Assessment of Lead in PZ-13 Near the Site and Preliminary Design Validation (SPDV) Pile at Waste Isolation Pilot Plant

Prepared for **Washington TRU Solutions LLC**

June 11, 2010

Daniel B. Stephens & Associates, Inc.

6020 Academy NE, Suite 100 • Albuquerque, New Mexico 87109

Table of Contents

Section **Page**

Table of Contents (Continued)

Section **Page**

List of Figures

List of Tables

List of Tables (Continued)

List of Appendices

Executive Summary

This assessment of dissolved lead detected in water quality samples from monitor well PZ-13 examines the potential sources of elevated lead concentrations and the geochemical conditions that influence lead mobility. PZ-13 was installed in 2007 to investigate shallow subsurface water (SSW) conditions in the vicinity of the Site and Preliminary Design Validation (SPDV) pile at the Waste Isolation Pilot Plant (WIPP). The PZ-13 lead assessment was conducted on behalf of the U.S. Department of Energy (DOE) by Daniel B. Stephens & Associates, Inc. (DBS&A), under contract to Washington TRU Solutions LLC (WTS).

Monitor wells PZ-13, -14, and -15 were installed adjacent to the SPDV pile to determine whether SSW exists around the SPDV pile and to monitor water quality. The SPDV pile received excavated rock and minor construction debris from the construction of shafts and the repository excavation during the WIPP design validation phase. The three monitor wells found that SSW exists in thin perched zones at depths ranging from 40 to 65 feet below ground surface (bgs). At PZ-13, the SSW saturated interval observed during drilling is 2.5 feet thick. Monitoring shows that PZ-13 has a total dissolved solids concentration of 230,000 to 255,000 milligrams per liter (mg/L) and dissolved lead concentration of 0.13 to 0.40 mg/L. Based on the different levels at which saturation occurs in the Gatuña and Santa Rosa Formations and water quality differences in PZ-13, -14, and -15, the thin perched zones at these wells do not appear to be continuous.

This assessment considers whether the lead source is naturally occurring (due to soil or formation materials), a result of waste in the SPDV pile, or due to monitoring methods or materials. Formation materials were tested for lead concentrations using an x-ray fluorescence (XRF) field instrument to screen the archived core samples representative of the formations contained in the SPDV pile, the Dewey Lake at its outcrop at Nash Draw, and the Salado at the repository level. XRF testing identified detectable lead concentrations ranging from 17 to 31 milligrams per kilogram (mg/kg) in the upper Dewey Lake from cores collected from PZ-13 and -14, and ERDA-9. ERDA-9 was drilled in 1976; therefore, the archived core has not been affected by SSW. Samples from this upper Dewey Lake horizon were tested for leachable lead by laboratory methods.

Conclusions regarding the potential lead sources considered in the assessment include:

- *Monitoring methods and laboratory procedures* do not appear to be a likely source of lead. Water quality results appear to accurately characterize the lead concentration.

- *Monitor well materials* are standard and do not appear to be a source of lead.

- *Drilling tools* used at PZ-13 used a custom-made bit that needed welding to repair lost auger teeth. Samples of drill bit teeth were collected from the driller for laboratory analysis, which showed no leachable lead and only one sample containing a lead concentration less than the lead concentration in water at PZ-13. These results show that the drilling tools are not the source of lead.

- *Historical and surrounding activities* at WIPP, including ranching, hunting and trapping, and oil and gas and potash production, do not appear to be a source of lead.

- *Geologic materials* in the SPDV pile and underlying formations do not contain primary lead minerals, but contain minerals that can contain lead impurities. High salinity increases lead solubility to levels exceeding the observed PZ-13 concentration. Geochemical analysis and leaching tests of the Dewey Lake using brine show that lead dissolution from minerals is the source of lead.

- The possibility that *construction debris* in the SPDV pile may have included unreported lead-bearing materials such as galvanized chain link mesh and lead wool linked to dissolved lead in seepage through the Exhaust Shaft liner was considered. However, no records exist of any lead-bearing materials in the SPDV pile, and evidence generated to date gives no support for such a source.

The evidence from testing completed for this assessment shows that dissolution of naturally occurring lead in the upper Dewey Lake Formation by saline SSW is the cause of the lead concentrations measured in PZ-13. Laboratory testing of Dewey Lake core samples measured lead concentrations of 12 to 16 mg/kg in the red, oxidized portion of the rock. Leaching tests were performed using brine matching PZ-13 water quality and deionized water. Brine leach tests produced lead concentrations from 0.204 to 0.32 mg/L after one day, whereas no lead was detected for deionized water leach tests. The leaching tests show that the interaction of highly saline water with the upper Dewey Lake horizon where PZ-13 is screened produces experimental lead concentrations close to the lead concentrations observed at PZ-13.

The assessment also provides information on the potential fate and transport of lead detected at PZ-13. Little potential appears to exist for hydrologic transport of SSW at PZ-13 over significant distance to a groundwater aquifer because the thin saturated zones occur within low-transmissivity unsaturated formation materials. Geochemical modeling also shows that lead adsorption to iron oxides characteristic of sandstone and siltstone materials substantially reduces lead mobility.

1. Introduction

This report provides an assessment of dissolved lead that has been detected in water quality samples from monitor well PZ-13 at the Waste Isolation Pilot Plant (WIPP) site near Carlsbad, New Mexico. PZ-13 was installed to investigate shallow subsurface water (SSW) conditions in the vicinity of the Site and Preliminary Design Validation (SPDV) pile. The PZ-13 lead assessment examines the potential sources of elevated lead concentrations and the geochemical conditions that influence lead mobility. It was conducted on behalf of the U.S. Department of Energy (DOE) by Daniel B. Stephens & Associates, Inc. (DBS&A), under contract to Washington TRU Solutions LLC (WTS).

This lead assessment was prompted by the detection of a dissolved lead concentration of 0.25 milligrams per liter (mg/L) in an SSW sample collected from PZ-13 when sampling began in October 2007. The lead concentration was verified during confirmation sampling completed during 2008. The objective of this assessment is to examine potential sources of the lead and to determine how lead is likely to behave in the subsurface over time. The assessment considers whether the lead source is naturally occurring (due to soil or formation materials), a result of waste in the SPDV pile, or due to monitoring methods or materials.

The assessment of lead in PZ-13 involved examination of the potential sources of lead including:

- Records indicating characteristics of geologic materials and construction debris disposed of in the SPDV pile
- Monitor well installation methods and materials
- Water quality monitoring methods and equipment
- Geologic materials in the SSW-bearing zone and vadose zone

Because the water in PZ-13 is highly saline brine, the assessment examined the potential for lead dissolution and mobility for this water quality.

The assessment was conducted in two phases. During the first half of 2009, potential lead sources were examined using information available from records indicating the materials in the SPDV pile, geologic literature, well installation and monitoring reports, and geochemical analysis. The results of this phase of the assessment were presented in a draft report dated June 12, 2009 (DBS&A, 2009). At this stage, conclusions were presented regarding the potential plausible or unlikely sources of the lead; however, the assessment was inconclusive and unable to definitively determine the source of lead. A second phase was initiated in order to more conclusively identify the source of lead. This phase of the assessment involved testing geologic materials and the drill bits used for installation of PZ-13 in order to determine whether these materials are likely lead sources. The testing shows that naturally occurring lead in the upper Dewey Lake Formation is the source of lead in PZ-13. This report discusses both phases of the assessment, with a focus on testing yielding a conclusive determination of the lead source.

The overall purpose of the PZ-13 lead assessment is to support DOE and WTS efforts to ensure regulatory compliance at WIPP. The assessment provides information to assist DOE decision makers in determining the source and potential mobility of lead detected at PZ-13.

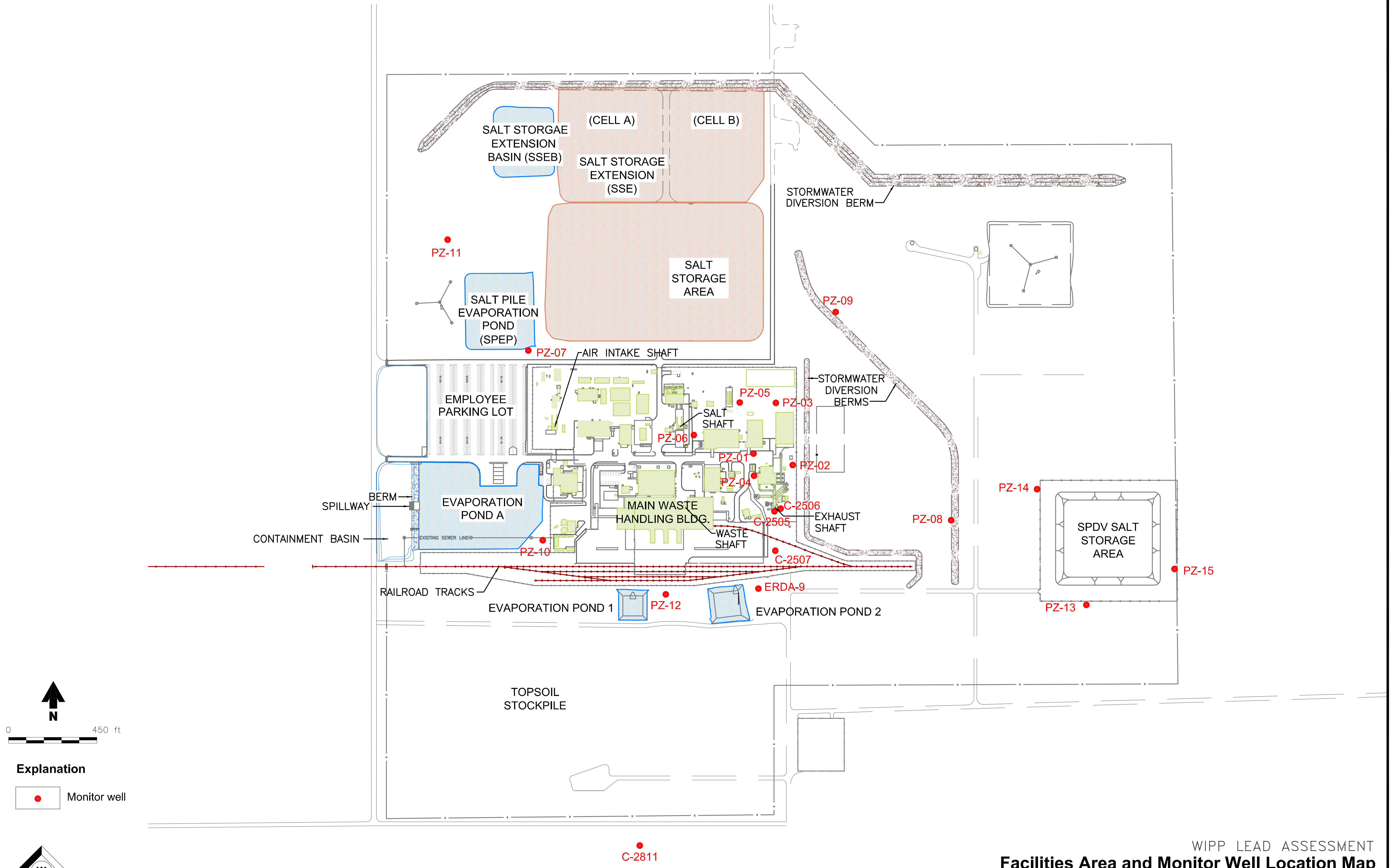
2. Background

The primary source of data related to the lead detections in PZ-13 is the basic data report from the installation of PZ-13 and other nearby piezometers (U.S. DOE, 2008). In 1995 DBS&A conducted an investigation to determine the chemical nature of wastes within the SPDV pile and to support selection of reclamation alternatives; this investigation resulted in a recommendation to recontour and cap the pile (DBS&A, 1996). DBS&A also performed hydrologic assessments of the SSW in 2002 (DBS&A, 2003) and 2008 (DBS&A, 2008). The only other investigation in the immediate vicinity was drilling completed for geotechnical analysis prior to the pile construction (Sergent, Hauskins & Beckwith, 1979).

As shown in Figures 1 and 2, the SPDV pile is located east of the WIPP facilities area and the other SSW monitor wells. The SPDV pile covers a roughly square area of approximately 10 acres and ranges in height from approximately 7 to 20 feet above ground surface. An engineered final cover was constructed over the SPDV pile in 2000 (U.S. DOE, 2008). The final cover consists of a low-permeability geosynthetic clay liner (GCL) covered by a 3-foot-thick soil layer to support vegetation. Vegetation is now well established on the final cover. Monitor well PZ-13 is located just south of the SPDV pile.

2.1 SPDV Pile Contents

The SPDV pile contains excavated salt, other rock and soil, and construction debris that was generated during the first several years of the WIPP facility construction during the WIPP design validation phase (U.S. DOE, 2008). Waste rock and tailings were generated during construction of shafts to the waste repository level at a depth of 2,150 feet below ground surface (bgs) and from excavation of drifts and rooms in a halite bed in the Salado Formation. Four shafts connect the repository level to the surface: (1) the Salt Handling Shaft, (2) the Waste Handling Shaft, (3) the Exhaust Shaft, and (4) the Air Intake Shaft. Shaft construction was accomplished using a combination of drilling, blasting, and upreaming techniques, whereas drifts and horizontal facilities were excavated mostly by using continuous mining machines (Bechtel, 1986). The period during which materials were disposed of in the SPDV pile reportedly included the period of construction of the Salt Handling Shaft, Waste Handling Shaft, and Exhaust Shaft,



WIPP LEAD ASSESSMENT

Facilities Area and Monitor Well Location Map

Figure 1

Daniel B. Stephens & Associates, Inc.

5-25-10

JN ES08.0072

S:\PROJECTS\ES08.0072_WIPP_SSW\VR_DRAWINGS\ES08_0072_06B_Lead_Assessment.DWG (BASED ON 952512B.DWG)

Source: May 2009 aerial photography from TerraServer

WIPP LEAD ASSESSMENT

Aerial Photograph of WIPP Facilities Area, 2009

Figure 2

Daniel B. Stephens & Associates, Inc.
05/25/2010 JN ES08.0072

S:/PROJECTS/ES08.0072_WIPP_SSW/GIS/MXDS/2010_REVISED_DRAFT_REPORT/FIG02_LEAD_ASSESSMENT.MXD 012140 which occurred between 1981 and 1984 (Bechtel, 1986). The SPDV pile was replaced by the Salt Storage Area and the Salt Storage Extension, which is the storage location for most salt excavated from the repository.

Based on visual inspection while trenching and drilling during DBS&A's 1995 investigation (DBS&A, 1996), the pile is composed of about 95 percent mined salt, other rock, and soil, interspersed with about 5 percent construction debris of various types. Appendix A provides photographs of the SPDV pile taken in 1995, prior to capping the pile, showing that the pile contains predominantly salt. Construction debris may include pieces of concrete, steel reinforcement bars (rebar), plastic, electrical cable, miscellaneous pieces of worn or broken equipment, rock bolts, rock bolt plates, limited quantities of petroleum hydrocarbons, and undetonated explosive material. DBS&A estimated the pile to contain approximately 168,000 cubic yards of material (DBS&A, 1996). Field characterization of the pile used a phased approach in which non-intrusive methods identified areas of interest for additional characterization by intrusive methods. The field activities included a magnetometer survey, a passive soil gas survey (PETREX), trenching, drilling, and collecting solid samples for chemical analysis.

2.2 SSW Occurrence and Water Quality

SSW at WIPP is a saturated perched lens of limited extent that occurs mainly in the Santa Rosa Sandstone Formation above the Dewey Lake Redbeds Formation contact. The SSW formed as a result of stormwater infiltration from recharge sources including stormwater retention ponds and the Salt Storage Area (DBS&A, 2003). Variable, elevated loads of total dissolved solids (TDS) occur in the SSW due to dissolution of the mined salt, which is primarily halite. The high TDS concentrations and the chemical composition of the seepage indicated that the SSW was caused in part by infiltration of precipitation in contact with the salt piles. In order to prevent further recharge, infiltration control systems were constructed at the SPDV pile in 2000 and at the stormwater retention ponds and the Salt Storage Area in 2004 and 2005 (DBS&A, 2008). Prior to the construction of WIPP, there had been no observed continuous zones of saturation in the shallow subsurface (e.g., Sergent, Hauskins & Beckwith, 1979). However, seeps and weeps were observed below approximately 60 feet bgs in the shafts in the 1980s (WIPP Lead

Working Group, 1996-1997), and a large lens of SSW was discovered after 1995 when water was found seeping at a sustained rate into the Exhaust Shaft (U.S. DOE, 2008). Lead has been detected in seepage into the Exhaust Shaft and the Waste Handling Shaft, most likely due to corrosion of galvanized mesh used to line sections of the shafts (WIPP Lead Working Group, 1996-1997; IT, 1996).

Investigation of the SSW began in 1996. A total of 18 shallow SSW monitor wells have been installed. Monitoring is performed under a New Mexico Environment Department (NMED) Ground Water Quality Bureau Discharge Permit (DP-831) in accordance with the requirements of the Water Quality Control Commission Regulations (20.6.2 NMAC). A modification to the permit in late 2006 resulted in the installation of wells PZ-13, -14, and -15 around the SPDV pile (U.S. DOE, 2008). The SSW investigation findings have been summarized in U.S. DOE (2008) and DBS&A (2008).

In 2007, monitor wells PZ-13, -14, and -15 were installed adjacent to the SPDV pile to determine whether SSW exists around the SPDV pile and to provide a means to monitor water quality (U.S. DOE, 2008). The three monitor wells installed adjacent to the SPDV pile found that SSW exists in multiple thin, possibly unconnected, perched zones below the SPDV pile at depths ranging from approximately 40 to 65 feet bgs. At PZ-13, the SSW saturated interval as observed during drilling is 2.5 feet thick.

