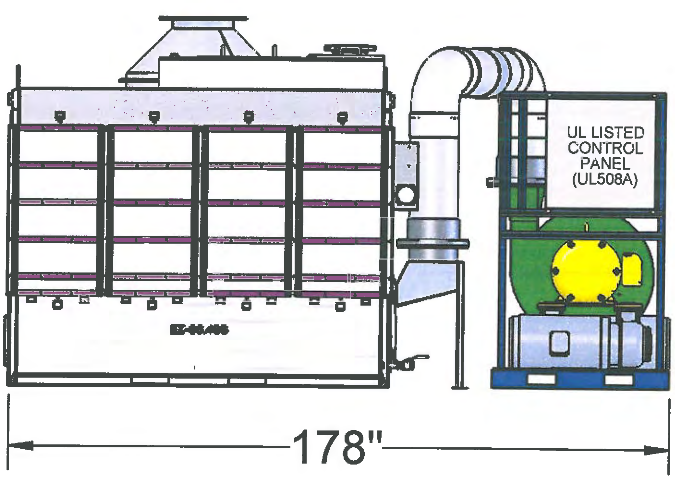
http://www.qedenv.com/Products/Airstrippers_VOC_Removal/Air_Stripper_Specifications/

NOT TO SCALE

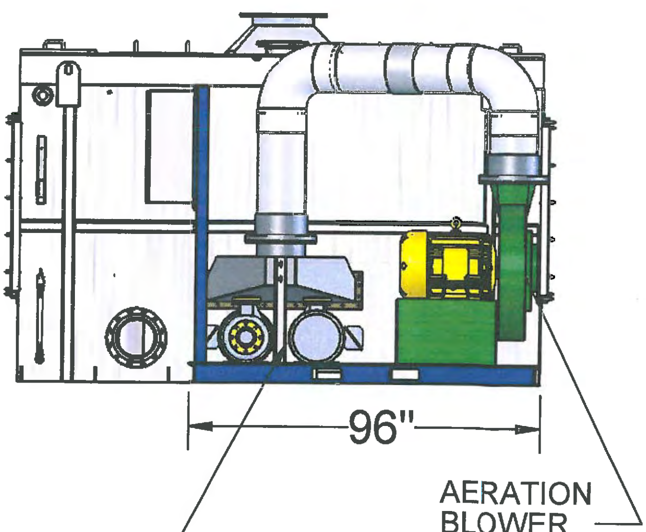
*NOT FOR CONSTRUCTION, FOR REFERENCE ONLY*




PLAN VIEW




FRONT VIEW




SIDE VIEW

WATER INLET AND DISCHARGE PUMPS
(TYPICALY 2" NPT CONNECTIONS)

# EZ-96.4SS

EXAMPLE OF A SKID SYSTEM WITH CONTROL PANEL, PUMPS, AND BLOWER
CONTACT QED FOR INFORMATION ON ALL OPTIONS.
NOT TO SCALE

*NOT FOR CONSTRUCTION, FOR REFERENCE ONLY*

# APPENDIX D

## GROUNDWATER CONTAINMENT WALL
## HAYWARD BAKER INC.

## Hemmen, Kenny

| | |
|---|---|
| **From:** | Hill, Jeff <JRHill@HaywardBaker.com> |
| **Sent:** | Friday, August 14, 2015 10:45 AM |
| **To:** | Hemmen, Kenny |
| **Subject:** | RE: Hayward Baker Trench Soil Mixing Project at OCI |
| **Attachments:** | TRD Brochure.pdf |

We have discussed this a bit further, The best solution would be the TRD wall method. The 100' length is getting beyond other less expensive techniques. Other techniques that our suitable will be more expensive than the this one.

Attached is a brochure. You can follow a link to a video as well

https://www.youtube.com/watch?v=BpgN8c2M1lg

This technique will easily reach the 100' depth and key into weathered rock. Cost is approximately $30 to 35 / sq ft plus mobilization. Permeability of 10 minus 6 / 7 should not be an issue. Wall would be in the neighborhood of 20" thick. Continuous without seams.

32.50 ave.

**Jeffrey R Hill, PE** | Director
**Hayward Baker Inc.** | www.HaywardBaker.com
tel: 847-343-2023 | email: jrhill@HaywardBaker.com

THINK SAFE

**From:** Hemmen, Kenny [mailto:K_Hemmen@geotechnology.com]
**Sent:** Friday, August 14, 2015 10:22 AM
**To:** Hill, Jeff <JRHill@HaywardBaker.com>
**Subject:** RE: Hayward Baker Trench Soil Mixing Project at OCI

Thanks Jeff for your time to discuss the hydraulic barrier project.

I look forward to receiving a very brief written follow-up summarizing unit costs.

Have a good weekend,

PARTNERSHIP SAFETY OPPORTUNITY INTEGRITY RESPONSIVENESS QUALITY

**Kenny J. Hemmen, RG, CGWP**
**Senior Project Manager**
**GEOTECHNOLOGY, INC.**
11816 Lackland Road, Suite 150
St. Louis, MO 63146-4237
(314) 997-7440 phone
(314) 452-8157 cell
(314) 997-2067 fax
www.geotechnology.com
**Please consider the environment before printing this email.**

**From:** Hill, Jeff [mailto:JRHill@HaywardBaker.com]
**Sent:** Thursday, August 13, 2015 3:17 PM
**To:** Hemmen, Kenny
**Subject:** FW: Hayward Baker Trench Soil Mixing Project at OCI

Here is a bit of info on a job we just finished in the mining sector in Montana

**Jeffrey R Hill, PE** | Director
**Hayward Baker Inc.** | www.HaywardBaker.com
tel: 847-343-2023 | email: jrhill@HaywardBaker.com

THINK SAFE

**From:** Gallet, Phillip
**Sent:** Wednesday, July 1, 2015 5:05 PM
**To:** cowant@cdmsmith.com
**Cc:** Hill, Jeff <JRHill@HaywardBaker.com>
**Subject:** Hayward Baker Trench Soil Mixing Project at OCI

Terry,

Attached is the plan, a picture and a video from the OCI project that Jeff mentioned to you.

Also, I attended the MRL Golf Outing last weekend and have to say that it was great time (though very hot). I will let you know next time I am up that direction and we can meet up for lunch.

Best Regards,

**Phillip A. Gallet, E.I.T.** | Project Manager
**Hayward Baker Inc.** | www.HaywardBaker.com
11575 Wadsworth Blvd | Broomfield, CO 80020
tel: 303.469.1136 | fax: 303.469.3581 | cell: 713-591-5396
email: pagallet@HaywardBaker.com

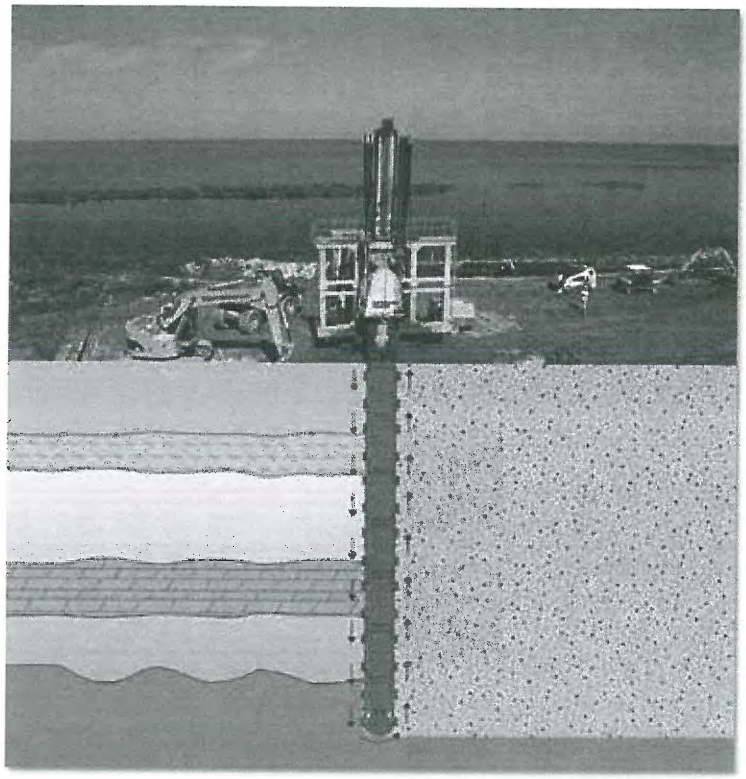
THINK SAFE

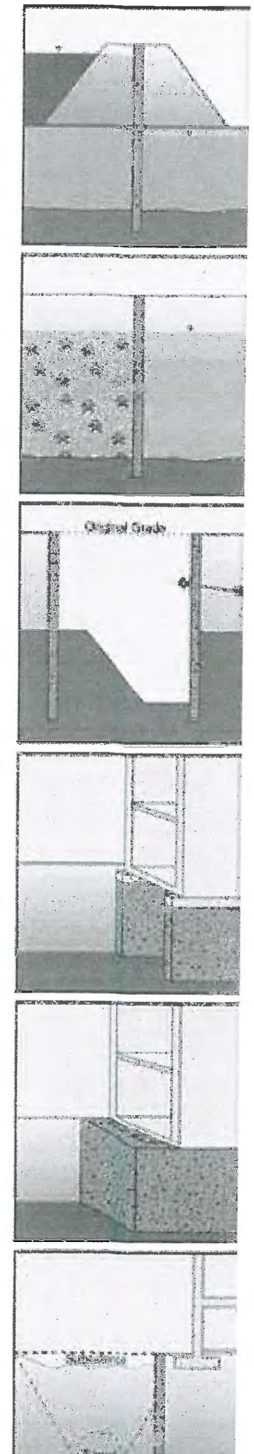
HAYWARD BAKER INC.

# TRD SOIL MIX WALLS

**Trench cutting and remixing deep (TRD) soil mix walls are mixed-in-place walls that address many geotechnical challenges, using a specialized vertical cutter post mounted on a base crawler machine.**

*The TRD method is unique in its ability to construct deep walls with a low height, low center of gravity rig.*





The Trench cutting and Remixing Deep (TRD) wall method is a relatively quiet, clean and compact technique developed in Japan for constructing an engineered, continuous in situ soil mix wall. The TRD machine advances horizontally along the wall alignment while the cutter post cuts and mixes the in situ soil with cement-based binder slurry. The full-depth vertical cutter post resembles a giant chain saw, which vertically blends the entire soil profile, eliminating any stratification and creating a near homogenous soil mix wall with low permeability. The TRD method produces the most uniform wall of any soil mixing process, with certainty of continuity in deep, challenging soil conditions.

Hayward Baker Inc. (HB), North America's leader in geotechnical construction, is committed to providing the most economical solution that satisfies the technical requirements of each project. Whether a situation is typical or unique, we have the experience and innovation to assist engineers, contractors and owners with identifying and implementing the best solution. For a variety of subsurface and access conditions, the TRD method of soil mixing may be the answer.

HAYWARD BAKER
Geotechnical Construction
KELLER

THINK SAFE

# Technology & Applications . . .

The TRD method is a relatively quiet, efficient way to construct continuous soil mix walls. Wall widths range from 22 to 33 inches (0.5 to 0.8 meters), and depths up to 180 feet (55 meters) have been constructed in nearly all subsurface conditions from soft organics to cobbles and some rock formations.

### Groundwater Cutoff Walls

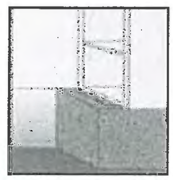
Seepage and erosion through levees, dams, and reservoir perimeters can be averted with TRD soil mix walls.

### Foundation Support

Soft soils beneath planned structures can be reinforced with TRD walls to reduce settlement and increase bearing capacity.

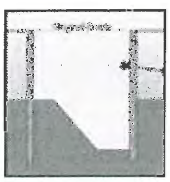
### Pollution Control

The TRD wall method provides containment structures for subsurface contaminants or barriers to protect against migration from off-site sources, and freshwater aquifers can be protected from saltwater intrusion.



### Liquefaction Mitigation

When used to construct cells, TRD soil mix walls can remediate liquefiable soils beneath planned structures such as buildings, port facilities, tank foundations, dams, and levees.



### Earth Retention & Excavation Support

Excavations for construction of below grade structures such as parking facilities, highways, subway stations, treatment plants, and others require perimeter earth retention, which TRD walls can provide.

### Subsidence Isolation

Subsurface construction activities such as tunneling and mining operations can loosen overlying soils and result in settlement of adjacent structures. TRD walls can be constructed between the subsidence source and the structures as a preventive measure.

① 

② 

③ 


④ 

⑤ 

① *Support for a planned excavation adjacent to apartment buildings provided by a TRD earth retention wall.*

② *Groundwater lowering beneath railway tracks during adjacent construction dewatering is prevented by a TRD cutoff wall.*

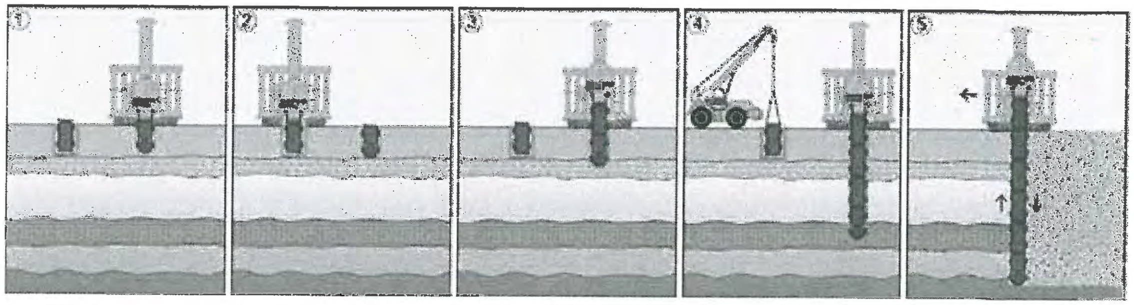
③ *Seepage and piping through a levee is prevented by construction of a TRD cutoff wall.*

④ *A TRD cutoff wall is constructed through a profile of limestone and clay beneath the centerline of a planned dam.*

⑤ *TRD wall grid constructed to provide liquefaction mitigation for a planned structure.*

HAYWARD BAKER
Geotechnical Construction

# Procedures & Design Considerations . . .

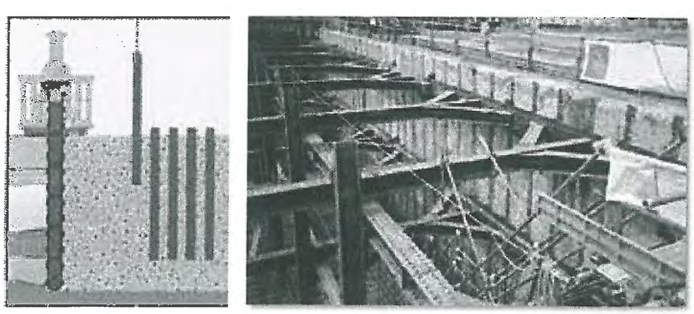


### TRD Method Procedures

The TRD base machine first connects to the idler post section (bottom section of post), which has previously been placed in an adjacent cutter post box. The machine is then moved to the starting position of wall construction. Vertical cutting then begins by starting chain rotation as the idler post is lowered into the soil ①. The TRD base machine is then disconnected from the idler post and moved back to the cutter post box where it is connected to the next section of post ②. The base machine then moves back to the starting position and connects this cutter post section to the previously installed idler post ③. The process is repeated with additional sections of cutter post ④ until the required depth is reached. The cutter post box is then removed and wall construction begins. The post is advanced horizontally along the wall alignment while the cutter chain cuts and mixes the in situ soil with cement-based binder slurry injected through ports near its tip ⑤. Conventional soil mixing techniques mix the soil in situ at its natural elevation. Therefore, the properties of the wall vary as different strata are encountered. The revolving TRD cutter chain creates a circulation of cut soil (or soil and rock) and injected slurry, vertically mixing the entire profile, eliminating the pre-existing stratification. This results in the highest homogeneity of any mixing method.

*Connecting sections of post.*

In the case of retaining walls, steel beams are inserted into the wall immediately behind the TRD machine.



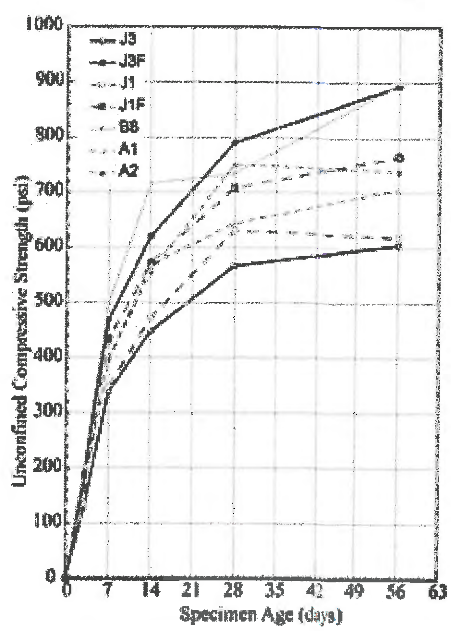
*Steel beam reinforcement in retaining walls.*

### Design Considerations

TRD walls can be installed in soils ranging from soft organics to dense sand with cobbles and some rock formations. Because the TRD method vertically mixes the soils within the total depth, individual strata are only significant to the degree they are a component of the total profile being mixed.

The site exploration should determine site geology, soil gradation, pH, in situ moisture content, and organic content of each stratum within the planned wall depth. Continuous sampling is required when retrieving samples for laboratory bench scale testing.

The strength and permeability of the soil mix wall depends on the entire soil profile, water content, and grout slurry composition and volume. Therefore, laboratory bench testing should be conducted using site soils and lab procedures that simulate the field mixing. Laboratory testing uses full-depth soil samples of the treatment zone. A series of slurry mixes can then be prepared, mixed with varying percentages of the soil samples, and cast into cylinders. Laboratory tests are performed on the cured cylinders to determine the mix design that will achieve the specified soilcrete properties, such as unconfined compressive strength and permeability.




*Unconfined compressive strength results from laboratory bench scale test program.*

HAYWARD BAKER
Geotechnical Construction

# Equipment & Materials . . .

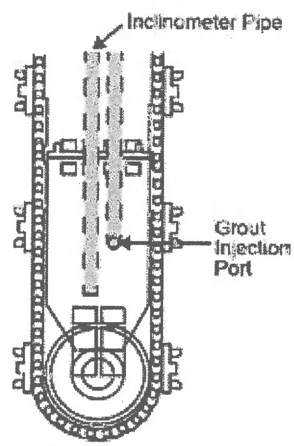
***The TRD wall method produces the most uniform wall of any soil mixing process with certainty of continuity in deep, challenging soil conditions.***

## TRD Rig

The TRD base machine is a 100 U.S. tons (91 tonnes) crawler crane. The hydraulic cutter motor is mounted on a short mast, which is connected to a wide frame. The motor can be raised and lowered on the mast, and the mast can be moved horizontally on the frame. The cutter post chain is connected to the hydraulic motor.

The cutter post is composed of an idler section at the base, which is attached to additional post sections to reach the required wall depth. The post guides and supports the chain, which is driven by a hydraulic motor at the top of the post. Pipes inside the post allow for the injection of grout slurry, air (if necessary), and the presence of inclinometers to measure cutter post verticality.

Insertion of the cutter post in sections allows the base unit to maintain a low profile of 40 feet (12 meters) tall while constructing walls to depths of 180 feet (55 meters). The low profile ensures stability of the base unit and allows wall construction at low headroom sites (see cover photo, left).




*Above: Bottom three sections of cutter post and drawing of internal inclinometer and grout pipes.*

*Left: Hydraulic motor, mast and frame connected to base crawler rig.*

## Grout Slurry Delivery

The slurry is produced in an on-site batch plant. The batching system can be a computer-controlled colloidal shear mixer or a continuous jet mixing system. The slurry is continuously agitated after mixing and before pumping.

A pipe inside the cutter post permits the injection of the grout slurry at depth. The pump delivery rate is adjusted to the cutting rate of the TRD machine to produce the prescribed mixture of grout and soil. Flow monitoring devices located in the delivery line monitor grout flow, pressure, density, and total injected grout.

A second pipe is available for the injection of air, which is sometimes used to increase fluidity and enhance mobility of the materials to be mixed.