Analytical data generated for PZ-13 to date are presented in Tables 1a, 1b, and 2. An initial water sample from PZ-13 collected on October 10, 2007 detected a dissolved lead concentration of 0.25 mg/L. A full chemical analysis of this sample is presented in Tables 1a and 1b. Lead is not currently routinely monitored in the other SSW wells, but historical samples detected lead at significantly lower concentrations than observed in PZ-13. Follow-up sampling of PZ-13 was conducted in September and October 2008 to confirm the lead detection, and measurement of lead has been added as a routine monitoring parameter for this well. During confirmation testing in 2008, lead was detected in three samples and one duplicate sample at concentrations ranging from 0.351 to 0.40 mg/L. Lead was not detected in the quality assurance field blank or in the laboratory method blanks at a concentration above the practical quantitation limit (PQL) of 0.005 mg/L. Table 2 shows that lead concentrations from the time of

Table 1a. Analyses of PZ-13 Samples Collected October 10, 2007

Value	Units	Dissolved Lead	Calcium (Ca^{2+})	Potassium (K^+)	Magnesium (Mg^{2+})	Sodium (Na^+)	Bicarbonate [a] (HCO_3^-)	Chloride (Cl^-)	Fluoride (F^-)	Sulfate (SO_4^{2-})	Nitrate [b] (NO_3^-)
Field parameters		*pH = 6.09*		*Temperature = 22.8 °C*		*Specific Conductance = >200,000 µmhos/cm (366,000 in laboratory)*					
Concentration (c)	mg/L	0.25	2220	618	1250	86100	89.2	150000	22.2	2670	54.9
	mg/kg	0.22	1910	532	1076	74094	76.8	129084	19.1	2298	47.2
Molecular mass	g/mol	207.19	40.08	39.098	24.305	22.989	61.0173	35.453	18.9984	96.0636	62.0049
Molarity	mol/L	1.2×10^{-6}	5.54×10^{-2}	1.58×10^{-2}	5.14×10^{-2}	3.75	1.46×10^{-3}	4.2	1.17×10^{-3}	2.78×10^{-2}	8.85×10^{-4}
Molality	mol/kg H_2O	1.4×10^{-6}	6.32×10^{-2}	1.80×10^{-2}	5.87×10^{-2}	4.27	1.67×10^{-3}	4.8	1.33×10^{-3}	3.17×10^{-2}	1.01×10^{-3}
Charge (z)	[–]	2	2	1	2	1	–1	–1	–1	–2	–1
Equivalent concentration (c * |z|)	eq/L	2.4×10^{-6}	1.11×10^{-1}	1.58×10^{-2}	1.03×10^{-1}	3.75	1.46×10^{-3}	4.2	1.17×10^{-3}	5.56×10^{-2}	8.85×10^{-4}
z^2	[–]	4	4	1	4	1	1	1	1	4	1
$c * z^2$	mol/L	4.8×10^{-6}	2.22×10^{-1}	1.58×10^{-2}	2.06×10^{-1}	3.75	1.46×10^{-3}	4.2	1.17×10^{-3}	1.11×10^{-1}	8.85×10^{-4}

[a] Reported as 144 mg/L bicarbonate alkalinity as $CaCO_3$
[b] Reported as 12.4 mg/L nitrate as N
°C = Degrees Celsius
µS/cm @ 25°C = Microsiemens at 25 degrees Celsius

mg/L = Milligrams per liter
mg/kg = Milligrams per kilogram
g/mol = Grams per mole
mol/L = Moles per liter

mol/kg H_2O = Moles per kilogram of water
[–] = Unitless
eq/L = Equivalents per liter

Table 1b. Calculations for PZ-13 Samples Collected October 10, 2007

Statistic	Value	Comments
Charge balance error	–3.82%	Charge balance error calculation uses Equation 3.21 of Freeze and Cherry (1979), thus may not be comparable to calculated values in other site documents.
Ionic strength (M)	4.27	
Sum of ions (mg/L)	243,024	
TDS (mg/L)	245,500	
Sum of Ions – TDS	–1.0%	
Estimated density (kg/L)	1.16	Density estimated from site-specific approximation by DBS&A (2008): 1 + [TDS (mg/L) $*$ 6.6 $*$ 10^{-7}].
kg H_2O / kg solution	0.7545	

Note: Geochemical modeling software used in this assessment may recalculate some values using slightly different methods.

M = Molar (moles per liter)
mg/L = Milligrams per liter

TDS = Total dissolved solids
kg/L = Kilograms per liter

kg = Kilograms

Table 2. Analyses of PZ-13 Samples

Sample Date	Sampling Method	Lead [a] (mg/L)	pH (S.U.)	Temperature (°C)	Specific Conductance (µS/cm @ 25°C)	Total Dissolved Solids (mg/L)	Chloride (mg/L)
Laboratory [b]		*HEAL*	*(field instrument)*			*HEAL*	*HEAL*
Analysis Method		*EPA 6010B*	*(field instrument)*			*SM 2540C*	*EPA 300.0*
10/10/2007	Low-flow	0.25	6.09	22.8	>200,000	245,500	150,000
6/06/2008	Bailer	NA	NA	NA	NA	240,000	170,000
9/17/2008	Low-flow	0.36	6.03	24.9	>200,000	NA	NA
10/13/2008	Low-flow	0.351	6.09	24.1	>200,000	230,000	160,000
10/22/2008	Low-flow	0.40	6.13	22.6	>200,000	NA	NA
10/22/2008	Low-flow (duplicate)	0.34					
5/18/2009	Low-flow	NA	6.11	26.2	>200,000	242,000	183,000
9/14/2009	Bailer	0.13J	NA	NA	NA	NA	NA
9/15/2009	Bailer	0.28	NA	NA	NA	NA	NA
9/16/2009	Bailer	0.31	NA	NA	NA	NA	NA
9/17/2009	Bailer	0.25	NA	NA	NA	NA	NA
9/17/2009	Bailer (duplicate)	0.39	NA	NA	NA	NA	NA
10/20/2009	Bailer	NA	NA	NA	NA	255,000	170,000

[a] Dissolved

[b] HEAL = Hall Environmental Analysis Laboratory

mg/L = Milligrams per liter
S.U. = Standard units
°C = Degrees Celsius
µS/cm @ 25°C = Microsiemens at 25 degrees Celsius
NA = Not analyzed

installation to the present have ranged from 0.13 to 0.40 mg/L. Concentrations of lead and other analytes in PZ-13 appear to be reasonably constant. Details of the well installation and sampling and analysis methods for PZ-13 that may affect the analytical data are discussed in Sections 5.4 and 7 and Appendix D (Section D.3).

3. Records Review

DBS&A reviewed records regarding material disposition into the SPDV pile, which are available at the WIPP records repository in Carlsbad, New Mexico. DBS&A examined records on April 30, 2009 along with staff from WTS. Little documentation was discovered that directly described placement of materials in the pile. Most records available describe drilling activities from the time of SPDV pile disposal operations. The documentation reviewed did not add information on the types of material disposed of in the pile beyond the information reported from the 1995 site investigation (DBS&A, 1996). At that time, direct observations of the material could be made in the uncovered pile and excavation of exploratory trenches. DBS&A's archives contain photographs and videotape from the 1995 site investigation. Some characteristic photographs are presented in Appendix A.

DBS&A reviewed reports and published literature that describe the geologic materials that would have been encountered by drilling and mining activities while the SPDV pile was open. Reports regarding the hydrogeology and water quality of the SSW were also reviewed. Several reports were reviewed on studies of SSW seepage into the Exhaust Shaft, which is collected and managed as hazardous waste due to the high lead content that the water acquires from contact with galvanized mesh in the shaft lining. Relevant findings from the review of the geology are presented in Section 4. The materials disposed of in the SPDV pile and shaft lining materials are discussed in Section 5.3.

DBS&A also reviewed field notes and documentation of drilling, well completion, field sampling, and laboratory analytical procedures used at PZ-13 and other SSW monitor wells. Individuals involved in drilling and sampling activities responded to questions through e-mail messages sent or forwarded to DBS&A by WTS. A review of original laboratory documentation for the lead detections in PZ-13 and related data was conducted to objectively test for laboratory influences on the lead results. The results of this review of monitor well drilling, sampling, and analysis practices are described in Sections 5.4 and 7 and Appendix D (Section D.3).

Subsequent to DBS&A's initial records review, WTS located and provided to DBS&A summaries of WIPP personnel interviews conducted at the time the 1995 site investigation was being planned. Personnel who had observed the generation or disposal of materials to the SPDV pile were queried regarding what materials they remembered being disposed of, whether they knew of any hazardous conditions that could potentially occur during the investigation work activities, and which other personnel might have knowledge of the pile contents. The interviews did not provide any specific evidence to support disposal of lead-bearing materials in the SPDV pile; rather, they indicated that the materials disposed of were primarily salt and shaft muck with small amounts of concrete and other construction debris, as was observed to be the case during the 1995 site investigation (DBS&A, 1996; Appendix A). Although galvanized mesh is a lead-bearing material used in shaft construction and possibly disposed of in the SPDV pile, Mr. Fred Ashford stated in his interview that no ground control material was disposed of in the pile, and no other interviewees identified ground control as a material disposed of there even though it was suggested as an example in the questionnaire.

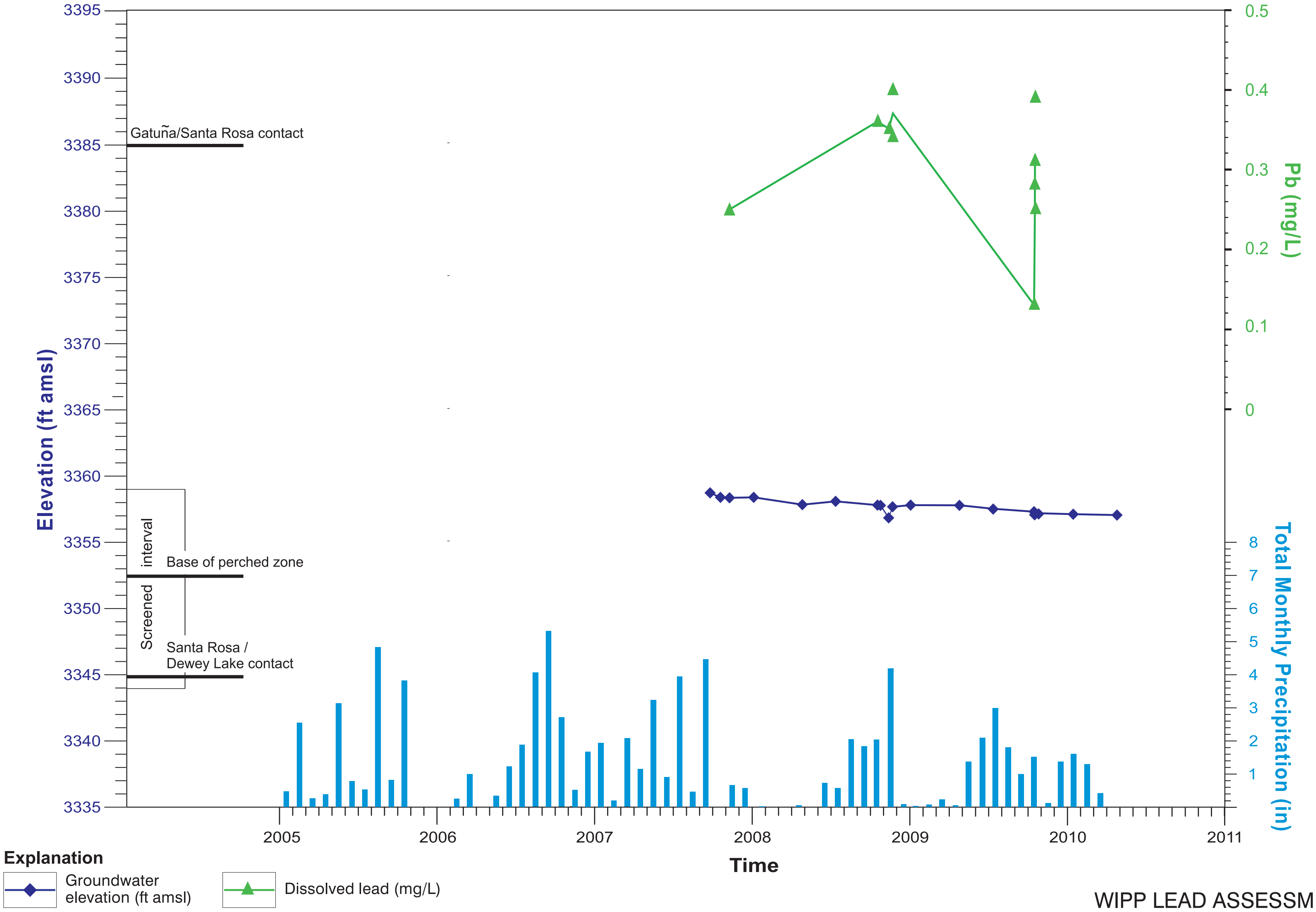
4. Overview of Site Geology, Mineralogy, and Hydrogeology

The geologic materials in the SPDV pile and the geology and hydrology of the formations underlying the pile are relevant to the occurrence of lead in the SSW at PZ-13 and its potential fate and transport. This section describes each formation and lists the minerals present based on previous studies. Additional mineralogy details are provided in Appendix B, including chemical formulas for all minerals discussed. Existing reports show an absence of lead-bearing minerals, but identify minerals that may contain lead impurities that influence the aqueous concentration of lead. Discussion of hydrogeology is presented only for those formations in which SSW occurs and not the deeper formations, although some of the deeper strata are water bearing.

4.1 Hydrogeology

The SPDV monitor wells, PZ-13, -14, and -15, encounter water in thin saturated zones. In PZ-13 and -15, these thin saturated zones occur in formation horizons that differ from the other SSW monitor wells in the previously studied SSW saturated lens (U.S. DOE, 2008). Copies of well logs from U.S. DOE (2008) are provided in Appendix C for reference. Hydrographs for these wells are provided in Figures 3 through 6, along with precipitation, chemical analyses, and geologic information. At PZ-13, a saturated interval 2.5 feet thick was encountered in a sandy siltstone layer in the lower Santa Rosa perched above a hard sandstone layer. Only PZ-14 encountered saturation in the lower Santa Rosa perched on the Dewey Lake contact, consistent with other SSW monitor wells. A thin saturated layer 0.8 foot thick was identified in PZ-14, overlying dry Dewey Lake claystone/siltstone. At PZ-15, a saturated interval 10 feet thick was encountered in the lower Gatuña, above the Santa Rosa, where dry and very hard sandstone was encountered. PZ-15 is the only SSW well that encountered saturation in the Gatuña. The hydrographs indicate that water levels are consistent to slightly declining, suggesting that precipitation-induced recharge is not affecting the wells.

S:\PROJECTS\ES08.0072_WIPP_SSW\VR_DRAWINGS\ES08_0072_013W_HYDROGRAPHS_4-12-10.CDR (PG 1)



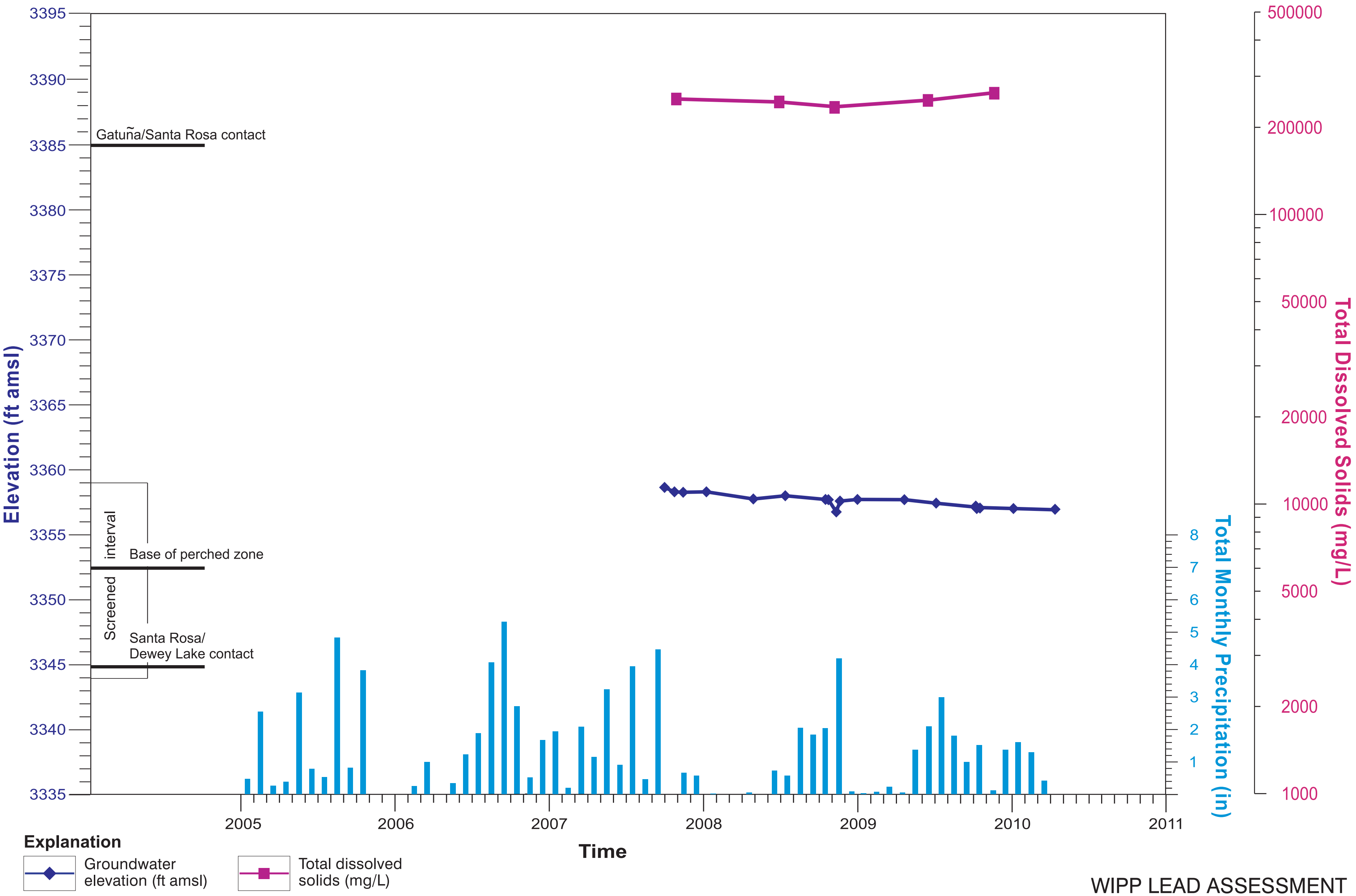
Notes: 1. All elevations to NGVD 29 datum.
2. For duplicate samples, symbols show values and line shows average.