*On-site grout batch plant.*

*Batch plant controls.*

## Grout Slurry

The grout slurry is typically composed of water, swelling clays (bentonite, attapulgites, or sepiolite), and cementitious binders. Binders are typically Portland cement, fly ash, and ground granulated blast furnace slag (GGBFS).

HAYWARD BAKER Geotechnical Construction

# Quality Control . . .

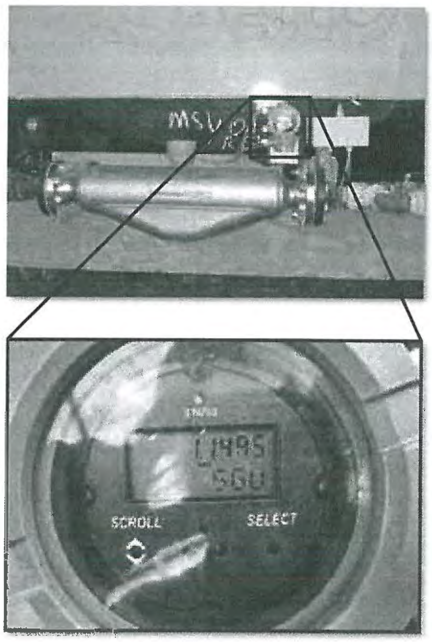
***HB has developed proprietary data acquisition (DAQ) equipment and software for real-time monitoring of all parameters during the TRD mixing process.***

## Pre-Construction

Prior to TRD wall construction, full-depth soil and rock samples are obtained and brought to a laboratory where mix design testing is performed. The final mixture consists of 65 to 80 percent of the in situ soil and rock.

## During Construction

Inclinometers located in the cutter post at multiple depths measure its verticality. The verticality in two planes is visually displayed on an in-cab monitor for the operator in real-time. GPS position tracking can be used to monitor and document wall alignment.



*In-line grout flow meter.*

During TRD construction, a mass flow sensor within the grout line records flow rate, specific gravity, and temperature of the grout slurry.

HB has developed proprietary data acquisition (DAQ) equipment and software for real-time monitoring of all parameters during the TRD mixing process. In-cab monitors display real-time quality control feedback to the operator and field engineer during wall construction. It is also possible to remotely monitor the feedback. All data are transmitted in near real-time to an online central database via cell modem.

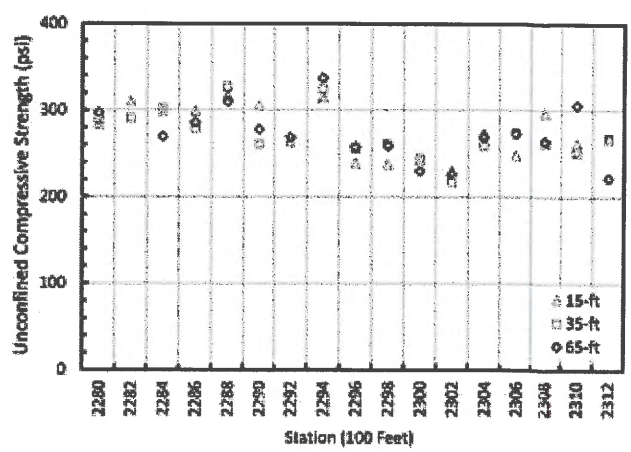
*In-cab DAQ monitor displaying real-time quality control feedback during wall construction.*

Wet grab samples are taken routinely during production for flow table tests to check the viscosity, ensuring that the soil mix can properly flow yet maintain cut up soil and rock particles in suspension. Wet grab samples retrieved from the wall immediately after mixing are also cast into cylinders for unconfined compressive strength and permeability testing, if required.

## Post-Construction

Coring of the cured wall is possible but not recommended because it creates a discontinuity in the wall. Because of the extensive quality control of the continuous, high uniformity wall produced by the TRD method, coring is generally only performed if a variation in the grout or construction process raises a concern over a specific segment of the wall.

If required, core sampling of the wall can be performed to assess homogeneity of the soil mix and to retrieve samples for strength testing. However, as is typical with core sampling, if aggregates are present in the wall matrix, they can dislodge from the weaker soil mix matrix inside the core barrel and damage the core sample. Downhole video logging of core holes can provide a visual assessment of homogeneity of the soil mix.




*Twenty-eight-day unconfined compressive strength test results of cylinders cast from samples retrieved from deep in wet wall. These results confirm the uniformity of the TRD wall both with depth and along the alignment.*

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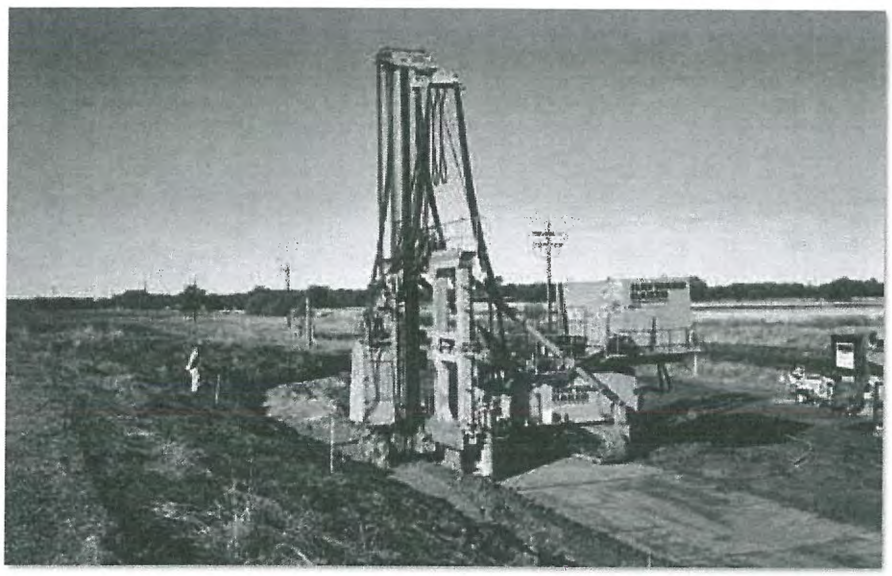
Geotechnical Construction

# Advantages of Hayward Baker TRD Soil Mix Walls

- *Compact, low headroom machinery*
- *Environmentally friendly*
- *Constructs a continuous wall*
- *Blends the entire soil profile*
- *Most homogeneous of soil mix technologies*
- *Certainty of continuity in deep, challenging soil conditions*
- *Wide variety of applications*



*TRD cutoff wall construction for a wastewater treatment plant in California.*

## Why Should You Choose Hayward Baker's TRD Soil Mix Walls?

Hayward Baker Inc. (HB) is North America's leading geotechnical contractor, offering the full range of pre- and post-construction services for foundation rehabilitation, settlement control, liquefaction mitigation, soil stabilization, groundwater control, slope stability, excavation support and underpinning. HB is annually ranked #1 in our field by Engineering News-Record.

Headquartered in Hanover, Maryland, HB has over 25 offices servicing North and Central America. Since its inception, HB has established itself in the forefront of geotechnical specialty contracting, evolving and expanding to meet the increasingly complex needs of the construction community. HB is capable of offering full design-build services for any geotechnical construction application.

Whether a situation is typical or unique, HB has the experience and innovation to assist engineers, contractors, and owners with identifying and constructing the most economical solution that satisfies the technical requirements of each project.

**HAYWARD BAKER**
Geotechnical Construction
KELLER

**Design-Build Services for the Complete Range of Geotechnical Technologies**

**Grouting**
Cement Grouting (High Mobility Grouting)
Chemical Grouting
Compaction Grouting (Low Mobility Grouting)
Fracture Grouting
Jet Grouting
Polyurethane Grouting

**Ground Improvement**
Dry Soil Mixing
Dynamic Compaction
Injection Systems for Expansive Soils
Rapid Impact Compaction
Rigid Inclusions (Controlled Stiffness Columns)
Vibro Compaction
Vibro Concrete Columns
Vibro Piers™ (Aggregate Piers)
Vibro Replacement (Stone Columns)
Wet Soil Mixing

**Structural Support**
Augercast Piles
Drilled Shafts
Driven Piles
Franki Piles (PIFs)
Helical Piles
Jacked Piers
Macropiles™
Micropiles
Pit Underpinning

**Earth Retention**
Anchors
Anchor Block Slope Stabilization
Gabion Systems
Micropile Slide Stabilization System (MS³)
Secant or Tangent Piles
Sheet Piles
Soil Nailing
Soldier Piles & Lagging

**Additional Services**
Earthquake Drains
Sculpted Shotcrete
Slab Jacking
Slurry Walls
TRD Soil Mix Walls
Wick Drains

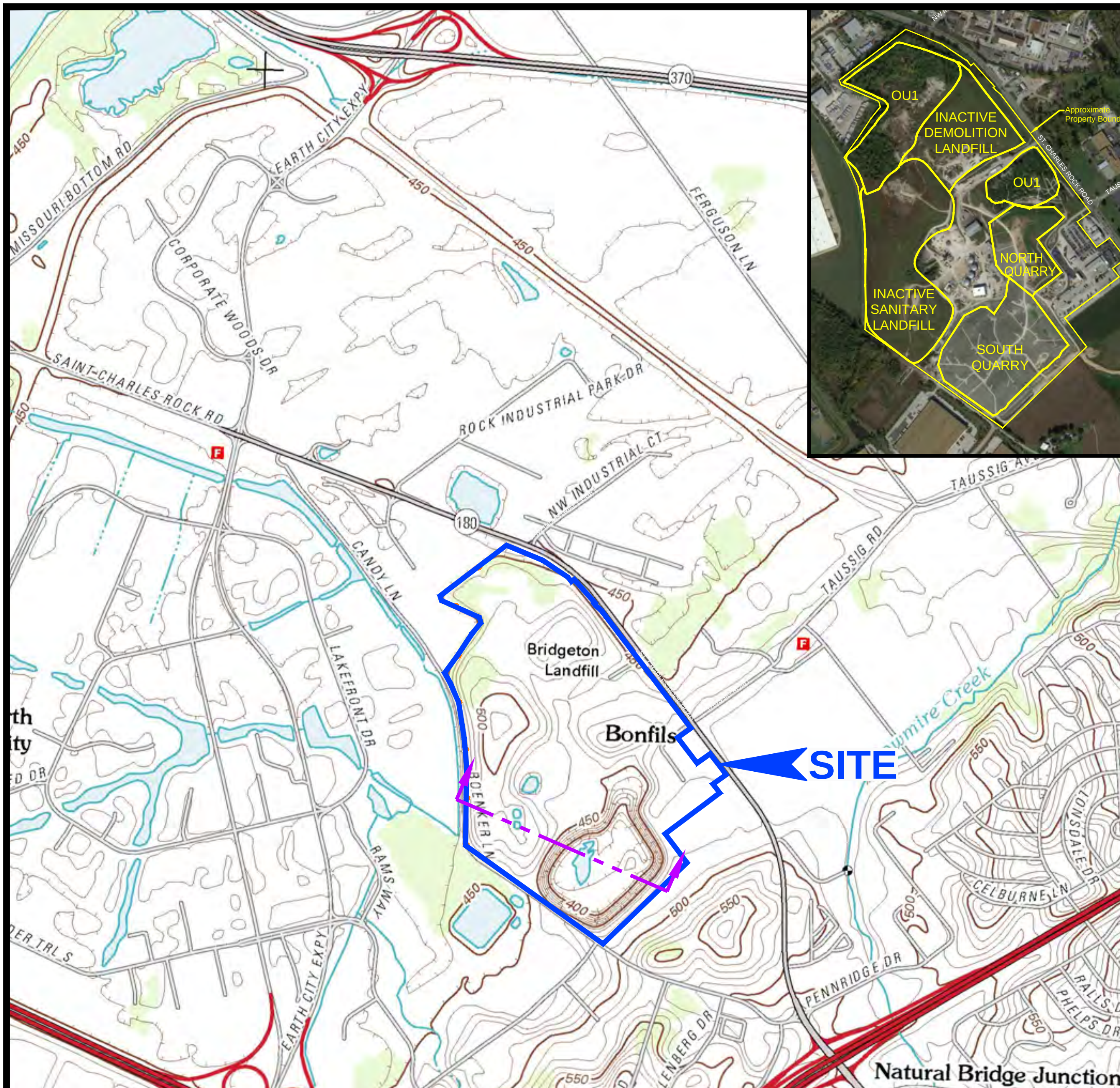
**Website** www.HaywardBaker.com
**Email** info@HaywardBaker.com

**Hayward Baker Inc.**
A member of the Keller worldwide group of companies


*HI-MAR-20007-JW Nov 2013*

For a complete list of our offices, visit: **www.HaywardBaker.com.**

THINK SAFE




NOTES

1. Plan adapted from a 7.5 minute U.S.G.S. map for St. Charles, Missouri quadrangle, last revised in 2012.

0 2,000 4,000

SCALE IN FEET

LEGEND

Approximate Profile Location (See Plate 2)

N

| Drawn By: WAH | Ck'd By: KJH | App'vd By: KJH |
|---|---|---|
| Date: 8-24-15 | Date: 8-28-15 | Date: 8-28-15 |

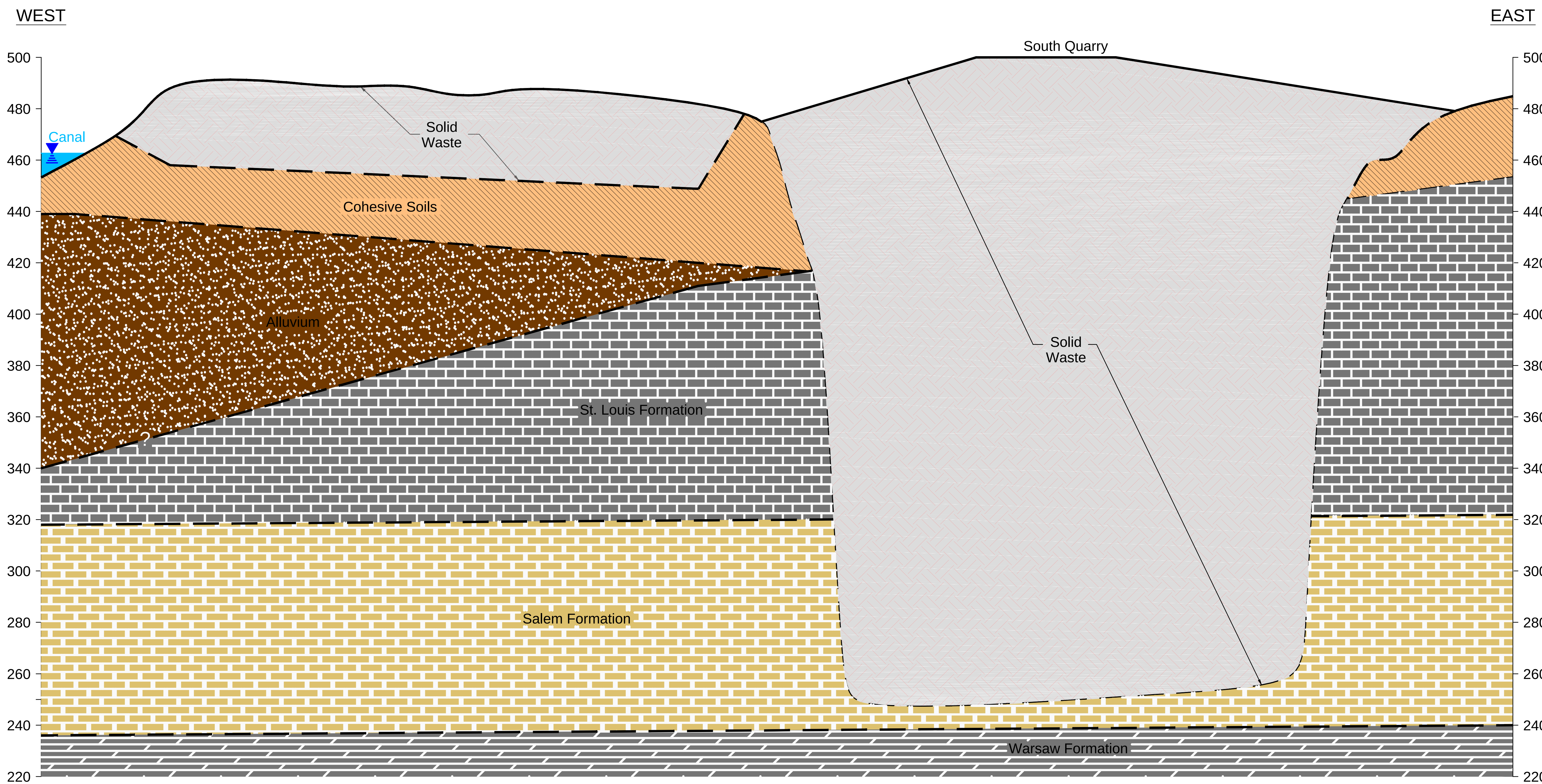
GEOTECHNOLOGY INC
FROM THE GROUND UP

Feasibility Study
Groundwater Remediation
Bridgeton Landfill
St. Louis County, Missouri

**SITE LOCATION AND TOPOGRAPHY**

Project Number J024889.02

PLATE 1




STRATIGRAPHY LEGEND

- Cohesive Soils (CH through ML)
- Alluvium (SC through SW)
- St. Louis Formation
- Salem Formation
- Warsaw Formation

NOTES

1. See Plate 1 for location of General Subsurface Profile.
2. All features shown approximate only.

SCALE IN FEET
HORIZONTAL 1" = 200'
VERTICAL 1" = 40'

| Drawn By: WAH | Ck'd By: KJH | App'vd By: KJH |
|---|---|---|
| Date: 8-21-15 | Date: 8-28-15 | Date: 8-28-15 |

GEOTECHNOLOGY FROM THE GROUND UP

Feasibility Study
Groundwater Remediation
Bridgeton Landfill
St. Louis County, Missouri

**GENERAL SUBSURFACE PROFILE**

Project Number J024889.02 | PLATE 2


NOTES

1. Plan adapted from an October 21, 2014 aerial photograph courtesy of Google Earth and a drawing dated January 22, 2014 titled "Figure 1 Base Map West Lake Landfill Operable Unit-1" prepared by Engineering Management Support, Inc.

2. Property boundaries from St. Louis County Government Parcel Viewer.

3. All features are shown approximate only.

0 600 1,200
SCALE IN FEET

N

| Drawn By: WAH | Ck'd By: KJH | App'vd By: KJH |
|---|---|---|
| Date: 8-24-15 | Date: 8-28-15 | Date: 8-28-15 |