WIPP LEAD ASSESSMENT

Hydrograph at PZ-13
Monthly Precipitation and Dissolved Lead

Figure 3

Daniel B. Stephens & Associates, Inc.
4-13-10
JN ES08.0072



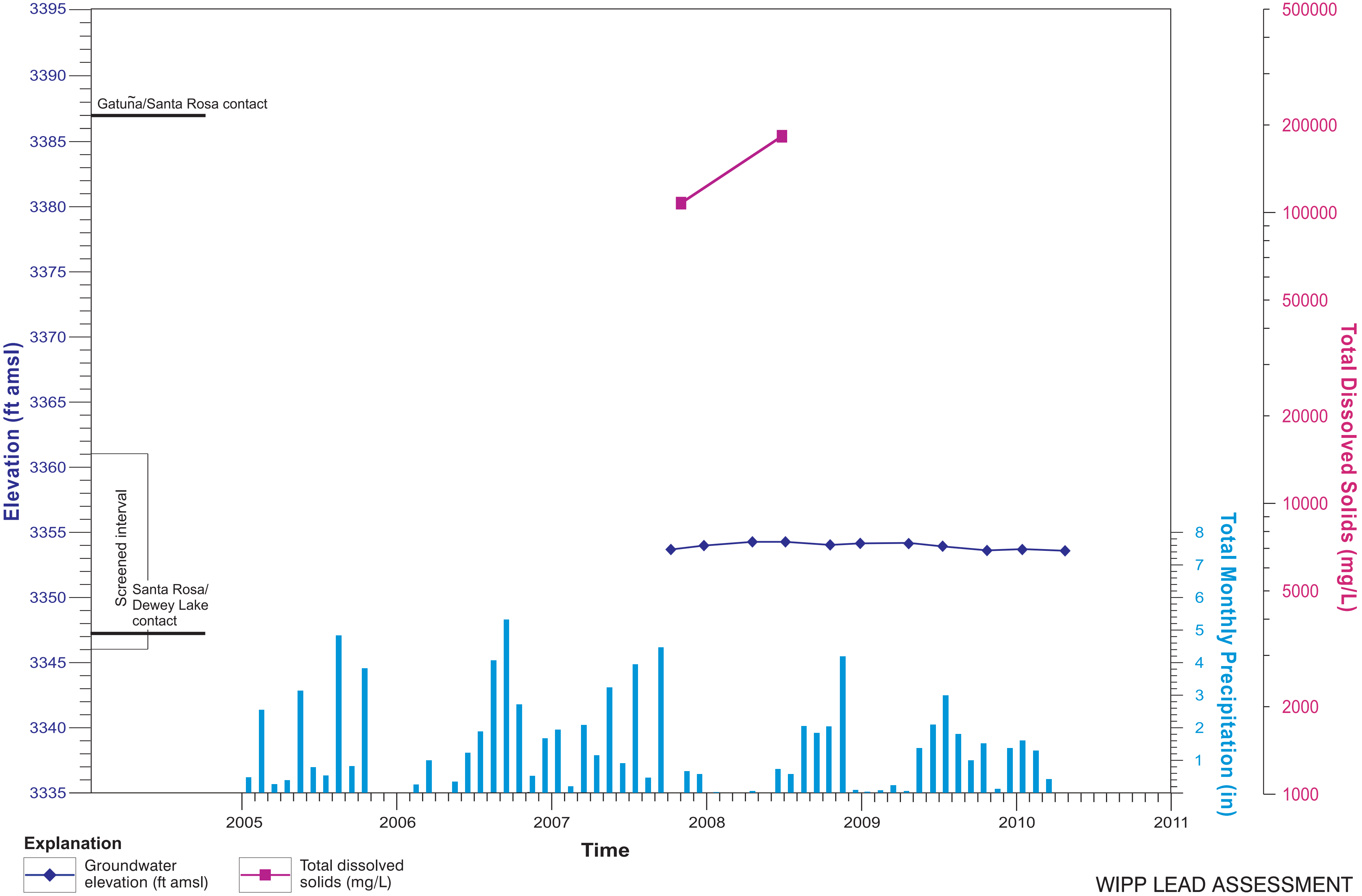
Note: All elevations to NGVD 29 datum.

WIPP LEAD ASSESSMENT

Hydrograph at PZ-13
Monthly Precipitation and Total Dissolved Solids

Figure 4

Daniel B. Stephens & Associates, Inc.
4-13-10
JN ES08.0072



Note: All elevations to NGVD 29 datum.

WIPP LEAD ASSESSMENT

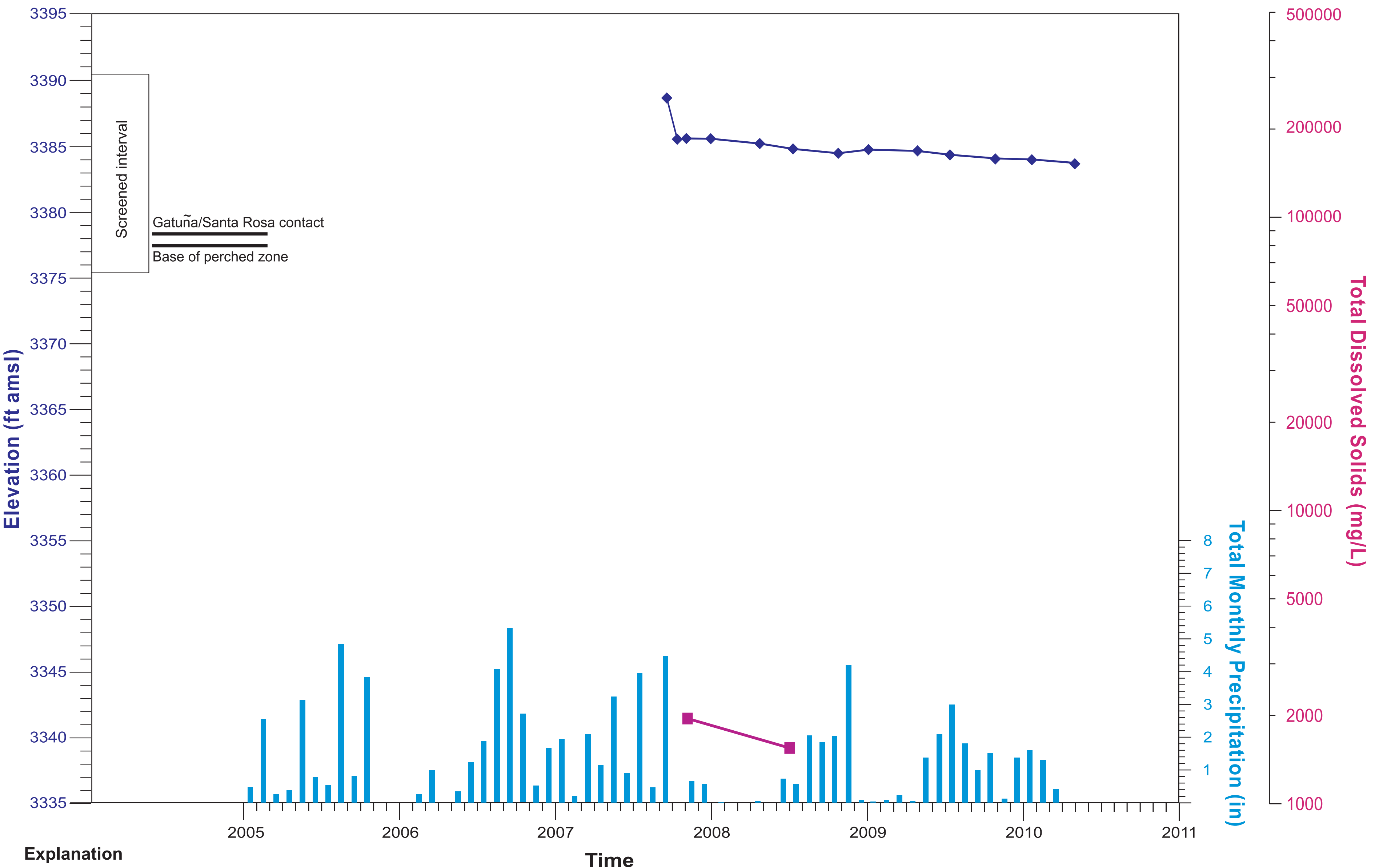
Hydrograph at PZ-14
Monthly Precipitation and Total Dissolved Solids

Figure 5

Daniel B. Stephens & Associates, Inc.

4-13-10

JN ES08.0072



Explanation

Groundwater elevation (ft amsl)

Total dissolved solids (mg/L)

Note: All elevations to NGVD 29 datum.

WIPP LEAD ASSESSMENT

Hydrograph at PZ-15
Monthly Precipitation and Total Dissolved Solids

Daniel B. Stephens & Associates, Inc.

4-13-10

JN ES08.0072

Figure 6

PZ-13 encounters a saturated interval in the Santa Rosa, but the well extends into the upper Dewey Lake. The saturated interval is at a depth of 65 to 67.5 feet bgs. This saturated interval is perched above a hard sandstone layer in the lower Santa Rosa, 7.5 feet higher than the Dewey Lake contact. PZ-13 is screened across the Santa Rosa/Dewey Lake contact and extends 2 feet into the upper Dewey Lake to a total depth of 77 feet bgs. During drilling, the Santa Rosa and Dewey Lake below 67.5 feet bgs were dry to moist, but unsaturated. Thus, the lower well casing behaves like a sump, holding water that enters from the saturated interval. Because the hard Santa Rosa encountered at PZ-13 and Dewey Lake form low-permeability aquitards capable of creating perched water conditions above, the water in PZ-13 is likely to fill the casing and saturate the sand pack, remaining relatively stagnant in the well between sampling events.

Table 3 summarizes the formation horizons and elevations where SSW is encountered in the three SPDV pile monitor wells. The differences suggest that the thin saturated zones are isolated, rather than being connected in a continuous saturated lens.

Table 3. SSW Perched Zone Thickness, Formation, and Depth

	Saturated Interval			
Well	Thickness (feet)	Horizon	Depth to Water (feet btoc)	Water Level Elevation (feet amsl)
PZ-13	2.5	Lower Santa Rosa perched on hard sandstone 7.5 feet above Dewey Lake contact	65	3,357
PZ-14	0.8	Lower Santa Rosa perched on Dewey Lake contact	67	3,354
PZ-15	10	Lower Gatuña perched on Santa Rosa contact	47	3,384

btoc = Below top of casing
amsl = Above mean sea level

Water quality in the SPDV pile monitor wells is highly variable, also suggesting that the saturated interval is not continuous between the three wells. TDS concentrations on October 10, 2007 were 2,060 mg/L in PZ-15, 106,000 mg/L in PZ-14, and 245,500 mg/L in PZ-13 (U.S. DOE, 2008). Figures 4 through 6 show that TDS concentrations have remained consistent over time in each of the three wells. Based on the variability in water quality and the formation intervals where saturation occurs, the water encountered in the SPDV pile wells is not clearly linked to the main SSW saturated lens and may be a result of infiltration through the SPDV pile prior to final cover construction or recharge from other sources.

Pumping and slug tests have shown relatively low saturated hydraulic conductivity (K_{sat}) values for the Santa Rosa Sandstone of 2.64×10^{-8} to 5.48×10^{-5} meters per second (m/s) (Intera, 1996 and 1997). The lowest K_{sat} values were measured at PZ-01, -02, and -05 and define a reduced conductivity zone on the east side of the WIPP facilities area that may impede or prevent hydraulic communication between the main SSW lens and the SSW below the SPDV pile (DBS&A, 2003; DBS&A, 2008). These low values may also account at least in part for the absence of saturation at PZ-08 until SSW spreading reached the well in March 2007. K_{sat} has not been measured directly for any of the formations at PZ-13, -14, or -15, but substantial drawdown and slow water level recovery observed while sampling these wells indicates that the local transmissivity values are small (Section 5.5.3). Recovery measured following bailing PZ-13 for the repeat sampling event described in this assessment (Section 7) was consistent with this interpretation; however, the construction of the well precludes an accurate quantitative baildown test analysis for transmissivity.

The upper layer of the Dewey Lake Formation behaves as an aquitard, with drilling logs showing decreasing moisture with depth in this layer locally (U.S. DOE, 2008). The upper surface of the Dewey Lake exhibits hummocky relief across the site and regionally, such that SSW migration is constrained by the uneven Dewey Lake surface that forms the perching horizon (DBS&A, 2003; U.S. DOE, 2008). The SPDV pile appears to be located over a local low area of the upper Dewey Lake surface with a sharp rise to the west (U.S. DOE, 2008). A large regional high occurs south of the SPDV pile, and a large regional low occurs to the northeast (DBS&A, 2003).

When the SPDV pile was surveyed in 1995, it sloped generally toward the southwest (DBS&A, 1996), which may have been conducive to focusing infiltration toward the southwest quadrant of the pile near PZ-13. The final cover over the SPDV pile is constructed with surface soils from a borrow pit on the east side of the pile (U.S. DOE, 2008). This borrow pit is currently a shallow depression visually estimated to be approximately 5 feet deep at the center and devoid of vegetation.

As the SSW studies have shown, land areas that receive precipitation or runoff without vegetation to remove moisture through transpiration will exhibit increased infiltration. Therefore, the borrow pit may provide an existing source for focused infiltration of stormwater just east of the SPDV pile. An effort to establish vegetation across the borrow pit could reduce the possibility of infiltration that may contribute to recharge to the SSW. Infiltration of stormwater in the borrow pit, which does not contact with the mined salt in the pile, would help to explain the much lower TDS concentration in well PZ-15 east of the pile (1,600 mg/L in June 2008) compared to TDS concentrations in well PZ-13 (240,000 mg/L in June 2008). On the other hand, no recharge is discernable from the hydrograph for PZ-15; therefore, if any recharge has recently occurred, it has not been as rapid as drainage from the perched zone.

4.2 Geology and Mineralogy

This section provides brief descriptions of the most significant formations for this assessment: the Gatuña, Santa Rosa, Dewey Lake, and Salado Formations. Details of the formation geology and mineralogy are provided in Appendix B. WIPP reports and published literature were examined to identify any lead-bearing minerals occurring in the formations. A thorough literature search did not identify any primary lead-bearing minerals, but did identify minerals that may contain lead impurities that influence the aqueous concentration of lead.

All formations from ground surface to the Salado Formation were mined from the four shafts; materials from these formations were placed in the SPDV pile, where they may have been leached by precipitation prior to the capping of the pile in 2000. Table 4 lists the approximate average thicknesses of the major formations from geologic logging and mapping of the shafts (Bechtel, 1986; Holt and Powers, 1990).

Table 4. Formation Thickness and Depth

Formation	Thickness (feet)	Depth (feet below ground surface)
Quaternary dune sand	10	0 to 10
Mescalero caliche	8	10 to18
Gatuña Formation	17	18 to 35
Santa Rosa Sandstone Formation	18	35 to 53
Dewey Lake Redbeds Formation	475	53 to 528
Rustler Formation	308	528 to 836
Salado Formation	>1,370	836 to >2,206

4.2.1 Gatuña Formation

The Gatuña Formation (the Gatuña) consists of silt, sand, and clay, and is discontinuous, with deposits in localized depressions (Hendrickson and Jones, 1952). Boring logs from on-site drilling by Sergent, Hauskins & Beckwith (1979) describe the Gatuña as predominantly sandstone with interbedded siltstone that is highly weathered, fractured, and moderately hard.

At PZ-13, -14, and -15, the Gatuña was described as argillaceous and calcareous, containing chert pebbles and carbonate clasts as well as carbonate and silica cementation (U.S. DOE, 2008).

4.2.2 Santa Rosa Sandstone Formation

The Santa Rosa Sandstone Formation (the Santa Rosa*)* consists of gray and red sandstone with lenses of shale and conglomerate (Hendrickson and Jones, 1952). Saturation in PZ-13 as encountered during drilling occurred in a sandy argillaceous siltstone interval from 65 to 67.5 feet bgs and decreased with depth as the siltstone became harder and as clay content increased (U.S. DOE, 2008). Thus, the base of the perching layer depicted at an elevation corresponding to 67.5 feet bgs in Figures 3 and 4 is interpreted from the drilling observations but is not a distinct boundary. Secondary iron oxide mineral coatings are abundant in the Santa Rosa.

4.2.3 Dewey Lake Redbeds Formation

The Dewey Lake Redbeds Formation (the Dewey Lake*)* consists of interbedded reddish brown fine sandstone, siltstone, mudstone, and claystone (Holt and Powers, 1990). The red color is due to a thin hematite coating deposited uniformly on the surface of the sand and silt grains as a chemical precipitate (Miller, 1966). The Dewey Lake is characterized by abundant greenish-gray reduction spots (Holt and Powers, 1990). The upper Dewey Lake at the Santa Rosa contact at PZ-13 is a dark reddish brown, micaceous, silty mudstone with greenish gray reduction spots (U.S. DOE, 2008).

4.2.4 Salado Formation

The Salado Formation consists of halite occurring in thick beds of rock salt that alternate with thinner beds of anhydrite, polyhalite, and glauberite (Jones et al., 1973). Rock salt constitutes 85 to 90 percent of the formation, with anhydrite the second most abundant rock (Jones et al., 1973). The formation comprises an unnamed upper member, a middle member locally known as the McNutt potash zone, and an unnamed lower member in which the WIPP repository horizon is located. According to Jones et al. (1973), enrichment in sylvite, carnallite, and other potassium- and magnesium-bearing minerals is distinct to the McNutt potash zone. Potash ore produced in the area typically contains about 60 percent halite, 30 percent sylvite, 5 percent langbeinite, 2 percent polyhalite, and 3 percent insolubles (NMBGMR, 2008). The insoluble fraction may include occluded iron minerals.

5. Possible Sources of Lead Detections at PZ-13

The dissolved lead observed in SSW at PZ-13 may be derived from lead-bearing construction debris disposed of in the SPDV pile or the natural occurrence of lead in geologic materials. Geologic materials include the formation materials placed in the SPDV pile and soil and rock formations in the vadose zone below the pile, including the SSW interval. The introduction of lead during drilling or sampling PZ-13 is another possibility for the source. Other possible sources of lead were considered in this assessment, but appear unlikely. Thus, the possible sources of the lead in PZ-13 samples are related to the SPDV pile contents, undisturbed strata between the ground surface and the SSW saturated interval, or the monitoring activities themselves. Potential sources of the lead detections in PZ-13 are summarized in Table 5 and discussed in the following subsections. Discussion of the potential lead sources considered to be unlikely are provided in Appendix D. This section focuses on the potential sources that were considered plausible after initial evaluation.

5.1 Natural Occurrence of Lead in Native Geologic Materials

Lead may occur in a variety of geochemical settings and be associated with many different minerals. The following discussion provides information on lead occurrence in geologic materials placed in the SPDV pile that have been encountered during drilling of shafts and mining of salt.

Records were sought that could indicate the concentrations of lead in native geologic materials between the ground surface and the mined depths of the Salado Formation, including the geologic strata present above the screen of PZ-13 as well as the mined materials that were placed in the SPDV pile. Few direct measurements of lead in soil or rock samples were available from historical investigations, but information regarding the mineralogy of the native materials was reviewed to evaluate primary and secondary minerals likely to contain relatively high lead concentrations. Based on review of the available geologic literature, there are no observations of primary lead minerals reported in any of the site formations; however, several minerals in sediment and bedrock at the site may contain traces of naturally occurring lead. Mined materials and their mineralogy are described in Section 4 and Appendix B.