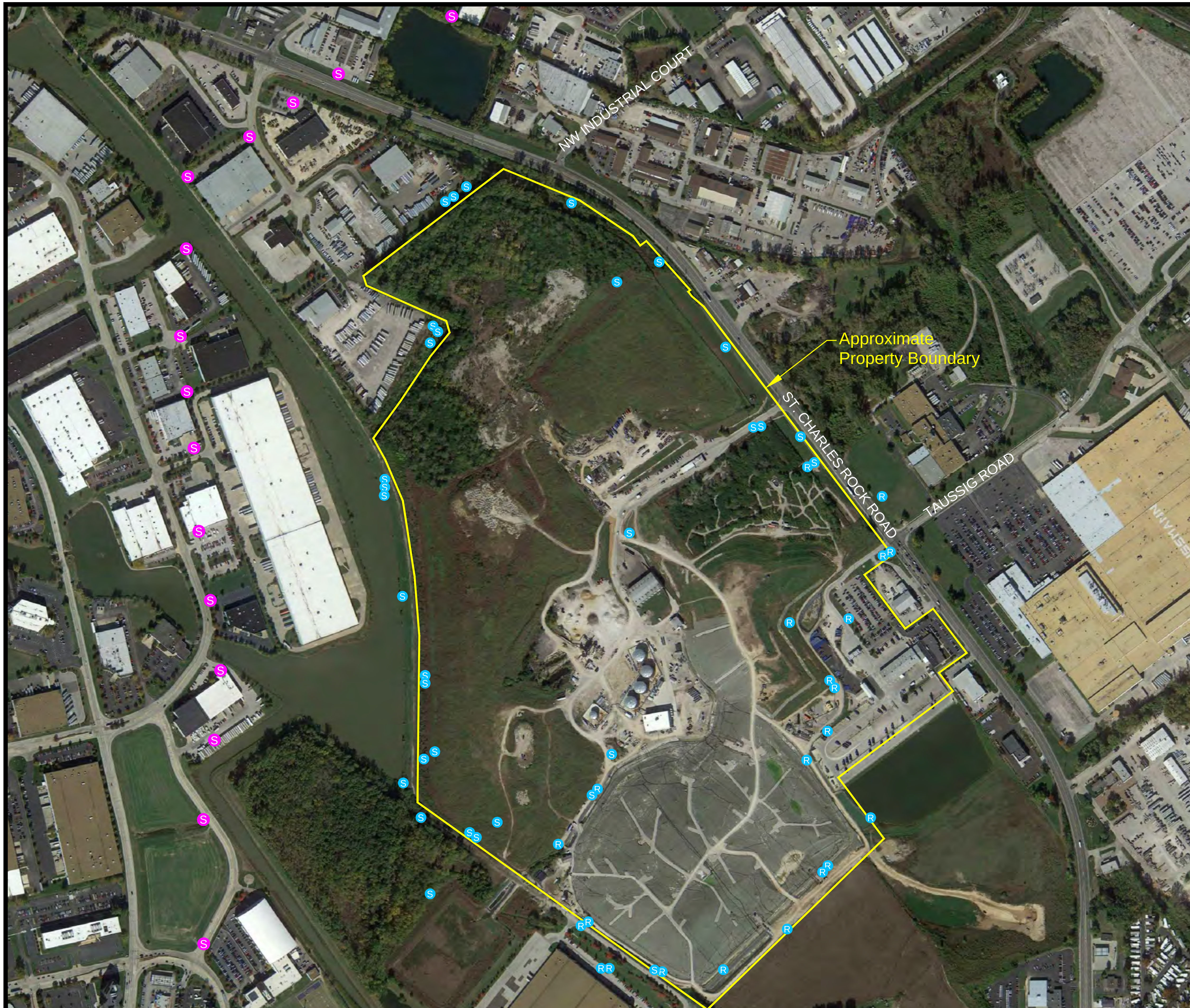
GEOTECHNOLOGY INC
FROM THE GROUND UP

Feasibility Study
Groundwater Remediation
Bridgeton Landfill
St. Louis County, Missouri

**PROPERTY PARCEL MAP**

Project Number J024889.02

PLATE 3




NOTES

1. Plan adapted from an October 21, 2014 aerial photograph courtesy of Google Earth and a drawing dated January 22, 2014 titled "Figure 1 Base Map West Lake Landfill Operable Unit-1" prepared by Engineering Management Support, Inc.

2. All features are shown approximate only.

LEGEND

S Existing Alluvium Groundwater Well in MNA Network

R Existing Bedrock Groundwater Well in MNA Network

S x 3 Proposed Shallow, Intermediate and Deep Zone Alluvium Wells in MNA Network

0 600 1,200

SCALE IN FEET

N

| Drawn By: WAH | Ck'd By: KJH | App'vd By: KJH |
|---|---|---|
| Date: 8-24-15 | Date: 8-28-15 | Date: 8-28-15 |

GEOTECHNOLOGY INC
FROM THE GROUND UP

Feasibility Study
Groundwater Remediation
Bridgeton Landfill
St. Louis County, Missouri

**REMEDIAL ALTERNATIVE 2 - MONITORED NATURAL ATTENUATION (MNA)**

| Project Number J024889.02 | PLATE 4 |
|---|---|


NOTES

1. Plan adapted from an October 21, 2014 aerial photograph courtesy of Google Earth and a drawing dated January 22, 2014 titled "Figure 1 Base Map West Lake Landfill Operable Unit-1" prepared by Engineering Management Support, Inc.

2. All features are shown approximate only

LEGEND

Injection Location - Barrier Treatment (Conceptual Only)

S Existing Alluvium Groundwater Well in MNA Network

R Existing Bedrock Groundwater Well in MNA Network

S x 3 Proposed Shallow, Intermediate and Deep Zone Alluvium Wells in MNA Network

0 600 1,200

SCALE IN FEET

N

| Drawn By: WAH | Ck'd By: KJH | App'vd By: KJH |
|---|---|---|
| Date: 8-24-15 | Date: 8-28-15 | Date: 8-28-15 |

GEOTECHNOLOGY INC

FROM THE GROUND UP

Feasibility Study
Groundwater Remediation
Bridgeton Landfill
St. Louis County, Missouri

**REMEDIAL ALTERNATIVE 3 - MNA AND BARRIER TREATMENT**

| Project Number J024889.02 | PLATE 5 |
|---|---|


NOTES

1. Plan adapted from an October 21, 2014 aerial photograph courtesy of Google Earth and a drawing dated January 22, 2014 titled "Figure 1 Base Map West Lake Landfill Operable Unit-1" prepared by Engineering Management Support, Inc.

2. All features are shown approximate only.

LEGEND

Proposed Extraction Well (Conceptual Only)

S x 3 Proposed Shallow, Intermediate and Deep Zone Alluvium Wells

0 600 1,200

SCALE IN FEET

N

| Drawn By: WAH | Ck'd By: | App'vd By: |
|---|---|---|
| Date: 8-24-15 | Date: | Date: |

GEOTECHNOLOGY INC
FROM THE GROUND UP

Feasibility Study
Groundwater Remediation
Bridgeton Landfill
St. Louis County, Missouri

**REMEDIAL ALTERNATIVE 4 - HYDRAULIC CONTAINMENT**

| Project Number J024889.02 | PLATE 6 |
|---|---|


NOTES
1. Plan adapted from an October 21, 2014 aerial photograph courtesy of Google Earth and a drawing dated January 22, 2014 titled "Figure 1 Base Map West Lake Landfill Operable Unit-1" prepared by Engineering Management Support, Inc.

2. All features are shown approximate only.

LEGEND

Groundwater Containment Wall from ground surface and keyed into weathered bedrock (Conceptual Only)

S x 3 Proposed Shallow, Intermediate and Deep Zone Alluvium Wells

N

0 600 1,200

SCALE IN FEET

| Drawn By: WAH | Ck'd By: | App'vd By: |
|---|---|---|
| Date: 8-24-15 | Date: | Date: |

GEOTECHNOLOGY INC. FROM THE GROUND UP

Feasibility Study
Groundwater Remediation
Bridgeton Landfill
St. Louis County, Missouri

**REMEDIAL ALTERNATIVE 5 - GROUNDWATER CONTAINMENT WALL**

Project Number J024889.02

PLATE 7

# TABLE 1
# ARAR SUMMARY
# GROUNDWATER REMEDIATION
# BRIDGETON LANDFILL
# ST. LOUIS COUNTY, MISSOURI

| Chemical-Specific ARARs | | |
|---|---|---|
| **Regulation** | **Citation** | |
| | **FEDERAL ARARs** | |
| Clean Water Act | Title 40, CFR, Chapter 1, Subchapter D. Parts 124 and 141-148. | This law requires the U.S. Environmental Agency to establish National Primary Drinking Water Regulations (NPDWRs) for contaminants that may cause adverse public health effects. The regulations include maximum contaminant levels (MCLs) for each relevant contaminant. The Safe Drinking Water Act (SDWA) establishes relevant and appropriate drinking water standards to protect public health. |
| Resource Conservation and Recovery Act (RCRA) | 40 CFR 261, 262, 264; 42 USC 6901 | Identifies and lists certain materials as hazardous wastes and sets management standards for such wastes. RCRA may apply to the management of materials generated at a site if they contain any listed hazardous waste or exhibit a characteristic of a hazard. |
| | **STATE ARARs** | |
| Missouri Public Drinking Water Program | 10 CSR 60-4.100 | Establishes and identifies maximum volatile organic chemical (VOCs) concentrations and monitoring requirements. Missouri 10 CSR 60-4.100 establishes relevant and appropriate drinking water standards and monitoring requirements related to drinking water supply. |
| **Action-Specific ARARs** | | |
| **Regulation** | **Citation** | **Description** |
| | **FEDERAL ARARs** | |
| Comprehensive Environmental Response, Compensation and Liability Act (CERCLA or Superfund) | 42 USC Chapter 103 | CERCLA provides guidance for the cleanup of hazardous waste sites. |
| Clean Air Act (CAA),1990 | 42 USC Sec. 7401 | The CAA provides guidance for air pollution prevention and control. Applies to air emissions for air stripping treatment. |
| Safe Drinking Water Act (SDWA) 1974 | Title 40, CFR, Chapter 1, Subchapter D. Parts 124 and 141-148. | The SDWA and later amendments established the Federal Underground Injection Control (UIC) Program. Applicable to site activities involving underground injection of materials for the purpose of groundwater remediation. |
| | **STATE ARARs** | |
| Missouri Clean Water Law | RSMo 577 and 644, 10 CSR 20-6090 and 20-6.011 | Establishes requirements for Underground Injection Control (UIC) Wells. |
| Missouri Clean Water Law | RSMo 644, Section 143 | Authorizes the State to establish groundwater remediation procedures based on risk to human health and the environment for any particular site. Risk-based methods are applicable to site remediation decisions. |
| Missouri Clean Water Law | RSMo 644 Section 405, 10 CSR 6.2 | Authorizes the State to regulate discharge from facilities in accordance with effluent limitations and monitoring requirements. The State implements federal NPDES program for surface water discharges. |
| Missouri Air Conservation Law | RSMo Chapter 643, 10 CSR 6 | Authorizes the State to establish maximum quantities of air contaminants that may be emitted from any air contaminant source. Applicable to air emissions from pump and treat remediation system. |
| Water Well Certification/Registration | RSMo 256.614, 256.615, 256.623, 256.628 and 10 CSR 23-3 | Regulates the construction and abandonment of water wells or monitoring wells. Applicable to site activities involving monitoring well/boring installation and abandonment. |
| Well Driller Permit | RSMo 256.607, 256.611, 256.617 and 10 CSR 23-1 | Regulates drilling contractors who operate in the state. A one time proficiency exam and drillers permit are required for drilling contractors. Applicable to site activities involving monitoring well/boring installation and abandonment. |
| **Location-Specific ARARs** | | |
| St. Louis County | St. Louis County Code of Ordinances | Ordinances may be applicable to certain construction and building activities. |
| St. Louis County Flood Plain Development | St. Louis County Ordinances and relevant U.S. Army Corp. of Engineers (COE) regs. | Regulates development in the 100 year floodplain. Applicable to construction of a pipeline and outfall structure to discharge treated groundwater. |