Table 5. Summary of Potential Sources of Lead Detections at PZ-13
Page 1 of 3

Item	Conclusion	Main Supporting Factors For Conclusion	Notes/Caveats
Monitoring Materials or Procedures			
Laboratory contamination or false positives	Not the source	Multiple samples, methods, and laboratories, documented QA/QC	
Acidification of sediment in samples	Not the source	Filtering and other precautions, uniqueness to PZ-13, lack of other elevated trace metals	
Contamination from well materials or sampling equipment	Not the source	Materials intended for environmental monitoring, same equipment used at other SSW wells; repeat sampling event data suggest that the source is not located in the well.	PZ-13 brine could corrode some materials more aggressively than other SSW, but presence of lead in equipment unlikely.
Contamination from drilling apparatus	Not the source	Drill bit teeth lost downhole at PZ-13. Tests show lead does not leach from the different drill bit teeth used at PZ-13 and no parts of drilling apparatus contain high lead concentrations.	Drilling method at PZ-13 used custom fabricated equipment.
Historical Activities at or Near the WIPP Facility			
Oil and gas exploration and production	Not the source	No evidence activity occurred in immediate vicinity of PZ-13, and activity not specifically associated with lead contamination.	
Potash mining	Not the source	No evidence activity occurred in immediate vicinity of PZ-13, activity not specifically associated with lead contamination, and calculation shows maximum lead concentration in potash is too low.	Potash brine may have been used for drilling shafts; traces of lead conceivably present in potash but concentrations negligible.
Ranching (cattle grazing)	Not the source	Activity not associated with lead contamination.	
Hunting and trapping	Not the source	No evidence activity occurred in immediate vicinity of PZ-13, measures taken to secure site from trespassing	Lead used in ammunition.
WIPP activities other than SPDV disposal	Not the source	Physical distance between PZ-13 and main campus, natural and engineered transport barriers	

Table 5. Summary of Potential Sources of Lead Detections at PZ-13
Page 2 of 3

Item	Conclusion	Main Supporting Factors For Conclusion	Notes/Caveats
Geologic Materials in situ or in SPDV Pile			
Halite	Not the source	Lead not detected by XRF screening of halite horizons or by laboratory analysis of Salt Storage Extension Evaporation Basin water with higher salt concentration than PZ-13.	Most abundant material in SPDV pile
Sand, sandstone, siltstone, and similar clastic sediments	Most likely source	Lead adsorption to iron oxides and association with other Dewey Lake minerals shown by quantitative laboratory analysis and electron microprobe imagery, feasibility of enhanced dissolution by brine in PZ-13 proven by leaching tests.	Upper Dewey Lake is the only geologic material with lead levels detectable by XRF.
Sulfate minerals	No evidence of contribution	Elevated lead not generally expected in sulfates, but little relevant site data exists.	
Carbonate minerals	No evidence of contribution	Lead not detected in Mescalero caliche by XRF or 1995 TCLP, but other horizons not tested, and lead concentrations in carbonates conceivably similar to those in sandy sediments.	
Potash minerals	Not the source	Calculation shows maximum lead concentration in potash is too low.	
Other geologic materials	Not the source	No primary lead minerals identified by electron microprobes or in any previous investigations or expected to occur in likely depositional environments, other minerals with potential lead association not likely to exist in significant quantity.	
Construction Wastes in SPDV Pile			
Concrete	No evidence of contribution	Lead not expected in either concrete or rebar	
Steel plate, scrap, and debris	No evidence of contribution	Lead not expected in ordinary steel	

Table 5. Summary of Potential Sources of Lead Detections at PZ-13
Page 3 of 3

Item	Conclusion	Main Supporting Factors For Conclusion	Notes/Caveats
Construction Wastes in SPDV Pile (cont.)			
Petroleum hydrocarbons	Not the source	No evidence of leaded gasoline, other petroleum products would not have contained enough lead to cause concentrations observed in PZ-13.	
Explosives	No evidence of contribution	Possible presence in pile indicated in personnel interviews, but not directly encountered.	May contain lead
Blasting caps	No evidence of contribution	Possible presence in pile indicated in personnel interviews, but not directly encountered.	May contain lead
Galvanized chain link mesh	No evidence of contribution	No evidence of disposal in pile. Lead to zinc ratios in PZ-13 similar to those in Dewey Lake leaching test. Chain link mesh corrosion testing found much higher zinc concentration not evident at PZ-13.	
Lead wool	No evidence of contribution	No evidence of disposal in pile	Used small amounts during shaft construction, consists of pure lead

In general, naturally occurring lead could exist as or be associated with a variety of minerals including:

- Primary lead minerals such as galena, anglesite, or cerussite
- Rock-forming minerals as secondary trace constituents in plagioclase and potassium feldspars, amphiboles, and biotite micas, or decay products of uranium and thorium occurring as trace constituents in other minerals
- Potash minerals as a secondary trace constituent, particularly sylvite due to cation substitution
- Materials adsorbed onto clay minerals or mineral coatings on aquifer grains and soil particles such as those formed by iron and manganese oxides
- Weathering and erosion of any of these types of geologic materials forming sedimentary rocks or soils

5.1.1 Lead Minerals

Primary lead minerals include galena (PbS) or weathering products derived from galena such as anglesite ($PbSO_4$), cerussite ($PbCO_3$), chloropyromorphite ($Pb_5(PO_4)_3Cl$), or plumbojarosite ($PbFe_2(SO_4)_4(OH)_{12}$). Significant concentrations of these minerals would be found associated with mineral deposits and probably not in the sedimentary rocks of southeastern New Mexico. Researchers at the WIPP site have not identified lead minerals occurring in the on-site geologic materials (Section 4).

5.1.2 Rock-Forming Minerals

In common rock-forming minerals, lead would be a minor secondary constituent if present and could occur due to substitution in the crystal structure. Cation substitution is a common phenomenon during mineral formation. Cations with a similar ionic radius may replace other similarly sized cations within a crystal lattice. Lead is known to substitute in plagioclase and potassic feldspars, biotite, and amphiboles, and lead would only be a trace constituent in these minerals (Smith and Huyck, 1999). Plagioclase and orthoclase feldspars and biotite were identified in the Santa Rosa and Dewey Lake.

Some igneous minerals may naturally contain trace constituents of uranium and thorium that are capable of decaying to lead. Weathering and erosion of these igneous rocks may contribute to small quantities of these minerals and constituents in sedimentary rocks. Monazite (Ce, La, Nd, Th, YPO_4) and xenotime (YPO_4) may contain uranium and thorium and was identified in this study within samples of the Dewey Lake (Section 6.2).

5.1.3 Weathering and Soil Minerals

Lead is a trace element found in sedimentary rocks and soils. Lead occurs as lead oxides (e.g., litharge-PbO), lead phosphates (e.g., chloropyromorphite), or adsorbed as Pb^{2+} on iron and manganese coatings (Traina and Laperche, 1999). In the acidic to neutral pH range, the sulfates, carbonates, and oxides that may contain lead will be soluble, whereas lead phosphates are essentially insoluble. Therefore, phosphate concentrations in water may control lead solubility.

During weathering of minerals in the subsurface, the lead and other cations that have substituted in these minerals can be released into the environment along with major cations typically associated with these minerals (e.g., calcium and sodium from plagioclase). Weathering products such as clays derived from these minerals are more stable than the parent minerals in a surficial environment. Although the lead would be exposed to weathering, the mobility may be limited because it would become incorporated in or adsorbed to the surface of the newly formed minerals.

As a basis for considering concentrations of lead in on-site geologic materials, comparisons can be made with average concentrations elsewhere. The average crustal abundance of lead is approximately 15 milligrams per kilogram (mg/kg) (Callahan et al., 1979). Sposito (1989) reported a soil enrichment factor (soil concentration/crustal abundance) for lead of 1.4. Background lead concentrations in soils in the continental U.S. are generally well below 100 mg/kg, with a geometric mean of 17 mg/kg (Shacklette and Boerngen, 1984). The range of naturally occurring lead concentrations in the crust and/or soils may serve as a basis for crude estimates of concentrations in clastic sedimentary rocks at the site.

5.1.4 Potash Minerals

The types of primary minerals (halite, gypsum, anhydrite, polyhalite, and potash minerals) found in the evaporites of the Rustler and Salado Formations typically contain very little lead. Potash salts, particularly sylvite, may be an exception because researchers have reported that lead will substitute for the potassium cation by solid solution or diffusion mechanisms. Potash salts are also generally the last evaporites to precipitate from formation brines, acquiring the greatest evapoconcentration of trace constituents. The lead content of potash in the Salado Formation at the WIPP site has not been measured. Reported lead concentrations in sylvite vary from 0.8 to 1.3 micromoles per kilogram (µmol/kg) (Kühn, 1966; Amdouni, 2009). This type of cation substitution is plausible given that the ionic radii of Pb^{2+} and K^{+} are fairly similar. For example, for a coordination number of 6, the ionic radii of Pb^{2+} and K^{+} are 1.26 and 1.46 angstroms, respectively (Faure, 1991). Due to the slight difference in ionic radius and the charge difference, sylvite crystals with lead substituted would likely have crystal defects that would probably weather faster than a pure crystal.

The concentration of lead that could be released from potash minerals in the SPDV pile during weathering and dissolution can be estimated using a rough mass-balance calculation based on certain assumptions. One assumption is that the potash initially contained lead concentrations ranging from 0.8 to 1.3 µmol/kg as reported for sylvite in other parts of the world (Kühn, 1966). These values correspond to concentrations of 0.17 to 0.27 mg/kg, which may be too low to be easily detected by x-ray fluorescence (XRF) screening or other rapid methods.

Using the reported lead concentration in sylvite, the potential concentration that would result in PZ-13 water from sylvite dissolution can be considered. It is convenient to assume that lead dissolves from sylvite in direct proportion to its mass concentration in the salt and that the dissolved potassium concentration of 618 mg/L measured in PZ-13 is derived entirely from dissolution of sylvite. This assumption yields higher estimates of potential lead concentrations than a calculation that includes contributions from potash salts with higher stoichiometric ratios of magnesium to potassium (lead does not substitute as easily for magnesium) or non-potash sources to the measured potassium concentration. The concentration of dissolved lead from the corresponding mass of dissolved sylvite would then be on the order of 10^{-4} mg/L. Even if the concentration of lead in potash from the site were higher than the values from the literature or the potassium concentration measured for PZ-13 were somewhat lower than the actual quantity dissolved from potash in the pile, it is unlikely that the resulting concentration of dissolved lead would exceed 10^{-3} mg/L. Therefore, dissolution of potash salts alone could not account for the observed lead concentrations in PZ-13.

As discussed in Section 5.4, drilling fluids derived from potash brines may have been used at the WIPP site and may have contained levels of lead similar to those estimated here.

5.1.5 Secondary Minerals

Secondary minerals such as coatings of iron and manganese oxides on soil or aquifer grains and also clay minerals have a relatively large surface area for surface complexation to adsorb cations such as lead. This is generally referred to as the cation exchange capacity (CEC). The ability of these minerals to adsorb cations is often pH dependent; for example, lead adsorption at neutral to alkaline pH is higher than at acidic pH. Organic material found in soils or aquifers also has an affinity for metal adsorption.

Iron and manganese oxides often form coatings on soil and aquifer particles and are in direct contact with pore solutions. These variably charged minerals have the capability to adsorb ions from solution without releasing ions in equivalent proportions as surface charge varies between positive and negative (Appelo and Postma, 2005).

Clay minerals and iron and manganese oxides have been detected in the Gatuña, Santa Rosa, Dewey Lake, and Salado, as discussed in this section and in Appendix D.

5.2 Geologic Materials in the SPDV Pile

Prior to capping, the SPDV pile was visually estimated to contain approximately 95 percent geologic material, including mined salt, rock, and soil from the construction of the shafts (DBS&A, 1996). As reported by DOE, "All formations to the depth of the shafts were mined; therefore, minerals such as gypsum ($CaSO_4 \cdot 2H_20$), anhydrite ($CaSO_4$), halite (NaCl), sylvite (KCl), carnallite ($KMgCl_3 \cdot 6H_20$), and soda niter ($NaNO_3$) associated with gypsum and halite were included in the SPDV pile cuttings" (U.S. DOE, 2008). The information compiled in Section 4 indicates that the excavated formations would also have included noteworthy quantities of silicate, carbonate, potassium, iron, and clay minerals.

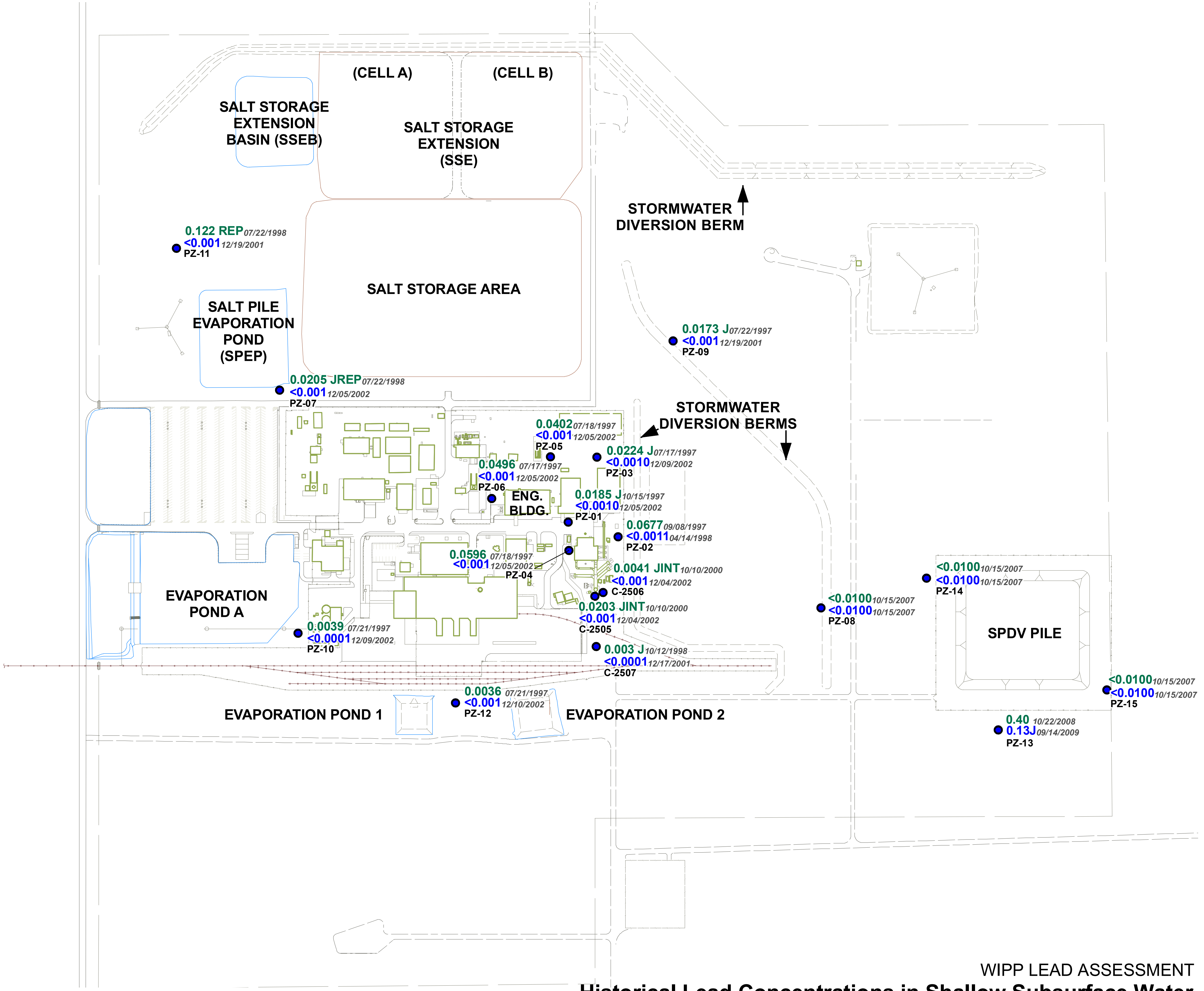
The relative abundance of minerals from each formation in the SPDV pile can be estimated from the thicknesses of the formations encountered in the shafts (e.g., Table 4). Salado Formation materials (mostly halite) account for more than 60 percent of the excavated stratigraphic column from drilling the shafts to the repository level and 100 percent of the excavated drifts and rooms. Therefore, the most abundant material in the pile is expected to be halite, followed by sandstone and siltstone materials, sulfates (anhydrite and gypsum), carbonates (dolomite and calcite), and finally potash salts (sylvite and langbeinite). Impurities in the halite may also account for significant quantities of materials. The repository horizon was selected to avoid fractures, clay seams, anhydrite beds, and "horizons containing substantial amounts of polyhalite", whereas "minor impurities, such as argillaceous halite and polyhalite" were considered acceptable (Bechtel, 1986).

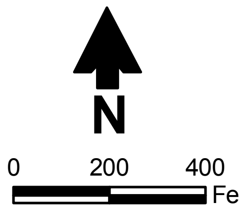
During the 1995 SPDV pile investigation, DBS&A collected samples from 10 borings into the pile for laboratory analyses that included toxicity characteristic leaching procedure (TCLP) analyses for the Resource Conservation and Recovery Act (RCRA) 8 metals (arsenic, barium, cadmium, chromium, lead, mercury, selenium, and silver). Lead concentrations were below the reporting limit of 0.1 mg/kg in the TCLP leachate of all samples. Other metals were also below reporting limits, except for low concentrations of barium and a single detection of chromium exactly at the reporting limit. The borings were targeted toward areas of the pile where soil gas surveys indicated elevated hydrocarbons, and the boring logs described the sampled intervals as pinkish white to light red salt, silty sand, caliche, or combinations thereof. Some samples contained traces of material identified alternately as limestone gravel or caliche gravel, and some intervals in the borings reacted moderately to strongly with hydrochloric acid, confirming the presence of carbonate minerals (probably calcite because dolomite has a weaker reaction).

Although the formation materials sampled from the pile are limited, the lack of lead detections in the TCLP samples is noteworthy because it demonstrates the absence of leachable lead under more aggressive, acidic leaching conditions than would likely occur with the moisture in the pile prior to its capping. The lack of detectable concentrations of lead measured in the 10 samples tested in 1995 is important to the current assessment, as it suggests that substantial amounts of material in the heterogeneous salt pile do not contain elevated lead concentrations.