# TABLE 2
## PRELIMINARY COST SUMMARY
## REMEDIAL ALTERNATIVE 2 - MONITORED NATURAL ATTENUATION (MNA)
## BRIDGETON LANDFILL
## ST. LOUIS COUNTY, MISSOURI

| ITEM | UNIT | EST. QTY. | UNIT COST ($) | TOTAL COST ($) |
|---|---|---|---|---|
| **1. ADDITONAL MONITORING WELL INSTALLATION** | | | | |
| a. Project Management/Coordination | Each | 1 | $36,000.00 | $36,000.00 |
| b. Field Observation | Each | 1 | $37,500.00 | $37,500.00 |
| c. Well Installation/Development | Well | 45 | $9,000.00 | $405,000.00 |
| d. Reporting | Each | 1 | $15,000.00 | $15,000.00 |
| e. Institutional Controls | Each | 15 | $100,000.00 | $1,500,000.00 |
| f. Contingency | Each | 1 | 10% | $49,350.00 |
| | | | **Subtotal** | **$2,042,850.00** |
| **2. MNA SEMI-ANNUAL MONITORING/REPORTS** | | | | |
| a. Project Management/Coordination | 1 | 60 | $5,000.00 | $300,000.00 |
| b. Field Work Sampling | 1 | 60 | $53,000.00 | $3,180,000.00 |
| c. Laboratory Testing | 1 | 60 | $51,000.00 | $3,060,000.00 |
| d. Reporting | 1 | 60 | $12,000.00 | $720,000.00 |
| | | | **Subtotal** | **$7,260,000.00** |
| **3. MNA BIENNIAL SAMPLING LIST** | | | | |
| a. Laboratory Testing | 1 | 15 | $100,000.00 | $1,500,000.00 |
| | | | **Subtotal** | **$1,500,000.00** |
| | | | **PRESENT VALUE TOTAL:** | **$5,640,772.00** |

# TABLE 2
## PRESENT VALUE CALCULATIONS
## REMEDIAL ALTERNATIVE 2 -MONITORED NATURAL ATTENUATION (MNA)
## BRIDGETON LANDFILL
## ST. LOUIS COUNTY, MISSOURI

| ITEM | YEAR | EST. COST | DISCOUNT FACTOR | PRESENT VALUE ($) | CUMULATIVE TOTAL ($) |
|---|---|---|---|---|---|
| capital costs (all) | 0 | $2,042,850.00 | 1.0000 | $2,042,850.00 | $2,042,850.00 |
| semi-annual gwm | 1 | $242,000.00 | 0.9350 | $226,270.00 | $2,269,120.00 |
| semi-annual and biennial gwm | 2 | $342,000.00 | 0.8730 | $298,566.00 | $2,567,686.00 |
| semi-annual gwm | 3 | $242,000.00 | 0.8160 | $197,472.00 | $2,765,158.00 |
| semi-annual and biennial gwm | 4 | $342,000.00 | 0.7630 | $260,946.00 | $3,026,104.00 |
| semi-annual gwm | 5 | $242,000.00 | 0.7130 | $172,546.00 | $3,198,650.00 |
| semi-annual and biennial gwm | 6 | $342,000.00 | 0.6660 | $227,772.00 | $3,426,422.00 |
| semi-annual gwm | 7 | $242,000.00 | 0.6230 | $150,766.00 | $3,577,188.00 |
| semi-annual and biennial gwm | 8 | $342,000.00 | 0.5820 | $199,044.00 | $3,776,232.00 |
| semi-annual gwm | 9 | $242,000.00 | 0.5440 | $131,648.00 | $3,907,880.00 |
| semi-annual and biennial gwm | 10 | $342,000.00 | 0.5080 | $173,736.00 | $4,081,616.00 |
| semi-annual gwm | 11 | $242,000.00 | 0.4570 | $110,594.00 | $4,192,210.00 |
| semi-annual and biennial gwm | 12 | $342,000.00 | 0.4440 | $151,848.00 | $4,344,058.00 |
| semi-annual gwm | 13 | $242,000.00 | 0.4150 | $100,430.00 | $4,444,488.00 |
| semi-annual and biennial gwm | 14 | $342,000.00 | 0.3880 | $132,696.00 | $4,577,184.00 |
| semi-annual gwm | 15 | $242,000.00 | 0.3620 | $87,604.00 | $4,664,788.00 |
| semi-annual and biennial gwm | 16 | $342,000.00 | 0.3390 | $115,938.00 | $4,780,726.00 |
| semi-annual gwm | 17 | $242,000.00 | 0.3170 | $76,714.00 | $4,857,440.00 |
| semi-annual and biennial gwm | 18 | $342,000.00 | 0.2960 | $101,232.00 | $4,958,672.00 |
| semi-annual gwm | 19 | $242,000.00 | 0.2770 | $67,034.00 | $5,025,706.00 |
| semi-annual and biennial gwm | 20 | $342,000.00 | 0.2580 | $88,236.00 | $5,113,942.00 |
| semi-annual gwm | 21 | $242,000.00 | 0.2420 | $58,564.00 | $5,172,506.00 |
| semi-annual and biennial gwm | 22 | $342,000.00 | 0.2260 | $77,292.00 | $5,249,798.00 |
| semi-annual gwm | 23 | $242,000.00 | 0.2110 | $51,062.00 | $5,300,860.00 |
| semi-annual and biennial gwm | 24 | $342,000.00 | 0.1970 | $67,374.00 | $5,368,234.00 |
| semi-annual gwm | 25 | $242,000.00 | 0.1840 | $44,528.00 | $5,412,762.00 |
| semi-annual and biennial gwm | 26 | $342,000.00 | 0.1720 | $58,824.00 | $5,471,586.00 |
| semi-annual gwm | 27 | $242,000.00 | 0.1610 | $38,962.00 | $5,510,548.00 |
| semi-annual and biennial gwm | 28 | $342,000.00 | 0.1500 | $51,300.00 | $5,561,848.00 |
| semi-annual gwm | 29 | $242,000.00 | 0.1410 | $34,122.00 | $5,595,970.00 |
| semi-annual and biennial gwm | 30 | $342,000.00 | 0.1310 | $44,802.00 | $5,640,772.00 |
| | | **$10,802,850.00** | | **$5,640,772.00** | |

**PRESENT VALUE TOTAL: $5,640,772.00**

discount factor = 7%

J024889.02

# TABLE 3
## PRELIMINARY COST SUMMARY
## REMEDIAL ALTERNATIVE 3 - MNA AND BARRIER TREATMENT
## BRIDGETON LANDFILL
## ST. LOUIS COUNTY, MISSOURI

| ITEM | UNIT | EST. QTY. | UNIT COST ($) | TOTAL COST ($) |
|---|---|---|---|---|
| Task 1 - Planning, Coordination, Design, and Barrier Treatment | | | | |
| a. Site Characterization | LS | 1 | $200,000.00 | $200,000.00 |
| b. Groundwater Flow Model | LS | 1 | $150,000.00 | $150,000.00 |
| c. Permits, Plans, Surveying, Utilities | LS | 1 | $50,000.00 | $50,000.00 |
| d. Pilot Test | LS | 1 | $150,000.00 | $150,000.00 |
| e. Plume Stop Barrier Treatment | LS | 1 | $7,200,000.00 | $7,200,000.00 |
| f. Field Observation | Day | 120 | $1,200.00 | $144,000.00 |
| g. As-Built Survey, Const. Comp. Report | LS | 1 | $30,000.00 | $30,000.00 |
| h. Project Management | LS | 1 | $80,000.00 | $80,000.00 |
| i. Institutional Controls | Parcel | 15 | $100,000.00 | $1,500,000.00 |
| | | | **Subtotal** | **$9,504,000.00** |
| Task 2 - Additional Monitoring Well Installation | | | | |
| a. Project Management/Coordination | Each | 1 | $36,000.00 | $36,000.00 |
| b. Field Observation | Each | 1 | $37,500.00 | $37,500.00 |
| c. Well Installation/Development | Well | 45 | $9,000.00 | $405,000.00 |
| d. Reporting | Each | 1 | $15,000.00 | $15,000.00 |
| e. Contingency | Each | 1 | 10% | $49,350.00 |
| | | | **Subtotal** | **$542,850.00** |
| Task 3 - MNA Semi-Annual Monitoring/Reports | | | | |
| a. Project Management/Coordination | 1 | 60 | $4,000.00 | $240,000.00 |
| b. Field Work Sampling | 1 | 60 | $48,000.00 | $2,880,000.00 |
| c. Laboratory Testing | 1 | 60 | $50,000.00 | $3,000,000.00 |
| d. Reporting | 1 | 60 | $10,000.00 | $600,000.00 |
| | | | **Subtotal** | **$6,720,000.00** |
| Task 4 - MNA Biennial Sampling List | | | | |
| a. Laboratory Testing | 1 | 15 | $95,000.00 | $1,425,000.00 |
| | | | **Subtotal** | **$1,425,000.00** |
| | | | **PRESENT VALUE TOTAL:** | **$13,391,769.00** |