The Salt Storage Area is a source of dissolved salt that has impacted the SSW salinity (DBS&A, 2003). If Salado Formation materials in the SPDV pile were the source of the lead detections in PZ-13, similar lead concentrations would be expected elsewhere in the SSW. However, lead concentrations measured in SSW monitor wells away from the SPDV pile are generally less than 0.07 mg/L, with one detection of 0.12 mg/L (which was qualified by the laboratory, making this result less reliable). The ranges of lead concentrations detected in the SSW wells are shown on the map in Figure 7. Solutions saturated with salt mined from the Salado have been tested to show lead concentrations of 0.0311 mg/L (IT, 1996) to 0.1 mg/L (IT, 1997) in brine samples considered indigenous to the Salado by previous investigators. However, the lead detections in PZ-13 are roughly 3 times higher than the maximum detection in any other SSW well. These data suggest that Salado halite or other impurities in halite are probably not the source of elevated lead at PZ-13; however, potash salts, clays, and other minerals only found in significant concentration above the repository horizon cannot be ruled out on this basis.

Materials likely representing all formations removed during shaft drilling were temporarily stored in a lined pit at the present location of the Engineering Building (Figure 7). These materials were described as being in contact with fluid before the liner was perforated to dewater the pit prior to backfilling and closing the pit (U.S. DOE, 1997b). If geologic materials from above the repository horizon were the source of lead, an association with relatively high lead concentrations could potentially be identified in samples from the SSW wells nearest to the location of this pit, along with a decreasing trend for samples taken at increasing distances from





Explanation

●	Well
0.0036	Maximum historical concentration (mg/L)
<0.0010	Minimum historical concentration (mg/L)
07/21/1997	Date sampled
PZ-12	Designation

Notes:

1. Qualifier codes reported by analytical laboratories indicate greater uncertainties for some laboratory results:
   J = Estimated value due to concentration below the quantitation limit but above the method detection limit.
   REP = Duplicate analysis not within limits.
   JINT = Estimated value due to concentration below the quantitation limit and interference.
   JREP = Estimated value due to concentration below the quantitation limit and duplicate analysis not within limits.

2. Saturation at PZ-13 is perched within the lower Santa Rosa Formation. Well PZ-15 is screened across the Gatuña Formation/Santa Rosa Formation contact. All other wells shown, including PZ-13, are screened at or across the Santa Rosa Formation/Dewey Lake Formation contact.

Daniel B. Stephens & Associates, Inc.
04/12/2010
JN ES08.0072

WIPP LEAD ASSESSMENT

Historical Lead Concentrations in Shallow Subsurface Water

Figure 7

S:/PROJECTS/ES08.0072_WIPP_SSW/GIS/MXDS/CHEMISTRY/LEAD_HISTORICAL_SUBSURFACE_WATER.MXD 012140 the pit and a decrease over time after the materials were removed. As shown in Figure 7, some of the nearest wells did in fact detect relatively high lead concentrations; however, it is difficult to discern a clear spatial or temporal pattern to the concentrations. The wells surrounding the location of the lined pit at the current Engineering Building location (PZ-01, -03, -04, -05, and -06) all contained lead concentrations below the laboratory reporting limit in 2002 testing. Lead has generally not been analyzed in SSW samples since 2002 except for the initial sampling of wells near the SPDV pile and follow-up testing of PZ-13.

5.3 Construction Debris in the SPDV Pile

The SPDV pile contains approximately 5 percent construction debris and other possible waste material. Items reported as potentially present in the construction debris include pieces of concrete, steel reinforcement bars (rebar), plastic, electrical cable, miscellaneous pieces of worn or broken equipment, rock bolts, rock bolt plates, limited quantities of petroleum hydrocarbons, and undetonated explosive material. Construction waste types that were considered in the assessment but were found to be unlikely sources of lead in PZ-13 are addressed in Appendix D. Feasible lead sources are addressed in this section.

Site investigation activities have included visual inspection of the pile surface and trenches and a magnetometer survey confirming the presence of sheet iron sections, a steel T-post (fence post), a thick, flat steel plate, a thin steel plate resembling a traffic sign, a pipe, a culvert, a concrete slab, and small pieces of scrap iron, rebar, and small metallic objects that could have been large nuts and bolts (DBS&A, 1996; Sunbelt, 1995). The magnetometer detected four “significant magnetic features . . . which had no observed surface source,” two of which were likely accounted for by the fence post, rebar, and steel plates discovered in test trenches (Sunbelt, 1995). No drums or containers were encountered (DBS&A, 1996). Lead is unlikely to originate from concrete or ordinary steel, but could feasibly be present in other types of construction debris.

Although not specifically reported to be potentially present in the SPDV pile, the galvanized chain link mesh used to line portions of the shafts and drifts for ground control was determined to be the source of elevated lead in brine water seeping into the Exhaust Shaft and the Waste

Handling Shaft (IT, 1996 and 1997). The process of galvanizing steel involves electroplating zinc onto the steel, and lead is present as an impurity in the zinc (IT, 1996). Lead concentrations ranging from about 0.1 to 48 mg/L (with some concentrations possibly affected by evaporation) were detected in brine collected in the Exhaust Shaft Basin and were attributed to corrosion of this galvanized mesh (IT, 1996 and 1997; U.S. DOE, 1997a). Laboratory tests using a solution saturated with salt mined from the Salado at the site to leach samples of galvanized mesh taken from the shafts produced lead concentrations up to 2.47 mg/L in the leachate (IT, 1996).

Another construction material used in the shafts and identified as a potential source of lead was the lead wool used to seal joints and borings in the cement liners (IT, 1996). Lead wool was considered a less probable source of lead in the brine in the shafts because the volume of lead wool used was reportedly less than that of the galvanized mesh, the lead wool was less exposed, and other observations were consistent with corrosion of the mesh (IT, 1996).

Galvanized mesh and lead wool could both potentially be present in the SPDV pile based on their use as construction materials in the shafts, though no such disposal has been reported. Based on the previous laboratory tests, water in contact with both the salt in the SPDV pile and one of these lead-bearing construction materials could reasonably account for lead concentrations observed in samples from PZ-13. However, no specific information is available indicating that these materials are present in the SPDV pile.

Brine was used as a drilling fluid for the construction of the shafts (Bechtel, 1986; Holt and Powers, 1990) and could feasibly be present in the SPDV pile as fluid or residual with rock cuttings. The 1995 borings and trenches did not encounter any liquids (DBS&A, 1996), and personnel interviewed at the time stated that none were disposed of in the SPDV pile. Fluid reportedly had to be pumped from the pit used to settle drill cuttings from the pilot shaft for the Salt Handling Shaft (U.S. DOE, 1997b), which illustrates that cuttings would have been wet with drilling brine. SSW samples near the pit had elevated sodium, chloride, and potassium concentrations (similar to samples from PZ-13), prompting an early assessment of the SSW to note that not only were potassium salts from the McNutt present in the cuttings, but “drilling practice in the 1980’s often included the use of saturated brine from potash operations as drilling fluid in order to mitigate Salado dissolution" (U.S. DOE, 1997b). Concentrations of lead that might occur in a solution of natural potash are discussed in Section 5.1.4.

5.4 Materials Used in Monitoring Activities

Opportunities exist during monitoring to potentially introduce lead to water samples such that the monitoring results would not be representative of environmental conditions. Drilling fluids or sampling equipment can contaminate water samples directly or by interacting with geologic solids. The high TDS and chloride concentrations in PZ-13 have thermodynamic consequences that may favor and magnify such interactions, as explained in more detail in Section 6.

5.4.1 Sampling Equipment

Equipment used for gauging, well development, and sampling included standard equipment designed for routine environmental monitoring; therefore, it should all, by design, be free of lead and other contaminants. Most of the equipment used at PZ-13 was also used in other SSW wells containing high TDS concentrations (after appropriate decontamination) without detecting similar lead concentrations. It is therefore highly unlikely to be the source of the lead in PZ-13.

5.4.2 Drilling Materials

PZ-13 was completed using a hybrid drilling technique involving air-rotary drilling and a hollow-stem auger with a custom-made bit and core barrel used to log the lithology as continuously as possible. Drilling at nearby monitor wells PZ-14 and -15 switched to air-rotary drilling only in the more consolidated zones, and thus avoided grinding with the augers (Stewart Brothers, 2009). No drilling fluids other than air were used. Because of hard drilling in consolidated rock in the Santa Rosa at PZ-13, it was necessary to change out drill heads and replace lost auger teeth by arc welding and brazing new teeth on the bit (Stewart Brothers, 2009), and a first attempt to drill the well was abandoned before reaching the target depth (Salness, 2007-2009). The teeth were high-strength tungsten carbide. The tungsten carbide crystals are set in a cobalt matrix and welded to the steel components of the bits. The drilling apparatus would not likely have included any lead parts or coatings, based on experience and as asserted by the driller (Stewart

Brothers, 2009). However, it is not impossible that the welding materials contained lead or that the saline geochemical conditions in the water-bearing zone could have caused dissolution from the welded drilling apparatus that would not occur under typical environmental conditions. The driller also reported that the rod manufacturer suggested that zinc, nickel, or brass constituents (copper and zinc) would likely be detected before lead if the welding materials were the source (Stewart Brothers, 2009).

Testing of drill bit samples is described in Sections 6.1.3 and 9. Water in PZ-13 was analyzed for several inorganic constituents, including chromium, cobalt, copper, iron, nickel, and zinc, during the PZ-13 repeat sampling event described in Section 7. The high ratios of lead to metals that are major constituents in steel, welding materials, and drill bit teeth suggest that dissolution from the drilling equipment or similar materials is not significant and not the source of lead.

5.4.3 Well Construction Materials

The well installed in PZ-13 consists of 2-inch polyvinyl chloride (PVC) casing surrounded by a sand filter with a bentonite seal and cement grout (U.S. DOE, 2008; Salness, 2007-2009). All of these components are selected for the purpose of environmental monitoring and should not contain lead contamination.

6. Mineralogy and Lead Distribution Analyses

In order to distinguish the source of lead, DBS&A performed tests to evaluate the mineralogy and distribution of lead within geologic materials from previous drilling operations, local outcrops, and in the repository at the WIPP site. Testing for lead was also performed on the drill bits used to install PZ-13, -14, and -15. Each geologic unit penetrated by the PZ-wells was tested, as were Salado samples that comprise the majority of the SPDV pile material. The analyses were performed with an XRF instrument and with electron probe microanalysis (EPMA). The presence of lead in geologic materials was confirmed and the mineralogy associated with lead occurrence was identified.

6.1 X-Ray Fluorescence Testing for Lead

DBS&A performed non-intrusive analyses of geologic materials at and near the WIPP site on July 7 and 8, 2009. Chemical analyses were performed with a portable XRF instrument (ThermoScientific Niton XLT). The XRF provides whole-rock elemental composition directly on samples that were retained in core boxes. This method allows collection of a large amount of data in a short time period. The XRF reported units as parts per million (ppm), which is approximately equal to milligrams per kilogram (mg/kg). Complete XRF results are provided in Appendix E.

DBS&A analyzed cuttings and core samples from PZ-13, -14, and -15. Data were also collected from ERDA-9 cuttings. ERDA-9 was installed in 1976 and represents conditions before development of the site. In situ measurements were performed on the Salado samples within Rooms 2 and 4 in the repository and on outcrops of Dewey Lake in the Nash Draw area. Drill bits used at the WIPP site for installing PZ-13 were analyzed by XRF on July 9, 2009 at Stewart Brothers Drilling in Milan, New Mexico. Confirmation laboratory samples were collected to represent the range of lead concentrations reported by the XRF from various geologic materials, and the analyses were performed by Hall Environmental Analysis Laboratory (HEAL) in Albuquerque, New Mexico. Complete XRF results, including analyses of elements other than lead, are provided in Appendix E. Key findings with respect to lead are discussed in the following subsections.

6.1.1 XRF Results

The Dewey Lake is the only geologic unit with detectable levels of lead documented in core and cutting samples by XRF screening during this study. (Some samples of the Santa Rosa sent for laboratory analysis had lead present at levels below the XRF detection limits). Only the upper horizon of the Dewey Lake contained detectable lead concentrations; other portions of the formation did not. The Dewey Lake typically has green reduction spots in otherwise oxidized red mudstone and sandstone. The sandstone units were below detection limits for lead. Based on observations during this study, lead has a heterogeneous distribution in the mudstone samples and was only detected in oxidized (red portion of sample that has iron oxide coatings) portions of the sample. Lead was detected with the XRF in the upper Dewey Lake at the following locations:

- PZ-13 (lead 19 to 27 mg/kg)
- PZ-14 (lead 17 to 21 mg/kg)
- ERDA-9 (lead 17 to 31 mg/kg)

Samples from 90 other intervals tested were non-detect for lead.

Outcrops of the Dewey Lake near Nash Draw were also tested with the XRF, but lead was not detected. PZ-15 did not penetrate the Dewey Lake. The Salado was also tested in the repository and lead was not detected.

The majority of the geologic units tested for lead did not have detections (detection limit range is approximately 10 to 15 mg/kg). The following locations and geologic formations tested did not detect lead above the XRF instrument detection limit.

- PZ-13:
    - Berino soil
    - Mescalero caliche
    - Gatuña Formation
    - Santa Rosa Formation

  - Dewey Lake Formation (portions non-detect in reduced (green) areas of mudstones)

- PZ-14: Dewey Lake Formation (portions non-detect in reduced (green) areas of mudstones)

- PZ-15: Gatuña Formation

- ERDA-9:
  - Dewey Lake Formation (portions non-detect with variable lead distribution)
  - Salado Formation

- Repository (Salado Formation): Map units (MU) 0 through 6 tested in Rooms 2 and 4

Lead measured by XRF from rock at PZ-13 could be affected by contact with the SSW; therefore, the results were contrasted with those for samples from other locations. At PZ-14, the SSW quality is significantly different; in particular, no lead has been detected in SSW at PZ-14. Cores from ERDA-9 were especially useful because they were collected reasonably close to PZ-13 in 1976, before the SPDV pile and other WIPP features were constructed and before the SSW had developed. DBS&A was not allowed to use ERDA-9 core samples for destructive laboratory testing; however, it was possible to approximate the concentration of lead in them by XRF analysis, for which the accuracy could be tested using correlation of XRF measurements of other cores to their respective laboratory analyses. Although no available core was an ideal control for use in all the testing conducted in this assessment, each of the analyses strengthened the ability to understand the dataset as a whole.

6.1.2 Laboratory Analyses of Lead

Samples with lead detections and non-detect samples were collected and submitted for laboratory testing from PZ-13, -14, and -15 core archives. Samples could not be removed for laboratory analyses from the archived ERDA-9 cuttings. Laboratory analysis for lead confirmed the XRF lead detections (Table 6).

Detection limits were about 10 to 15 mg/kg with the XRF and 0.25 to 1.3 mg/kg in the laboratory. Because the laboratory method had a lower detection limit compared to the XRF, several samples, which were non-detect with the XRF, did have lead that was detected by the laboratory below the detection limit of the XRF (Table 6). The laboratory analyses also confirmed that lead is only detected in the oxidized portion (red) of the Dewey Lake.

Table 6. Summary of Lead Detections, XRF and Laboratory

Well	Depth (feet bgs)	Formation	Comment	Lead Concentration (mg/kg)	
				Laboratory	XRF
PZ-13	46–47	Santa Rosa	Whole rock	4	<12
	65–67.5	Santa Rosa	Whole rock	1.4	<9.9
	74–75	Santa Rosa/Dewey Lake	Whole rock	12	27
	76–77	Dewey Lake	Red	16	19
		Dewey Lake	Green	<1.3	<12
PZ-14	71–72	Dewey Lake	Whole rock	12	17
	72.5–73	Dewey Lake	Whole rock	8.8	<13
	73–73.5	Dewey Lake	Red	12	21
		Dewey Lake	Green	<0.25	<11
PZ-15	45–45.3	Gatuña	Whole rock	2.4	<11
	50.5–52	Santa Rosa	Red	3.3	<12
		Santa Rosa	Green	<0.25	<11
ERDA-9 [a]	60–65	Dewey Lake	Whole rock	---	31
	75–80	Dewey Lake	Whole rock	---	17

[a] ERDA-9 installed in 1976 before SSW development
bgs = Below ground surface
mg/kg = Milligrams per kilogram
--- = Not applicable

Based on the comparison of XRF and laboratory data for rock samples the following conclusions may be reached:

- There were no false positive results from XRF in rock samples.
- XRF results are reasonable within the precision and accuracy of the field method.
- Several laboratory samples with lead detects are lower than XRF detection limit.
- XRF is a reliable method for field analysis of lead in geologic materials.

6.1.3 Lead Analysis of Tungsten Carbide Drill Bits

The XRF was used to analyze the steel and tungsten carbide components of two drill bits that were used to install PZ-13, -14, and -15 at the WIPP site (Salness, 2007-2009). The XRF was placed directly on the tungsten carbide and steel components for analyses. One replicate was performed to confirm the precision of the analyses. XRF results indicated a possible lead concentration of approximately 4,000 mg/kg in the tungsten carbide tips and steel body of the drill bits, but the detection of such significant concentrations was not confirmed with a laboratory digestion of the drill bits (Section 9).

Due to the detection of lead in the drill bits by XRF, three types of drill bit teeth were collected from the bits for further analyses, which are reported in Sections 6.2 and 9. Two teeth were collected from the hollow-stem auger bit (one flat and one with a round shape), and a third tooth was cut from the tri-cone bit (see photographs in Appendix E).

The XRF detections for lead in the drill bits are interpreted as false positive results. These results are probably due to overlapping peaks in the energy dispersive spectra (EDS) that could not be resolved by the deconvolution software (Suzuki and Rohde, 2008; Schueler, 2008). The XRF instrument was set up for analyses of geologic materials and not steel or ceramic materials. X-ray lines for lead and tungsten have similar wavelengths (5.286 kiloelectronvolts [keV] and 5.357 keV, respectively) and K-lines (2.346 keV and 2.31 keV, respectively). Because the bits are composed of tungsten carbide in a cobalt matrix, the large tungsten peak overlapped the neighboring lead peak, and the software could not distinguish the elements. This interference was confirmed when analyzing the bit with EDS analyses on an electron microprobe. Finally, acid digestion of the drill bits followed by metals analyses indicated that only a low concentration of lead was present in one bit; lead concentrations in the others were below analytical detection limits.