# TABLE 3
## PRELIMINARY COST SUMMARY
## REMEDIAL ALTERNATIVE 3 - MNA AND BARRIER TREATMENT
## BRIDGETON LANDFILL
## ST. LOUIS COUNTY, MISSOURI

| ITEM | YEAR | EST. COST | DISCOUNT FACTOR | PRESENT VALUE ($) | CUMULATIVE TOTAL ($) |
|---|---|---|---|---|---|
| capital costs (all) | 0 | $10,046,850.00 | 1.0000 | $10,046,850.00 | $10,046,850.00 |
| semi-annual gwm | 1 | $224,000.00 | 0.9350 | $209,440.00 | $10,256,290.00 |
| semi-annual and biennial gwm | 2 | $319,000.00 | 0.8730 | $278,487.00 | $10,534,777.00 |
| semi-annual gwm | 3 | $224,000.00 | 0.8160 | $182,784.00 | $10,717,561.00 |
| semi-annual and biennial gwm | 4 | $319,000.00 | 0.7630 | $243,397.00 | $10,960,958.00 |
| semi-annual gwm | 5 | $224,000.00 | 0.7130 | $159,712.00 | $11,120,670.00 |
| semi-annual and biennial gwm | 6 | $319,000.00 | 0.6660 | $212,454.00 | $11,333,124.00 |
| semi-annual gwm | 7 | $224,000.00 | 0.6230 | $139,552.00 | $11,472,676.00 |
| semi-annual and biennial gwm | 8 | $319,000.00 | 0.5820 | $185,658.00 | $11,658,334.00 |
| semi-annual gwm | 9 | $224,000.00 | 0.5440 | $121,856.00 | $11,780,190.00 |
| semi-annual and biennial gwm | 10 | $319,000.00 | 0.5080 | $162,052.00 | $11,942,242.00 |
| semi-annual gwm | 11 | $224,000.00 | 0.4570 | $102,368.00 | $12,044,610.00 |
| semi-annual and biennial gwm | 12 | $319,000.00 | 0.4440 | $141,636.00 | $12,186,246.00 |
| semi-annual gwm | 13 | $224,000.00 | 0.4150 | $92,960.00 | $12,279,206.00 |
| semi-annual and biennial gwm | 14 | $319,000.00 | 0.3880 | $123,772.00 | $12,402,978.00 |
| semi-annual gwm | 15 | $224,000.00 | 0.3620 | $81,088.00 | $12,484,066.00 |
| semi-annual and biennial gwm | 16 | $319,000.00 | 0.3390 | $108,141.00 | $12,592,207.00 |
| semi-annual gwm | 17 | $224,000.00 | 0.3170 | $71,008.00 | $12,663,215.00 |
| semi-annual and biennial gwm | 18 | $319,000.00 | 0.2960 | $94,424.00 | $12,757,639.00 |
| semi-annual gwm | 19 | $224,000.00 | 0.2770 | $62,048.00 | $12,819,687.00 |
| semi-annual and biennial gwm | 20 | $319,000.00 | 0.2580 | $82,302.00 | $12,901,989.00 |
| semi-annual gwm | 21 | $224,000.00 | 0.2420 | $54,208.00 | $12,956,197.00 |
| semi-annual and biennial gwm | 22 | $319,000.00 | 0.2260 | $72,094.00 | $13,028,291.00 |
| semi-annual gwm | 23 | $224,000.00 | 0.2110 | $47,264.00 | $13,075,555.00 |
| semi-annual and biennial gwm | 24 | $319,000.00 | 0.1970 | $62,843.00 | $13,138,398.00 |
| semi-annual gwm | 25 | $224,000.00 | 0.1840 | $41,216.00 | $13,179,614.00 |
| semi-annual and biennial gwm | 26 | $319,000.00 | 0.1720 | $54,868.00 | $13,234,482.00 |
| semi-annual gwm | 27 | $224,000.00 | 0.1610 | $36,064.00 | $13,270,546.00 |
| semi-annual and biennial gwm | 28 | $319,000.00 | 0.1500 | $47,850.00 | $13,318,396.00 |
| semi-annual gwm | 29 | $224,000.00 | 0.1410 | $31,584.00 | $13,349,980.00 |
| semi-annual and biennial gwm | 30 | $319,000.00 | 0.1310 | $41,789.00 | $13,391,769.00 |
| | | **$18,191,850.00** | | **$13,391,769.00** | |

**PRESENT VALUE TOTAL: $13,391,769.00**

discount factor = 7%

# TABLE 4
## PRELIMINARY COST SUMMARY
## REMEDIAL ALTERNATIVE 4 - HYDRAULIC CONTAINMENT
## BRIDGETON LANDFILL
## ST. LOUIS COUNTY, MISSOURI

| ITEM | UNIT | EST. QTY. | UNIT COST ($) | TOTAL COST ($) |
|---|---|---|---|---|
| Task 1 - Planning, Coordination, and Design | | | | |
| a. Site Characterization and Groundwater Pump Test | LS | 1 | $300,000.00 | $300,000.00 |
| b. Groundwater Flow Model | LS | 1 | $150,000.00 | $150,000.00 |
| c. Permits, Plans, Surveying, Utilities | LS | 1 | $75,000.00 | $75,000.00 |
| d. Design - Hydraulic Containment | LS | 1 | $50,000.00 | $50,000.00 |
| e. Design - Treatment System | LS | 1 | $120,000.00 | $120,000.00 |
| f. Design - Conveyance Piping | LS | 1 | $90,000.00 | $90,000.00 |
| g. Design - Treatment Building | LS | 1 | $60,000.00 | $60,000.00 |
| h. As-Built Survey, Const. Comp. Report | LS | 1 | $50,000.00 | $50,000.00 |
| i. Project Management | LS | 1 | $200,000.00 | $200,000.00 |
| j. Institutional Controls | Each | 15 | $100,000.00 | $1,500,000.00 |
| | | | **Subtotal** | **$2,595,000.00** |
| Task 2 - Additional Monitoring Well Installation | | | | |
| a. Project Management/Coordination | Each | 1 | $36,000.00 | $36,000.00 |
| b. Field Observation | Each | 1 | $37,500.00 | $37,500.00 |
| c. Well Installation/Development | Well | 45 | $9,000.00 | $405,000.00 |
| d. Reporting | Each | 1 | $15,000.00 | $15,000.00 |
| e. Contingency | Each | 1 | 10% | $49,350.00 |
| | | | **Subtotal** | **$542,850.00** |
| Task 3 - MNA Semi-Annual Monitoring/Reports | | | | |
| a. Project Management/Coordination | 1 | 60 | $4,000.00 | $240,000.00 |
| b. Field Work Sampling | 1 | 60 | $24,000.00 | $1,440,000.00 |
| c. Laboratory Testing | 1 | 60 | $25,000.00 | $1,500,000.00 |
| d. Reporting | 1 | 60 | $6,000.00 | $360,000.00 |
| | | | **Subtotal** | **$3,540,000.00** |
| Task 4 - Extraction Well and Conveyance Piping Installation | | | | |
| a. Extraction Well Installation | Well | 7 | $120,000.00 | $840,000.00 |
| b. Directional Drill Piping | LS | 7,000 | $100.00 | $700,000.00 |
| c. Outfall at Missouri River | LS | 1 | $150,000.00 | $150,000.00 |
| d. Trenched Piping | LF | 4,600 | $80.00 | $368,000.00 |
| e. Extraction Pumps | Pump | 7 | $8,000.00 | $56,000.00 |
| f. Manhole/Value Vaults | Each | 7 | $5,000.00 | $35,000.00 |
| g. Electrical Contractor | LS | 1 | $125,000.00 | $125,000.00 |
| | | | **Subtotal** | **$2,274,000.00** |

# TABLE 4
## PRELIMINARY COST SUMMARY
## REMEDIAL ALTERNATIVE 4 - HYDRAULIC CONTAINMENT
## BRIDGETON LANDFILL
## ST. LOUIS COUNTY, MISSOURI

| ITEM | UNIT | EST. QTY. | UNIT COST ($) | TOTAL COST ($) |
|---|---|---|---|---|
| Task 5 - Treatment System | | | | |
| a. Metals Removal - Aerator, Settling Equipment, Filters | Each | 1 | $350,000.00 | $350,000.00 |
| b. Air Strippers - Skid Units with Blower and Pump | Each | 3 | $120,000.00 | $360,000.00 |
| c. Instrumentation, Control Panel, Chemical Feed System | Each | 1 | $250,000.00 | $250,000.00 |
| d. Electrical/Mechanical Contractor | LS | 1 | $250,000.00 | $250,000.00 |
| | | | **Subtotal** | **$1,210,000.00** |
| Task 6 - Treatment System Building | | | | |
| a. Building - 5,000 sq. ft. | LS | 1 | $350,000.00 | $350,000.00 |
| b. Concrete Slab - 5,000 sq. ft. | LS | 1 | $50,000.00 | $50,000.00 |
| c. Plumbing, Lighting, Controls, Fire Suppression | LS | 1 | $120,000.00 | $120,000.00 |
| d. Parking Area - Gravel (100' x 100') | LS | 1 | $10,000.00 | $10,000.00 |
| e. Fence, Signage, Gate | LS | 1 | $24,000.00 | $24,000.00 |
| | | | **Subtotal** | **$554,000.00** |
| Task 7 - Utilities | | | | |
| a. Electrical Service | LS | 1 | $120,000.00 | $120,000.00 |
| b. Water Service | LS | 1 | $50,000.00 | $50,000.00 |
| | | | **Subtotal** | **$170,000.00** |
| Task 8 - Operation and Maintenance ( O & M) | | | | |
| a. Labor | Hour | 1,700 | $85.00 | $144,500.00 |
| b. Electricity to Operate Equipment | LS | 1 | $80,000.00 | $80,000.00 |
| c. Supplies, Parts, Treatment Materials | LS | 1 | $75,000.00 | $75,000.00 |
| d. Waste Handling | LS | 1 | $60,000.00 | $60,000.00 |
| e. Reporting | LS | 1 | $60,000.00 | $60,000.00 |
| f. Project Management | LS | 1 | $40,000.00 | $40,000.00 |
| | | | **Subtotal** | **$459,500.00** |
| | | | **PRESENT VALUE TOTAL:** | **$14,501,653** |