6.2 Mineralogical Examination

Dewey Lake samples were analyzed by EPMA to determine mineralogy and lead distribution. The instruments used for this study were a JEOL JSM-5800 LV scanning microscope and a

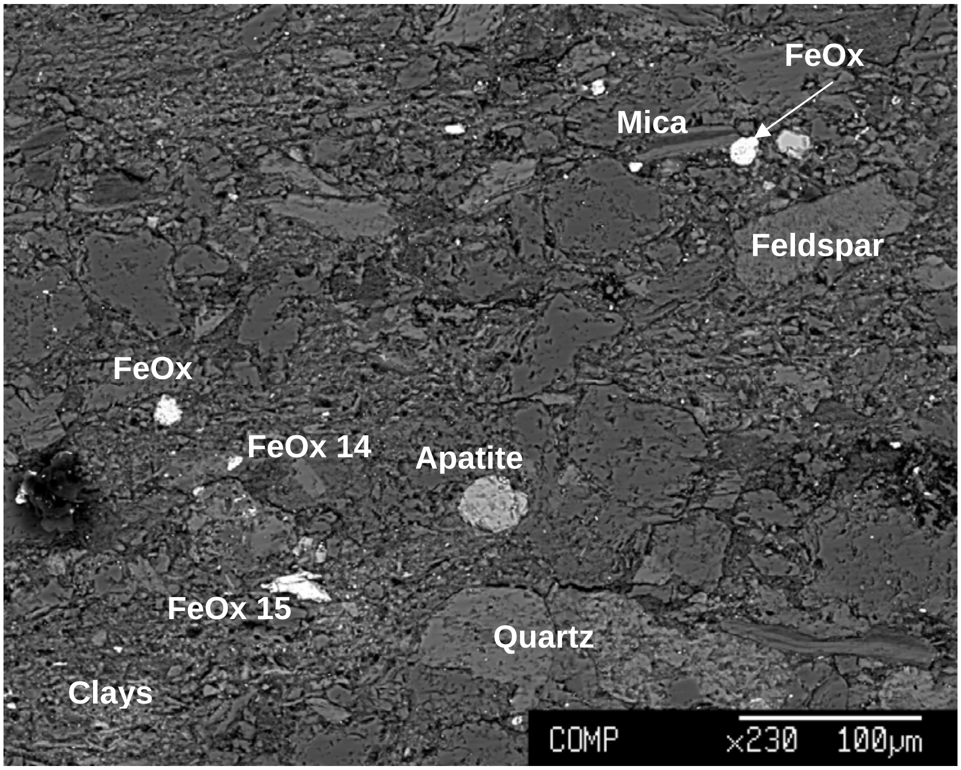
JEOL JXA-8200 WD/ED combined microanalyzer at the Institute of Meteoritics at the University of New Mexico. The distribution of lead is important for understanding lead behavior in PZ-13 and its potential mobility. Within core samples the lead may be distributed in (1) primary lead minerals, (2) igneous minerals as a trace constituent, or (3) secondary or authigenic minerals derived from either of these mineral types.

Data gathered included back-scattered electron (BSE) images (Figures 8 through 12), chemical composition by wavelength dispersive spectra (WDS) (Figure 12b), and quantitative EPMA of individual particles (Table 7). Quantitative EPMA provided elemental composition of individual grains (beam diameter of 1 micron) as mass percent in oxide form. The analyses may not sum to 100 percent due to water loss, elements not selected for the analyses, and calculations that assume the sample's surface is perfectly flat. The spectrometer array was calibrated using a hematite standard.

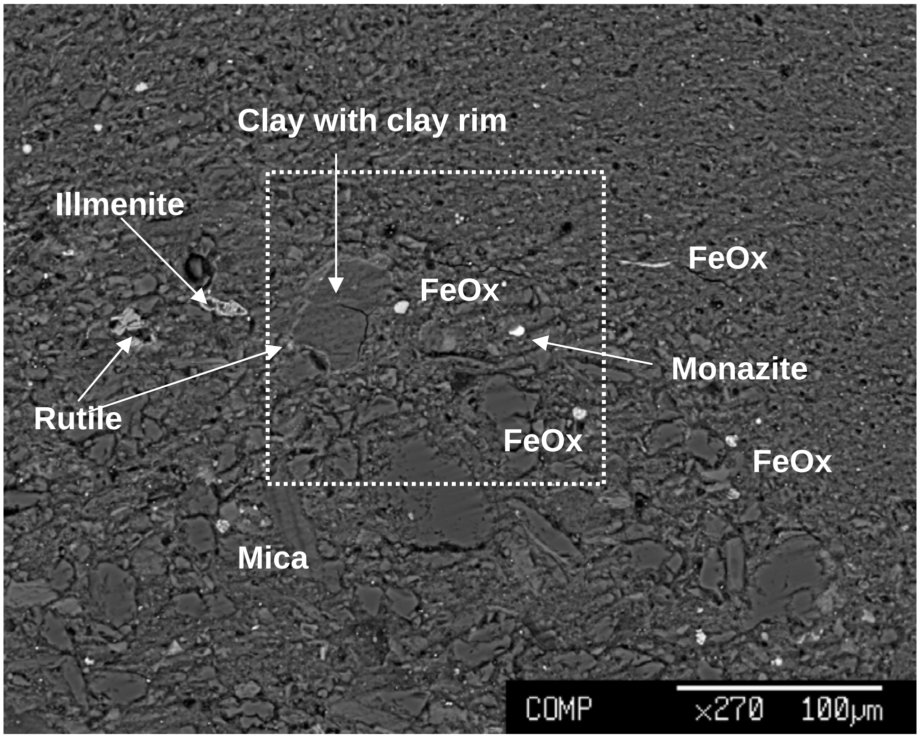
Thin sections were cut and polished for EPMA from Dewey Lake samples collected from PZ-13 at depths of 76 to 77 feet bgs and 74 to 75 feet bgs. The thin sections were coated with a thin film of gold and palladium. Because most geological materials are non-conducting, a thin film of a conducting metal (e.g., gold-palladium) is used to prevent charging of the sample during irradiation by the electron beam during analysis.

Within Dewey Lake samples tested, the mineralogy is dominated by illite/smectite clay and grains derived from an alkalic granite source including quartz, potassium feldspar, albite (plagioclase feldspar), muscovite, monazite, xenotime, magnetite, rutile, and illmenite.

The micromorphology of the samples shows some bedding orientation of clays with little porosity; however, muscovite mica grains tended to have more orientation than clays. The material appears to have compacted during lithification and experienced pressure solution resulting in grain to grain contacts that are concavo-convex between sand grains (Figure 8a). The grains are typically subangular to subrounded. Clay and iron oxide rims on grains were common. Iron oxide coatings on grains give the redbeds their characteristic red color, and the iron is probably derived from the breakdown of igneous minerals such as magnetite and illmenite (Van Houten, 1973)



a. Dewey Lake Formation, PZ-13, 74 to 75 feet bgs: Fine sand, silt, and clay size grains including mica, feldspar, quartz, apatite and iron oxides (FeOx). Number designations correspond to elemental oxide analyses performed on microprobe. Scale bar = 100 microns

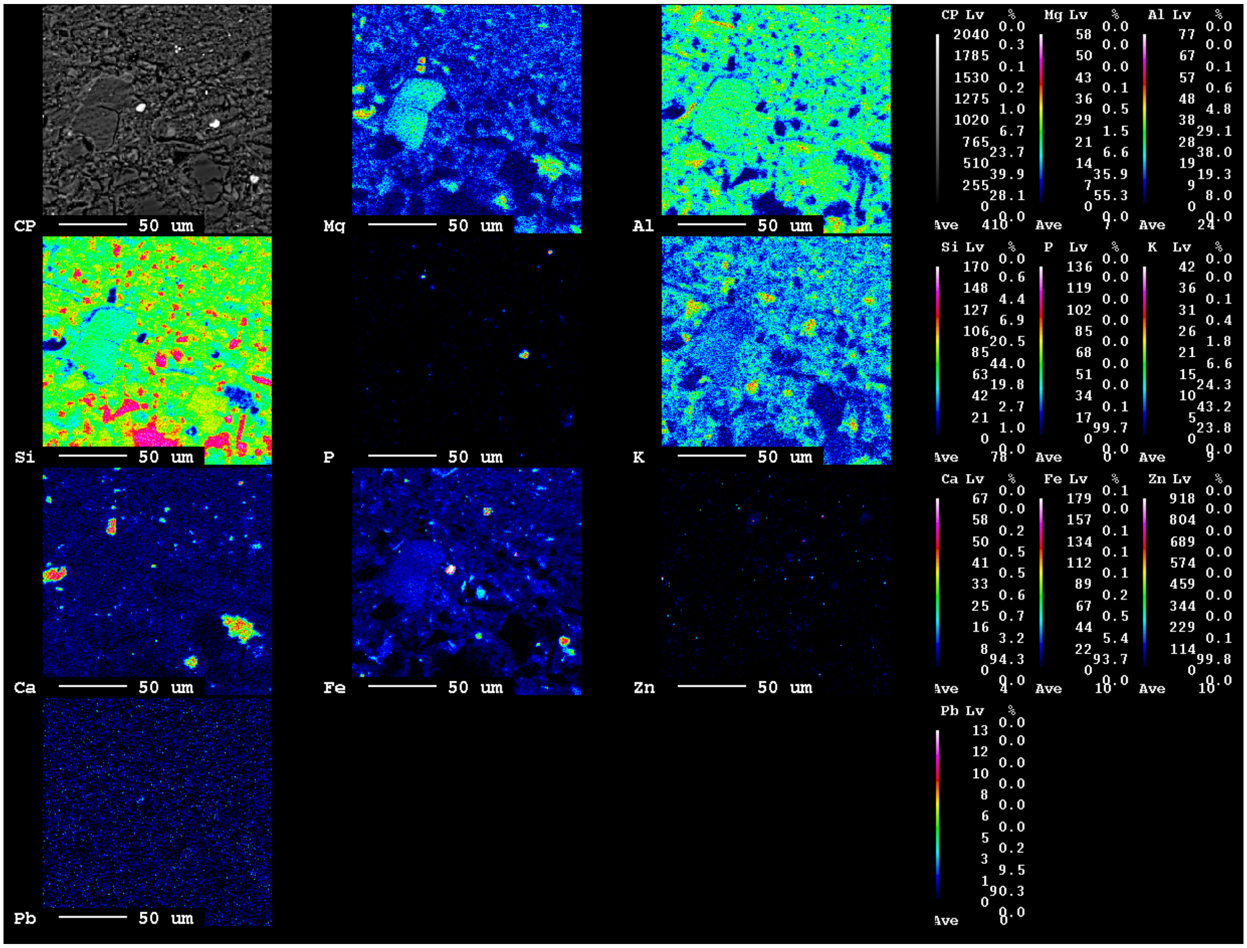


b. Dewey Lake Formation, PZ-13, 76 to 77 feet bgs: Sand, silt, and clay size grains including monazite, mica, rutile, illmenite, quartz, clay minerals, and iron oxides (FeOx). Square shows approximate area of x-ray mapping shown in Figure 9. Scale bar = 100 microns

WIPP LEAD ASSESSMENT

EPMA of the Dewey Lake

Figure 8



Dewey Lake Formation, PZ-13, 76 to 77 feet bgs: Back-scattered image and x-ray maps showing elemental distribution of Mg, Al, Si, P, K, Ca, Fe, Zn, and Pb. Scale bar = 50 microns

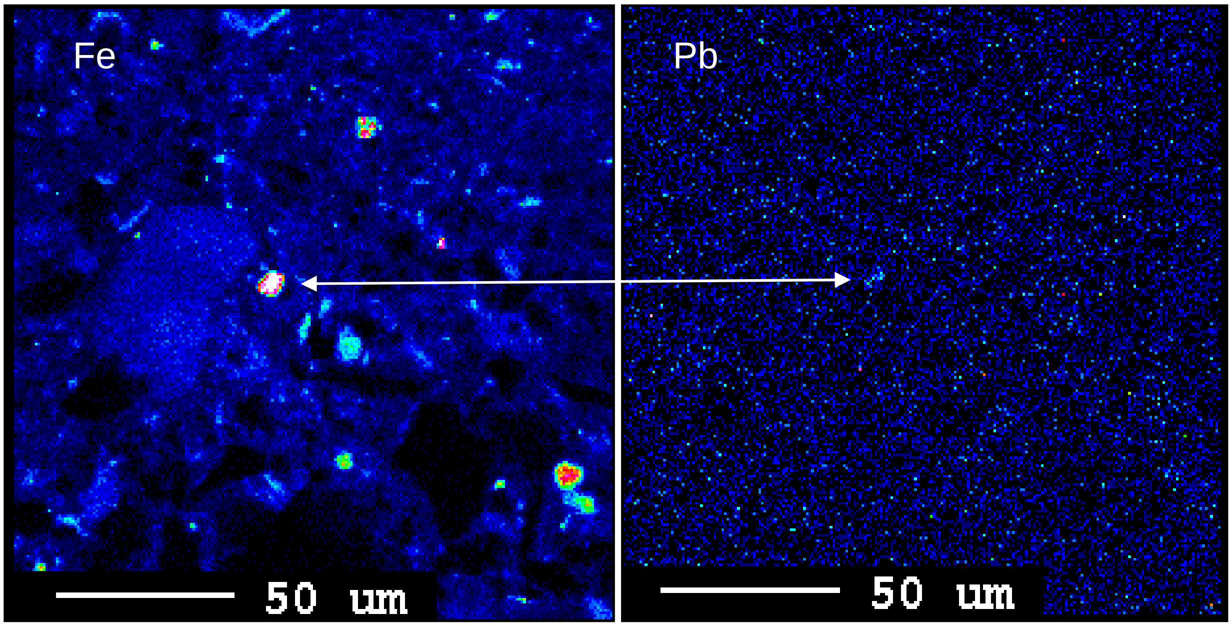
WIPP LEAD ASSESSMENT

X-Ray Map of the Dewey Lake

Daniel B. Stephens & Associates, Inc.

6/10/10

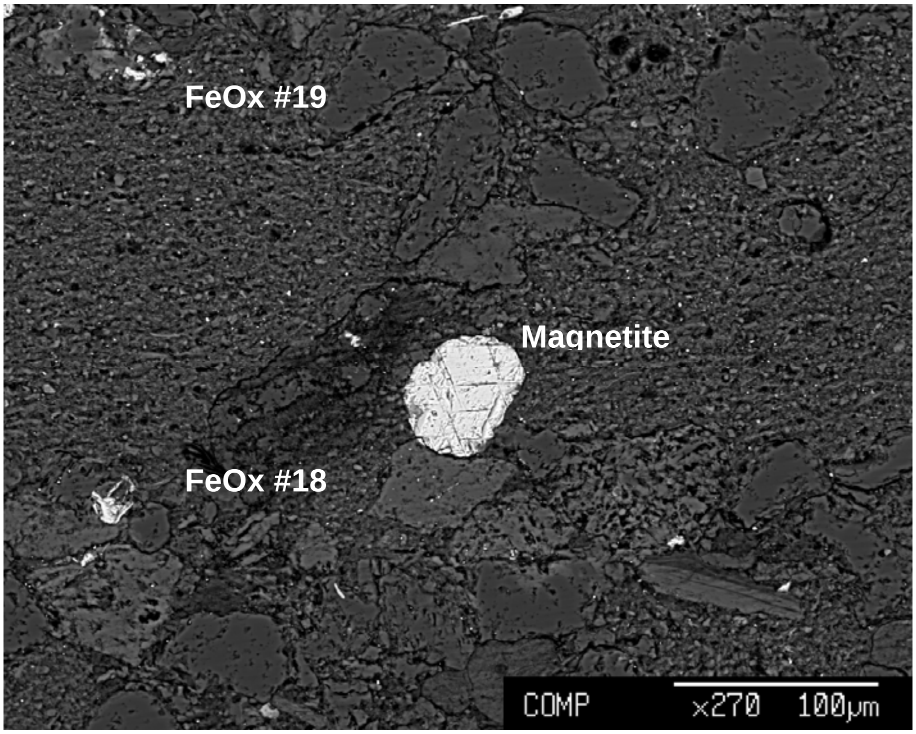
Figure 9



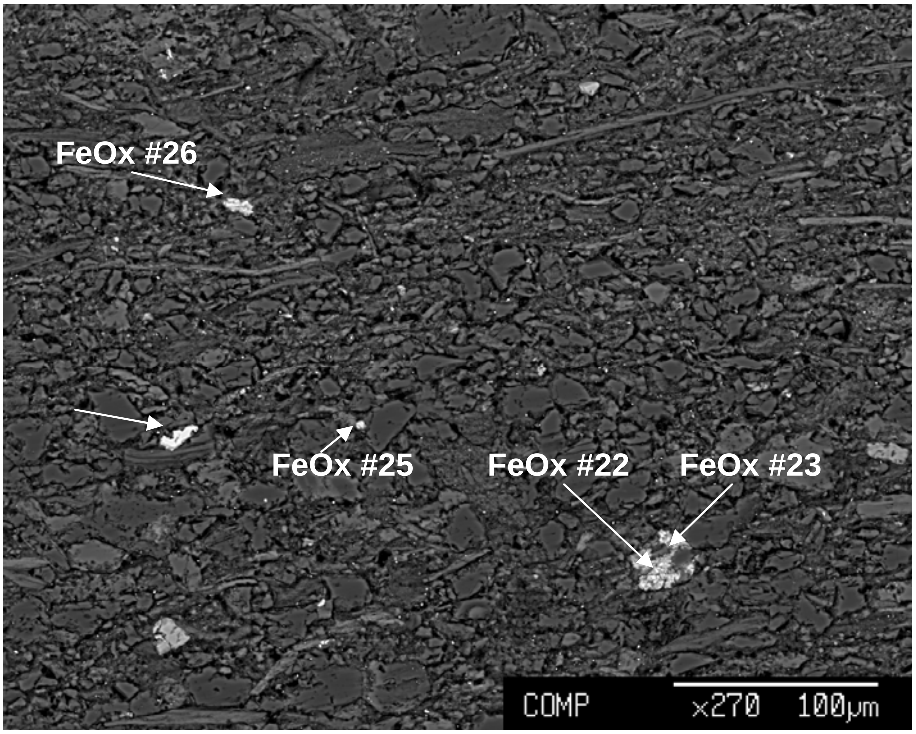
Dewey Lake Formation, PZ-13, 76 to 77 feet bgs: Enlarged x-ray maps showing distribution of Fe and Pb. Iron oxide grain associated with Pb indicated by arrow. Clay-sized iron oxides are disseminated throughout the sample shown by green to red colors on iron x-ray map. Scale bar = 50 microns

Iron and Lead X-Ray Maps of the Dewey Lake

Figure 10



a. Dewey Lake Formation, PZ-13, 74 to 75 feet bgs: Magnetite grain in center of view with PbO = 0.025 mass percent from quantitative analysis #17. Scale bar = 100 microns.



b. Dewey Lake Formation, PZ-13, 74 to 75 feet bgs: Iron oxides distributed throughout the sample. Scale bar = 100 microns.