# TABLE 4
## PRELIMINARY COST SUMMARY
## REMEDIAL ALTERNATIVE 4 - HYDRAULIC CONTAINMENT
## BRIDGETON LANDFILL
## ST. LOUIS COUNTY, MISSOURI

| ITEM | YEAR | EST. COST | DISCOUNT FACTOR | PRESENT VALUE ($) | CUMULATIVE TOTAL ($) |
|---|---|---|---|---|---|
| capital costs (all) | 0 | $7,345,850.00 | 1.0000 | $7,345,850.00 | $7,345,850.00 |
| semi-annual GWM and O & M | 1 | $577,500.00 | 0.9350 | $539,962.50 | $7,885,813.00 |
| semi-annual GWM and O & M | 2 | $577,500.00 | 0.8730 | $504,157.50 | $8,389,971.00 |
| semi-annual GWM and O & M | 3 | $577,500.00 | 0.8160 | $471,240.00 | $8,861,211.00 |
| semi-annual GWM and O & M | 4 | $577,500.00 | 0.7630 | $440,632.50 | $9,301,844.00 |
| semi-annual GWM and O & M | 5 | $577,500.00 | 0.7130 | $411,757.50 | $9,713,602.00 |
| semi-annual GWM and O & M | 6 | $577,500.00 | 0.6660 | $384,615.00 | $10,098,217.00 |
| semi-annual GWM and O & M | 7 | $577,500.00 | 0.6230 | $359,782.50 | $10,458,000.00 |
| semi-annual GWM and O & M | 8 | $577,500.00 | 0.5820 | $336,105.00 | $10,794,105.00 |
| semi-annual GWM and O & M | 9 | $577,500.00 | 0.5440 | $314,160.00 | $11,108,265.00 |
| semi-annual GWM and O & M | 10 | $577,500.00 | 0.5080 | $293,370.00 | $11,401,635.00 |
| semi-annual GWM and O & M | 11 | $577,500.00 | 0.4570 | $263,917.50 | $11,665,553.00 |
| semi-annual GWM and O & M | 12 | $577,500.00 | 0.4440 | $256,410.00 | $11,921,963.00 |
| semi-annual GWM and O & M | 13 | $577,500.00 | 0.4150 | $239,662.50 | $12,161,626.00 |
| semi-annual GWM and O & M | 14 | $577,500.00 | 0.3880 | $224,070.00 | $12,385,696.00 |
| semi-annual GWM and O & M | 15 | $577,500.00 | 0.3620 | $209,055.00 | $12,594,751.00 |
| semi-annual GWM and O & M | 16 | $577,500.00 | 0.3390 | $195,772.50 | $12,790,524.00 |
| semi-annual GWM and O & M | 17 | $577,500.00 | 0.3170 | $183,067.50 | $12,973,592.00 |
| semi-annual GWM and O & M | 18 | $577,500.00 | 0.2960 | $170,940.00 | $13,144,532.00 |
| semi-annual GWM and O & M | 19 | $577,500.00 | 0.2770 | $159,967.50 | $13,304,500.00 |
| semi-annual GWM and O & M | 20 | $577,500.00 | 0.2580 | $148,995.00 | $13,453,495.00 |
| semi-annual GWM and O & M | 21 | $577,500.00 | 0.2420 | $139,755.00 | $13,593,250.00 |
| semi-annual GWM and O & M | 22 | $577,500.00 | 0.2260 | $130,515.00 | $13,723,765.00 |
| semi-annual GWM and O & M | 23 | $577,500.00 | 0.2110 | $121,852.50 | $13,845,618.00 |
| semi-annual GWM and O & M | 24 | $577,500.00 | 0.1970 | $113,767.50 | $13,959,386.00 |
| semi-annual GWM and O & M | 25 | $577,500.00 | 0.1840 | $106,260.00 | $14,065,646.00 |
| semi-annual GWM and O & M | 26 | $577,500.00 | 0.1720 | $99,330.00 | $14,164,976.00 |
| semi-annual GWM and O & M | 27 | $577,500.00 | 0.1610 | $92,977.50 | $14,257,954.00 |
| semi-annual GWM and O & M | 28 | $577,500.00 | 0.1500 | $86,625.00 | $14,344,579.00 |
| semi-annual GWM and O & M | 29 | $577,500.00 | 0.1410 | $81,427.50 | $14,426,007.00 |
| semi-annual GWM and O & M | 30 | $577,500.00 | 0.1310 | $75,652.50 | $14,501,660.00 |
| | | **$24,670,850.00** | | **$14,501,652.50** | |

**PRESENT VALUE TOTAL: $14,501,653**

discount factor = 7%

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# TABLE 5
## PRELIMINARY COST SUMMARY
## REMEDIAL ALTERNATIVE 5 - GROUNDWATER CONTAINMENT WALL
## BRIDGETON LANDFILL
## ST. LOUIS COUNTY, MISSOURI

| ITEM | UNIT | EST. QTY. | UNIT COST ($) | TOTAL COST ($) |
|---|---|---|---|---|
| Task 1 - Planning, Coordination, Design, and Construction | | | | |
| a. Site Characterization | LS | 1 | $200,000.00 | $200,000.00 |
| b. Groundwater Flow Model | LS | 1 | $150,000.00 | $150,000.00 |
| c. Permits, Plans, Surveying, Utilities | LS | 1 | $50,000.00 | $50,000.00 |
| d. Containment Wall Design | LS | 1 | $50,000.00 | $50,000.00 |
| e. Containment Wall Installation | SF | 871,000 | $32.50 | $28,307,500.00 |
| f. Field Observation | Day | 90 | $1,200.00 | $108,000.00 |
| g. As-Built Survey, Const. Comp. Report | LS | 1 | $30,000.00 | $30,000.00 |
| h. Project Management | LS | 1 | $80,000.00 | $80,000.00 |
| i. Institutional Controls | Parcel | 15 | $100,000.00 | $1,500,000.00 |
| | | | **Subtotal** | **$30,475,500.00** |
| Task 2 - Additional Monitoring Well Installation | | | | |
| a. Project Management/Coordination | Each | 1 | $36,000.00 | $36,000.00 |
| b. Field Observation | Each | 1 | $37,500.00 | $37,500.00 |
| c. Well Installation/Development | Well | 45 | $9,000.00 | $405,000.00 |
| d. Reporting | Each | 1 | $15,000.00 | $15,000.00 |
| e. Contingency | Each | 1 | 10% | $49,350.00 |
| | | | **Subtotal** | **$542,850.00** |
| Task 3 - MNA Semi-Annual Monitoring/Reports | | | | |
| a. Project Management/Coordination | 1 | 60 | $4,000.00 | $240,000.00 |
| b. Field Work Sampling | 1 | 60 | $24,000.00 | $1,440,000.00 |
| c. Laboratory Testing | 1 | 60 | $25,000.00 | $1,500,000.00 |
| d. Reporting | 1 | 60 | $6,000.00 | $360,000.00 |
| | | | **Subtotal** | **$3,540,000.00** |
| Task 4 - MNA Biennial Sampling List | | | | |
| a. Laboratory Testing | 1 | 15 | $50,000.00 | $750,000.00 |
| | | | **Subtotal** | **$750,000.00** |
| | | | **PRESENT VALUE TOTAL:** | **$32,780,138.00** |

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# TABLE 5
## PRELIMINARY COST SUMMARY
## REMEDIAL ALTERNATIVE 5 - GROUNDWATER CONTAINMENT WALL
## BRIDGETON LANDFILL
## ST. LOUIS COUNTY, MISSOURI

| ITEM | YEAR | EST. COST | DISCOUNT FACTOR | PRESENT VALUE ($) | CUMULATIVE TOTAL ($) |
|---|---|---|---|---|---|
| capital costs (all) | 0 | $31,018,350.00 | 1.0000 | $31,018,350.00 | $31,018,350.00 |
| semi-annual gwm | 1 | $118,000.00 | 0.9350 | $110,330.00 | $31,128,680.00 |
| semi-annual and biennial gwm | 2 | $168,000.00 | 0.8730 | $146,664.00 | $31,275,344.00 |
| semi-annual gwm | 3 | $118,000.00 | 0.8160 | $96,288.00 | $31,371,632.00 |
| semi-annual and biennial gwm | 4 | $168,000.00 | 0.7630 | $128,184.00 | $31,499,816.00 |
| semi-annual gwm | 5 | $118,000.00 | 0.7130 | $84,134.00 | $31,583,950.00 |
| semi-annual and biennial gwm | 6 | $168,000.00 | 0.6660 | $111,888.00 | $31,695,838.00 |
| semi-annual gwm | 7 | $118,000.00 | 0.6230 | $73,514.00 | $31,769,352.00 |
| semi-annual and biennial gwm | 8 | $168,000.00 | 0.5820 | $97,776.00 | $31,867,128.00 |
| semi-annual gwm | 9 | $118,000.00 | 0.5440 | $64,192.00 | $31,931,320.00 |
| semi-annual and biennial gwm | 10 | $168,000.00 | 0.5080 | $85,344.00 | $32,016,664.00 |
| semi-annual gwm | 11 | $118,000.00 | 0.4570 | $53,926.00 | $32,070,590.00 |
| semi-annual and biennial gwm | 12 | $168,000.00 | 0.4440 | $74,592.00 | $32,145,182.00 |
| semi-annual gwm | 13 | $118,000.00 | 0.4150 | $48,970.00 | $32,194,152.00 |
| semi-annual and biennial gwm | 14 | $168,000.00 | 0.3880 | $65,184.00 | $32,259,336.00 |
| semi-annual gwm | 15 | $118,000.00 | 0.3620 | $42,716.00 | $32,302,052.00 |
| semi-annual and biennial gwm | 16 | $168,000.00 | 0.3390 | $56,952.00 | $32,359,004.00 |
| semi-annual gwm | 17 | $118,000.00 | 0.3170 | $37,406.00 | $32,396,410.00 |
| semi-annual and biennial gwm | 18 | $168,000.00 | 0.2960 | $49,728.00 | $32,446,138.00 |
| semi-annual gwm | 19 | $118,000.00 | 0.2770 | $32,686.00 | $32,478,824.00 |
| semi-annual and biennial gwm | 20 | $168,000.00 | 0.2580 | $43,344.00 | $32,522,168.00 |
| semi-annual gwm | 21 | $118,000.00 | 0.2420 | $28,556.00 | $32,550,724.00 |
| semi-annual and biennial gwm | 22 | $168,000.00 | 0.2260 | $37,968.00 | $32,588,692.00 |
| semi-annual gwm | 23 | $118,000.00 | 0.2110 | $24,898.00 | $32,613,590.00 |
| semi-annual and biennial gwm | 24 | $168,000.00 | 0.1970 | $33,096.00 | $32,646,686.00 |
| semi-annual gwm | 25 | $118,000.00 | 0.1840 | $21,712.00 | $32,668,398.00 |
| semi-annual and biennial gwm | 26 | $168,000.00 | 0.1720 | $28,896.00 | $32,697,294.00 |
| semi-annual gwm | 27 | $118,000.00 | 0.1610 | $18,998.00 | $32,716,292.00 |
| semi-annual and biennial gwm | 28 | $168,000.00 | 0.1500 | $25,200.00 | $32,741,492.00 |
| semi-annual gwm | 29 | $118,000.00 | 0.1410 | $16,638.00 | $32,758,130.00 |
| semi-annual and biennial gwm | 30 | $168,000.00 | 0.1310 | $22,008.00 | $32,780,138.00 |
| | | **$35,308,350.00** | | **$32,780,138.00** | |

**PRESENT VALUE TOTAL: $32,780,138.00**

discount factor = 7%