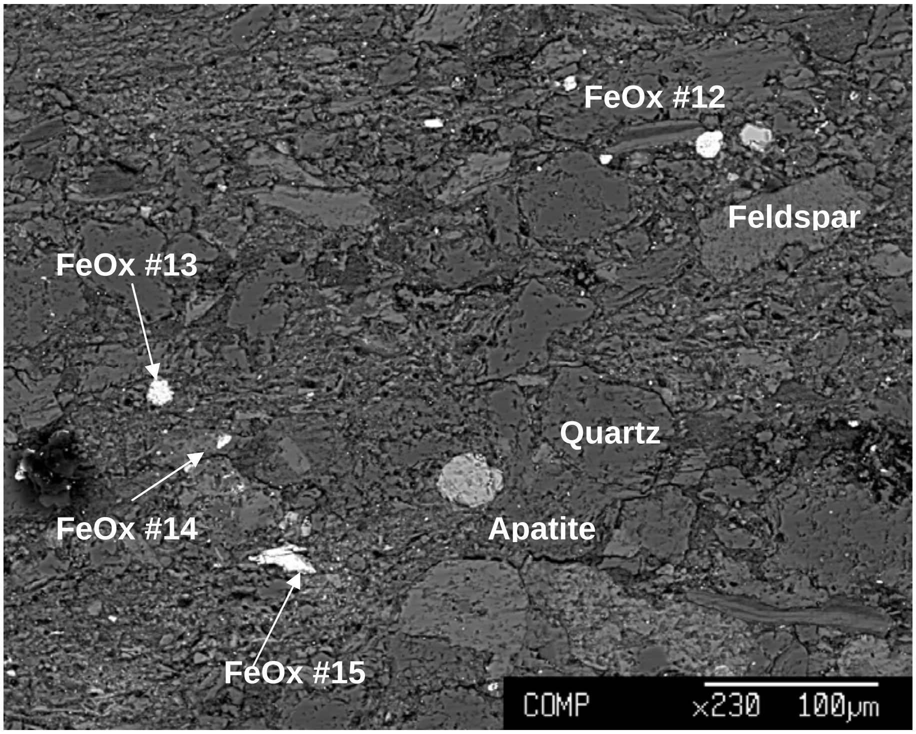
WIPP LEAD ASSESSMENT

Magnetite and Iron Oxides in the Dewey Lake

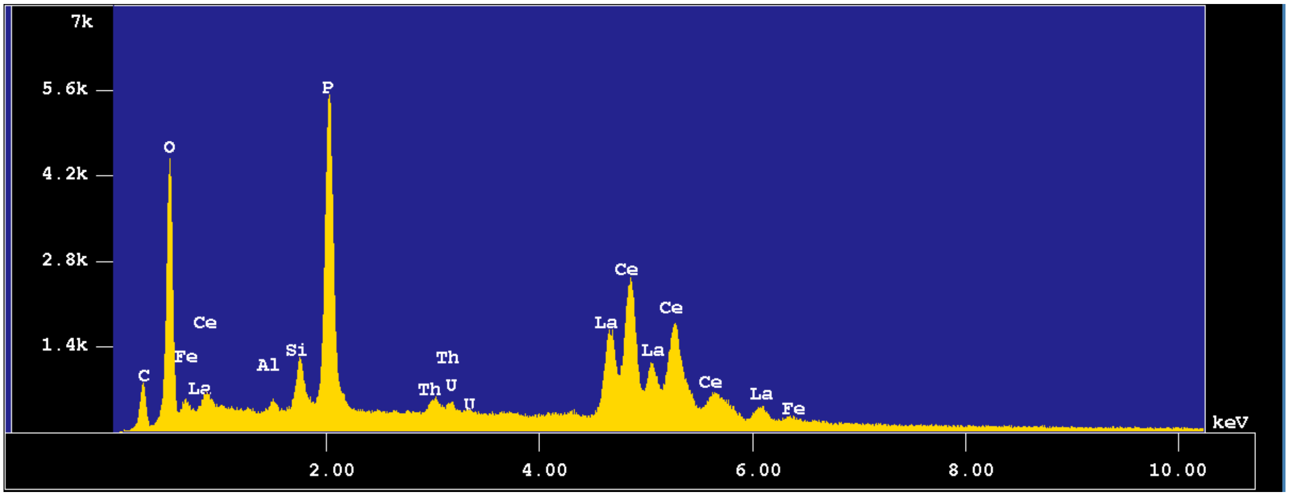
Daniel B. Stephens & Associates, Inc.

6/10/10

Figure 11



a. Dewey Lake Formation, PZ-13, 74 to 75 feet bgs: Sand, silt, and clay sized grains including quartz, feldspar, and iron oxides. Scale bar = 100 microns.



b. Dewey Lake Formation, PZ-13, 76 to 77 feet bgs: Spectra of monazite showing rare earth elements, thorium, and uranium.

WIPP LEAD ASSESSMENT

Iron Oxides and Monazite Spectra in the Dewey Lake

Figure 12

Daniel B. Stephens & Associates, Inc.

6/10/10

P:_ES08-072\Pb-Assmnt-Fnl.6-10\Figures\F12_FeOx-Mnznte-DL.doc

Table 7. Quantitative EPMA on Mineral Grains

Location	No.	Sample Name	PbO (mass %)
Standard	2	Hematite std	<0.013
PZ-13, 76–77 feet bgs	3	DB76-77 Fe-oxide	0.156
	4	DB76-77 Fe-oxide Image 2	0.056
	5	DB76-77 Image 2 Clay ball	<0.013
	6	DB76-77 Image 2 2nd Fe-oxide	0.006
	7	DB76-77 Image 2 monazite	0.049
	8	DB76-77 Image 1 Fe-oxide	0.036
	9	DB76-77 Fe-oxide	0.049
	10	DB76-77 Image 4 Fe-oxide 2	<0.013
	11	DB76-77 Image 4 Zn 3	<0.013
PZ-13, 74–75 feet bgs	12	DB74-75 Image 1 round Fe-ox	0.087
	13	DB74-75 Image 1 round Fe-ox	0.057
	14	DB74-75 Image 1 round Fe-ox	0.142
	15	DB74-75 Image 1 round Fe-ox	<0.013
	16	DB74-75 Image 1 round apatite	<0.013
	17	DB74-75 Image 2 magnetite	0.025
	18	DB74-75 Image 2 blade Fe-ox	<0.013
	19	DB74-75 Image 2 Fe-ox	0.026
	20	DB74-75 Image 2 Fe-ox core	0.038
	21	DB74-75 Image 2 Fe-ox rim	0.032
	22	DB74-75 Image 3 grunge Fe-ox	0.072
	23	DB74-75 Image 3 grunge Fe-ox	0.078
	24	DB74-75 Image 3 Fe-ox	<0.013
	25	DB74-75 Image 3 Fe-ox	0.032
	26	DB74-75 Image 3 Fe-ox	0.086

Chemical spectra collected by EDS and WDS spectral methods (Figure 12b) and x-ray mapping (Figures 9 and 10) were not capable of detecting the low concentrations of lead suspected in the samples; therefore, quantitative analyses were performed using WDS with a lower detection limit by targeting a smaller area of the sample and lengthening the duration of analysis. For the quantitative analyses, the method detection limit for lead oxide (PbO) was 0.013 mass percent.

Lead was detected using quantitative EPMA in both igneous and authigenic minerals in the Dewey Lake. Magnetite and monazite tested had PbO concentrations of 0.025 and 0.049 mass percent, respectively (Table 7). Iron oxide samples analyzed by quantitative analyses had a PbO concentration ranging from <0.013 to 0.156 mass percent (Table 7). If the pervasive iron oxide coatings that were observed on mineral grains are derived predominantly from magnetite and illmenite, the lead associated with the iron oxides probably originated in these same igneous minerals.

6.3 Discussion of Mineralogy and Lead Distribution

Based on these recent investigations, lead occurs naturally in the Dewey Lake and to a lesser extent the Santa Rosa, with measured concentrations in whole rock samples ranging from <0.25 to 26 mg/kg. Lead concentrations are highest in the upper Dewey Lake (8.8 to 16 mg/kg by laboratory analysis and up to 26 mg/kg by XRF). Santa Rosa concentrations are lower (1.4 to 4 mg/kg by laboratory analysis and non-detect by XRF). These lead concentrations were first detected with the XRF and then confirmed by laboratory analyses. The XRF and laboratory results indicate that the detectable lead in the Dewey Lake is associated with red, oxidized portions of the formation, while lead concentrations are below detection in the green, reduced “spots” common in the Dewey Lake. This observation was confirmed with EPMA.

Lead is associated with several minerals in the Dewey Lake. Lead was detected in some igneous minerals including monazite and magnetite and authigenic iron oxides. Most of the lead detections correlated with authigenic iron oxide minerals. The weathering of magnetite is probably the source for both iron and lead found in authigenic minerals. Illmenite also contributes iron, and perhaps lead, to authigenic minerals; however, lead was not analyzed for in these minerals.

Lead associated with authigenic iron oxides is distributed throughout the Dewey Lake samples. These iron oxides are fine silt and clay-sized particles. Dewey Lake samples from ERDA-9 indicate that the lead was present in 1976 before the WIPP site was developed as a repository site; therefore, the lead is most likely distributed regionally in the Dewey Lake.

7. PZ-13 Repeat Sampling Event

From September 14 through 17, 2009, WTS completed a four-day repeat sampling event to better characterize the effects of well purging and sampling methods on PZ-13 monitoring results. The testing followed the XRF measurements of lead concentrations of approximately 4,000 mg/kg in drill bit teeth of the type lost when drilling PZ-13. The approach examined whether stagnant water in the well with more time to contact possible drill bits would have a higher lead concentration than water collected after purging the well repeatedly to draw new water from outside the well casing and sand pack.

This section describes the PZ-13 repeat sampling event methods and results, which were provided to DBS&A by WTS.

7.1 Previous Well Development and Sampling Procedures

PZ-13 has not undergone traditional well development following well installation to remove sediment and increase the well’s yield. Substantial well development is impracticable given the thin 2.5-foot saturated zone and low yield. The well was pumped dry with a submersible pump as the initial sample was obtained (U.S. DOE, 2008). It was bailed dry about 8 months later and allowed to recover for 9 days prior to obtaining a second sample with a Teflon™ bailer (Salness, 2007-2009). Subsequent samples were obtained by the low-flow sampling technique as attempted with the initial sample (Salness, 2007-2009).

Low-flow sampling typically seeks to eliminate the need to purge a well completely by establishing a hydraulic regime in which water is produced from the geologic formation with minimal drawdown in the well. All of the samples obtained from PZ-13 using a submersible pump produced at least 3 feet of drawdown at very low pumping rates between 350 and 1,500 milliliters per minute (mL/min) (U.S. DOE, 2008; Salness, 2007-2009), indicating that the well is slowly recharged by the low-yielding formation. Water does not appear to be able to leak rapidly into or to significantly saturate the hard portion of the Santa Rosa on which saturation was perched when the well was drilled or the Dewey Lake in the lower 2 feet of the well, despite the well screen extending 8 feet below the perched zone. The observed drawdown below the perched zone indicates that the well is behaving like a sump where water is stored in the casing and sand pack in the hard lower Santa Rosa and Dewey Lake.

The water level in PZ-13 has gradually declined by about 1.4 feet during the 2.5 years since the well was installed and does not appear to respond to precipitation (Figure 3). Despite the decline, the water level has been higher than the top of the perched zone observed during drilling since the well was completed. Seepage out of the well into the unsaturated lower Santa Rosa and Dewey Lake could cause the thin perched zone to be dewatered in the vicinity of the well resulting in declining water levels; however, this must be proceeding quite slowly if at all. Alternatively, the local perched zone of SSW near PZ-13 may be more broadly draining away from the perching layer toward the Santa Rosa/Dewey Lake contact in the absence of continuing recharge.

7.2 Repeat Sampling Event Methods and Results

7.2.1 Repeat Sampling Methods

Repeat sampling began with collecting an initial sample of stagnant water prior to any purging of the well. The well was then purged by bailing and allowed to recharge for 24 hours prior to sample collection. Sampling followed by well purging was repeated on three consecutive days. For quality assurance/quality control (QA/QC) purposes, field blank, equipment blank, and duplicate samples were collected on the final day.

Initial water levels were gauged each day before sampling. Field staff estimated that about 5 gallons were purged from the well each day. Water levels were generally not gauged immediately after purging; rather, bailing was stopped when it became difficult to recover any more water. As seen in Figure 3, water levels were able to recover essentially completely overnight.

Samples were packaged each day in a cooler with ice and shipped by overnight delivery to HEAL for analysis. All samples were submitted with chain-of-custody forms. At the laboratory, water samples were filtered with a 0.45-micron filter prior to analysis; therefore, the laboratory results represent the concentrations of dissolved constituents.

At the time the repeat sampling event was conducted, plans were being made to conduct laboratory tests of the drill bit teeth. In order to make comparisons between the PZ-13 monitoring data and the drill bit data, water samples from PZ-13 were tested for numerous inorganic analytes by U.S. Environmental Protection Agency (EPA) method 6010B (ICP-AES) or, in a few cases, by EPA method 6020A (ICP-MS). HEAL analyzed the majority of the analytes by EPA method 6010B and forwarded samples to Anatek Labs, Inc. for analyses of tin, titanium, and uranium by EPA method 6020A. Laboratory analysis was completed for the following parameters:

- Aluminum (Al)
- Antimony (Sb)
- Arsenic (As)
- Barium (Ba)
- Beryllium (Be)
- Boron (B)
- Cadmium (Cd)
- Calcium (Ca)
- Chromium (Cr)
- Cobalt (Co)
- Copper (Cu)
- Iron (Fe)
- Lead (Pb)
- Magnesium (Mg)
- Manganese (Mn)
- Molybdenum (Mo)
- Nickel (Ni)
- Potassium (K)
- Selenium (Se)
- Silica (Si)
- Silver (Ag)
- Sodium (Na)
- Strontium (Sr)
- Thallium (Tl)
- Tin (Sn)
- Titanium (Ti)
- Uranium (U)
- Vanadium (V)
- Zinc (Zn)

7.2.2 Repeat Sampling Results

The results of the repeat sampling event do not suggest that leaching of lead from lost drill bit teeth or any other material located at the well is resulting in the lead detection in PZ-13. This source would have been indicated if the initial sampling of stagnant water contained the highest lead concentration, with subsequent samples containing lower concentrations due to dilution from water being drawn into the well each time purging occurred. Instead, the initial sample had the lowest lead concentration, with samples collected on subsequent days containing higher concentrations (Table 2 and Figure 3).

The complete laboratory report for the repeat sampling event is included in Appendix F. The lead concentration was 0.13J mg/L for the initial sampling of stagnant water prior to well purging. This result is below the laboratory's PQL. The lead concentrations measured on the three subsequent days ranged from 0.25 to 0.39 mg/L, with the highest concentration measured in one of the duplicate samples on the final day of the repeat sampling events. The analytical uncertainty of the lead measurements in the PZ-13 brine at a 50X dilution was large, given that the other duplicate sample had the second lowest concentration next to the sample from the first day. Even so, the concentration on the first day was significantly lower than all the others. The results do not provide evidence of drill bits leaching lead in close proximity to the well screen. Instead, the results suggest that the lead in the perched zone is from another source.

Water in PZ-13 was analyzed for several inorganic constituents that could be related to possible leaching of drill bits and equipment, including chromium, cobalt, copper, iron, nickel, and zinc. Testing of drill bit samples is described in Sections 6.1.3 and 9. The laboratory results for the PZ-13 water (Appendix F) show that zinc was detected below the laboratory PQL of 2.5 mg/L, and none of the other metals related to drilling equipment were detected above the laboratory PQLs, which were 1.0 mg/L for iron, 0.5 mg/L for nickel, and 0.3 mg/L for the other three analytes. Zinc was detected at concentrations in the range of 0.094 to 0.42 mg/L. All laboratory results for zinc are denoted with a J qualifier, indicating that the detections are below the PQL. Lead concentrations in the same samples ranged from 0.13J to 0.39 mg/L. The high ratios of lead to metals that are major constituents in steel, welding materials, and drill bit teeth suggest that dissolution from the drilling equipment or similar materials is not significant and not the source of lead.

8. Geochemical Modeling and Analysis

Geochemical modeling was used to evaluate the water quality in PZ-13 in relation to the mineralogy of the geologic formations that may influence the SSW. Because of the high chloride concentration of the saline SSW in PZ-13, the solubility of lead is elevated and the mobility, fate, and transport depart from behavior reported in the literature for typical low-ionic strength aqueous systems. Water in PZ-13 has the highest TDS concentration detected in any of the SSW wells and is almost saturated with respect to halite and other evaporite minerals. The geochemical model helps to determine the behavior of lead for the uncommon conditions of highly saline brine at PZ-13.

This section presents an overview of the general principles framing the analysis of lead geochemistry and discusses the results of geochemical modeling analyses. Details of the geochemical modeling methods and results are provided in Appendix G.

8.1 Lead Geochemistry

Mobilization and transport of lead are controlled by both hydrologic and geochemical processes. Lead is considered to be relatively immobile to highly mobile depending on ambient physicochemical conditions (Smith and Huyck, 1999). The geochemical processes involved in lead mobilization and transport include mineral dissolution, metal solubility, sorption, and diffusion. The following discussion will briefly outline the more significant geochemical processes with respect to lead occurrence in PZ-13.

Metal dissolution and solubility are governed by the chemical composition and atomic structure of the host mineral and the physicochemical conditions to which it is exposed. For a given mineral in an aqueous media, the primary differences in aqueous mobility at near-surface, low-temperature conditions arise as a result of pH, ionic strength, and oxidation/reduction (redox) conditions. pH and redox are considered “master variables” with respect to solid-phase stability and aqueous-phase composition. pH is governed by mineral reactions and is usually buffered at circumneutral conditions by reactions with soil and rock minerals in most natural waters unless oxidation of sulfides, organics, and transition metals is occurring or there is some source of acid. Redox conditions are primarily governed by the organic, sulfide, gas, and water content of the media, whether it is a waste pile, soil, sediment, or other geologic media. Unsaturated conditions are usually oxidizing relative to saturated conditions. For saturated conditions, oxygen is usually limited (unless the rate of flow is very rapid) and reducing conditions may occur.

Metal solubility is dependent on the aqueous chemical composition, temperature, and pressure. Chloride generally does not complex with metals under surficial conditions in fresh water, but higher concentrations can increase solubility due to complexation. This is true for lead and other cations. Other common anions such as sulfate, carbonate, phosphate, nitrate, and organic compounds form metal complexes and may increase or decrease solubility.

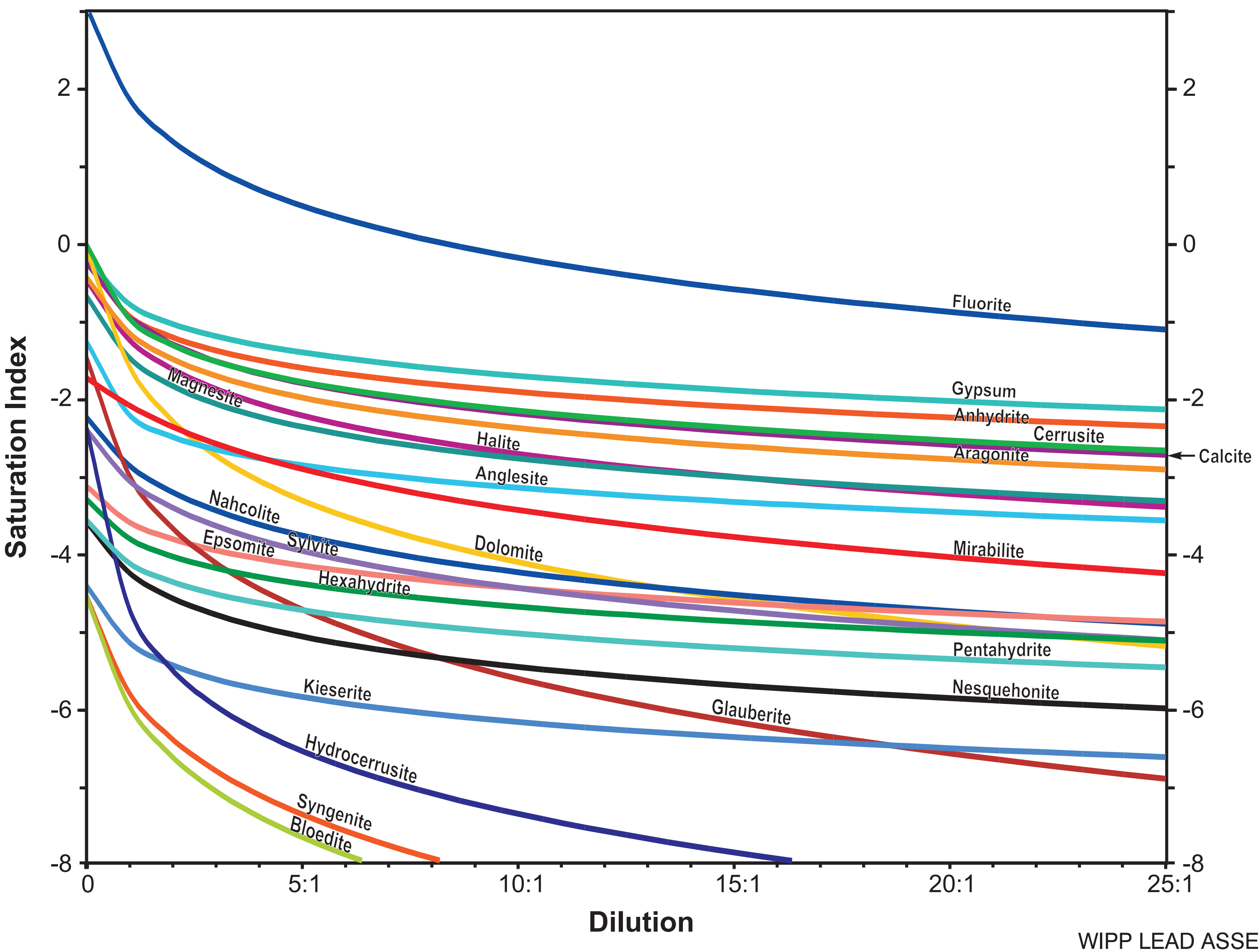
Solubility controls some metal concentrations in soils and rock; however, trace metal mobility in soils and rocks is highly influenced by presence of iron hydroxides, clays, and organic matter, which have high surface areas that promote binding with metals through adsorption and ion exchange reactions. Adsorption and ion exchange depend on many factors, including solution pH, temperature, the composition and structure of the solid surface, and the composition of the solution (which may precipitate surface functional groups that promote adsorption).

Metal mobility in soils and rock is very difficult to predict due to the highly variable chemical and physical properties. Concentrations of metals in soil pore water and in groundwater depend upon infiltration rates, permeability, and moisture content, as well as the physical and chemical properties of soil media and aquifers. A qualitative prediction of metal and other constituent mobility in surficial environments is provided by Railsback (2008) and Smith and Huyck (1999). Concentrations of most metals in soil water and groundwater located in undisturbed areas are usually low because of initially low concentrations in the geologic media, acid-base buffering reactions, chemical precipitation, and sorption by soil particles. Lead is most mobile under reducing conditions in the absence of hydrogen sulfide. Lead is moderately concentrated in soils due to its tendency to adsorb to silicates and oxides.

8.2 Model Methodology and Results

The numerical geochemical model PHREEQC (Parkhurst and Appelo, 1999) was used to calculate saturation indices for minerals of lead and major ions. Pitzer interaction parameters from literature had to be provided to the model to account for the ionic strength of PZ-13 water. Details of the geochemical model are provided in Appendix G. The geochemical model calculated aqueous speciation, saturation indices, and other geochemical equilibrium reactions for high ionic strength brine in PZ-13 (molarity greater than 4) and for water with progressively lower ionic strength that is characteristic of the SSW. Based on the water quality input, the model selects the important minerals that are potentially associated with the ionic species in solution. Positive values of the saturation index indicate that the solution is supersaturated with respect to the mineral (i.e., at equilibrium the mineral should precipitate). Negative values indicate that the solution is undersaturated (i.e., more of the mineral can dissolve before reaching equilibrium). Values that are close to or equal to zero reflect saturation with respect to the mineral, such that no net dissolution or precipitation is predicted to occur. Non-equilibrium conditions may persist if the relevant reactions are kinetically slow.

Results of the geochemical model indicate that PZ-13 water is undersaturated with respect to lead-bearing minerals. Figure 13 shows the saturation indices calculated for lead-bearing minerals and other primary minerals associated with the PZ-13 water quality. The PZ-13 water quality is represented by the zero-dilution line on Figure 13; more dilute solutions are represented by the dilution ratios up to 25:1, which represents a TDS concentration of approximately 10,000 mg/L. PZ-13 water is saturated (SI = 0) with respect to lead carbonate (cerussite), but undersaturated with respect to lead sulfates and other lead minerals that may be in this system. Therefore, lead will tend to dissolve from solid forms into solution. Precipitation and co-precipitation as solids are not expected to be significant sinks for lead. In addition to cerussite, the following minerals are near saturation at the observed composition of PZ-13 water: halite, anhydrite, gypsum, calcite, magnesite, and dolomite. Fluorite is supersaturated before dilution and is the only mineral that remains saturated in the PZ-13 solution during dilution. The predominant form of dissolved lead complexes in solution at the high chloride activity of PZ-13 is $PbCl_4^{2-}$, while the uncharged, aqueous $PbCO_3$ species is predominant in fresher water.



WIPP LEAD ASSESSMENT

Saturation State of Minerals in PZ-13 Water Over Dilution to 10,000 mg/L TDS

Figure 13

Daniel B. Stephens & Associates, Inc.
6-12-08
JN ES08.0072

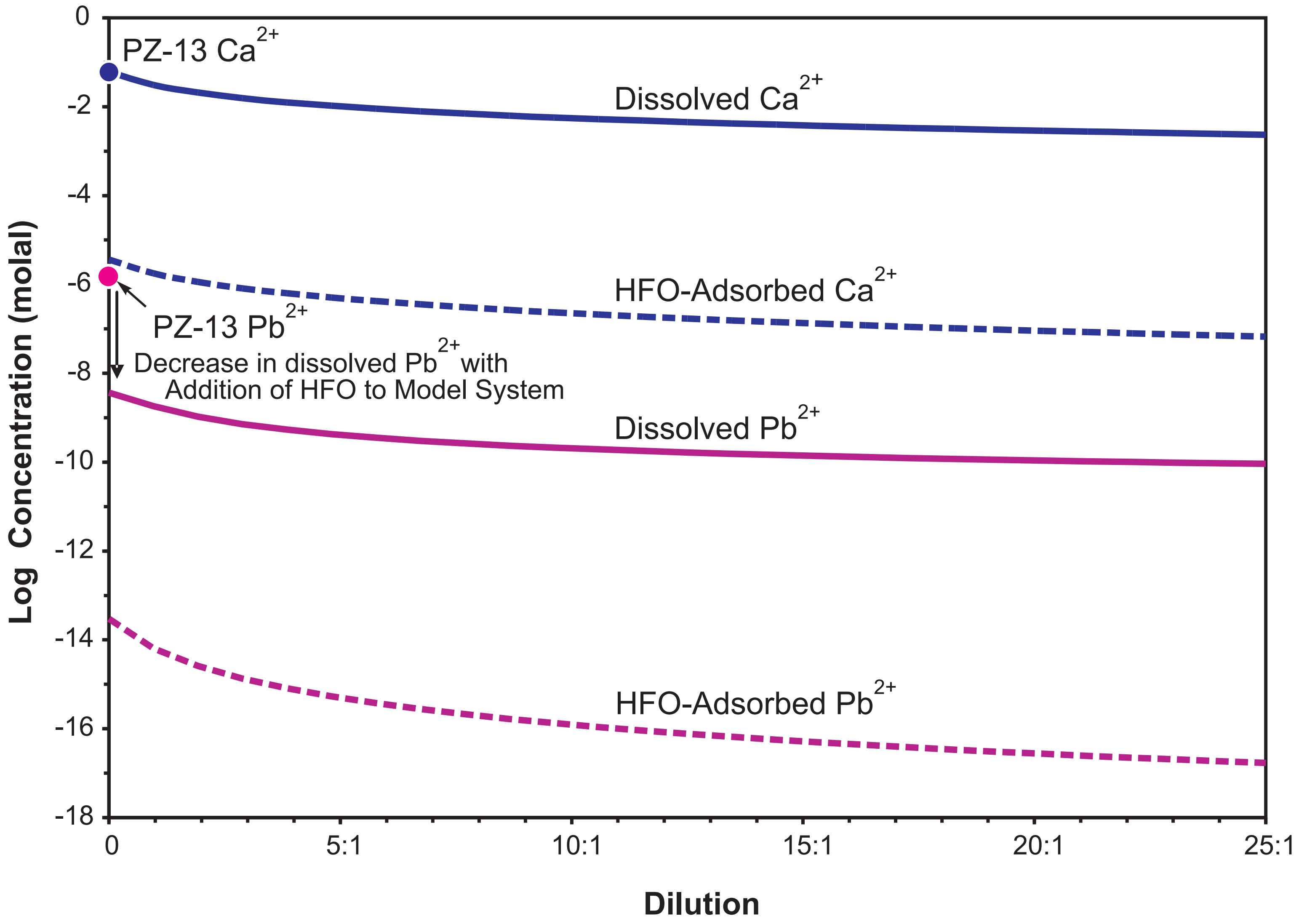
Dilution of the observed PZ-13 water composition was simulated to determine if the reduction in chloride levels and ionic strength would result in saturation with respect to lead phases (e.g., if the dominant lead species shifted from $PbCl_4^{2-}$ to $PbCO_3$). The simulated dilution represents the hypothetical migration of the brine into distant groundwater (without considering the hydrogeologic limits to such scenarios). With dilution, cerussite quickly becomes undersaturated as dilution proceeds. No saturation limit for any lead mineral is reached during progressive dilution to a final TDS concentration below 10,000 mg/L. The degree of mixing required to dilute the TDS concentration of PZ-13 water to less than 10,000 mg/L would simultaneously dilute the lead concentration to below the groundwater protection standard of 0.05 mg/L (Water Quality Control Commission Regulations 20.6.2 NMAC Part 3102.A).

8.3 Assessment of Lead Adsorption

Lead is susceptible to adsorption onto solids in the aquifer matrix, as indicated by the compilations of partition coefficients provided in Appendix H. The sorption edge, when lead will remain in solution, is between pH 3 and pH 5 (Smith, 1999); therefore, lead is readily sorbed at circumneutral pH conditions found in most groundwater and in SSW at the WIPP site. Briny solutions like PZ-13 water can suppress adsorption because the major ions compete with lead for surface sorption sites.

Sorption simulations were run using a conservative adsorption model for hydrous ferric oxides (HFO) (Dzombak and Morel, 1990). Considering adsorption by HFO on the solid matrix material in the SSW saturated interval, Figure 14 shows that HFO adsorption is expected to decrease dissolved lead concentrations by about two orders of magnitude. Adsorption of lead by HFO reduces the aqueous concentration by over two orders of magnitude at the observed composition of PZ-13 water. The mass of lead adsorbed declines with dilution as total lead concentration in solution decreases; the amount of decline depends on changing activity coefficients and effects of competing ions such as Ca^{2+}.

Because most sorption experiments are conducted at low ionic strength and theoretical isotherms are based on these experiments, a determination of the sorption capacity of the subsurface formations with respect to lead is difficult. Partition coefficients are also highly



WIPP LEAD ASSESSMENT

Hydrous Ferric Oxides (HFO) Double Layer Surface Complexation

Daniel B. Stephens & Associates, Inc.
6-10-08
JN ES08.0072

Figure 14

dependent upon the nature of the substrate (see compilations in Appendix H), which is highly heterogeneous.

The theoretical calculations of lead adsorption to HFO presented are estimates due to various significant uncertainties described in more detail in Appendix G. However, it is reasonable to expect the abundant iron mineral surfaces in the Santa Rosa and Dewey Lake to provide substantial sorption capacity. Section 6.3 describes the HFO coatings on Dewey Lake samples examined by electron microscopy. Notwithstanding the limitations of modeling adsorption processes for SSW, adsorption by HFO is expected to provide a significant barrier to migration of lead away from its source and a mechanism of attenuation near the source. Hydrologic factors are likely even more important in limiting the migration of lead-bearing SSW near PZ-13.

9. Leaching Tests of Dewey Lake and Drill Bits

Leaching experiments were conducted using multiple fluids to try to examine dissolution of lead from samples of rock cores and drill bit teeth that had elevated lead concentrations based on XRF testing. The leaching experiments were intended to confirm or rule out these materials as possible sources of the lead at PZ-13 as well as to explore the range of conditions under which lead could dissolve from each potential source and remain in solution. A plausible lead source would have to not only contain lead but also be able to leach lead into solution at a concentration near the concentration observed at PZ-13 under similar conditions. Other chemical constituents of the material would also have to behave in accordance with observations at the SSW monitor wells for the material to be a plausible source of the lead.

Over the course of this assessment, various lines of evidence pointed to lead adsorbed on iron oxide surfaces in the Dewey Lake and Santa Rosa as a plausible source of the dissolved lead in PZ-13. The XRF results, in particular, provided a basis to pursue this hypothesis in more detail by conducting leaching tests and EPMA of selected rock samples. Both types of testing were also conducted with samples of the drill bit teeth used at PZ-13 based on XRF results that indicated high concentrations of lead in the teeth. The leaching tests of drill bit teeth helped to establish that the XRF detections of lead in the teeth were false positives due to interference from the tungsten fluorescence spectra. The EPMA, discussed in Section 6, was conducted in the same time frame as the leaching tests. Therefore, the XRF results had the greatest role in guiding the leaching tests.

HEAL staff performed the leaching tests and related analyses with instruction and supervision from DBS&A. HEAL analyzed samples for metals by EPA method 6010B and forwarded some samples to Anatek Labs, Inc. for analysis of additional metals by EPA method 6020A. Due to concerns about detection limits and interferences, lead was generally analyzed by both methods. The leaching tests used high salinity water to replicate PZ-13 conditions, resulting in laboratory detection limits near the concentrations of interest for lead. Because the instruments used in the two methods (ICP-AES and ICP-MS) employ different physical principles to detect analytes, the use of both methods to independently quantify lead concentrations also provides cross-validation of results. Appropriate EPA methods and standard methods were used to analyze major ions and other parameters for selected samples. A summary of the lead results is presented in Table 8; complete laboratory reports for all the laboratory analyses described in this section are provided in Appendix I.

9.1 Leaching Fluid Selection

Leaching tests were performed using brine representative of PZ-13 water quality and deionized water to leach the same materials to test whether the solubility of lead depends on the particular geochemical conditions created by ion concentrations in the brine near PZ-13. Water in PZ-13 has the highest TDS concentration detected in any of the SSW wells and is almost saturated with respect to halite and other evaporite minerals. The extremely high chloride concentration at PZ-13 could promote complexation of lead and thereby increase the solubility of lead to uniquely high levels. This elevated lead dissolution was hypothesized based on the geochemical modeling discussed in Appendix G, and could explain why similar lead concentrations to those at PZ-13 have not been observed in the SSW at other locations (Figure 7). Although geochemical modeling was useful for exploring the relative importance of several parameters and processes controlling the potential mobility of lead near PZ-13, the geochemical modeling carried large uncertainties due to unmeasured water quality parameters. The opportunity to conduct leaching experiments allowed measurement of aqueous concentrations of lead and other chemical species under fresh water conditions and saline conditions encountered at PZ-13.

Various leach solutions were considered for use in simulating the brine at PZ-13. The goal was to match the major ion composition of the PZ-13 brine as closely as possible, while guaranteeing that the leach solution itself did not contain lead at a concentration that could affect the results. The PZ-13 brine composition was defined using the data in Table 1a.

Two alternatives were analyzed in the laboratory: (1) brine collected from the Salt Storage Extension Basin (SSEB), and brine prepared by mixing Salado salt with deionized water. The SSEB brine did not contain detectable lead, nor did a solid sample of the Salado material. The first attempt to match the PZ-13 brine composition with the Salado solution did not use enough salt to approach the necessary TDS concentration, but it was determined that the proportions of

Table 8. Summary of Lead Concentrations in Leaching Tests

Sample (Lab Sample ID)	Formation	Fraction	Leaching Fluid	Analysis Method	Lead Concentration (mg/L)		
					A: Day 1	B: Day 5	C: Day 28
Rock Samples							
PZ-13 (74-75) (0912387-01 A,B,C)	Santa Rosa/ Dewey Lake	Whole rock	Deionized water	6010B (ICP-AES)	<0.050	<0.050	<0.0050
				6020A (ICP-MS)	<0.1	<0.1	<0.1
PZ-13 (76-77) (0912387-02 A,B,C)	Dewey Lake	Red portion	Brine from Salado salt	6010B (ICP-AES)	**0.32**	**0.25J**	<0.25
				6020A (ICP-MS)	**0.206**	**0.122**	<0.1
PZ-14 (71-72) (0912387-03 A,B,C)	Dewey Lake	Whole rock	Brine from Salado salt	6010B (ICP-AES)	**0.22J**	<0.25	<0.25
				6020A (ICP-MS)	**0.204**	**0.111**	<0.1
Drill Bit Tooth Samples							
HSA Flat #3 (0912387-04 A,B,C)	NA	NA	Brine from Salado salt	6010B (ICP-AES)	<0.25	<0.25	<0.25
				6020A (ICP-MS)	<0.1	<0.1	<0.1
HSA Round #1 (0912387-05 A,B,C)	NA	NA	Brine from Salado salt	6010B (ICP-AES)	<0.25	<0.25	<0.25
				6020A (ICP-MS)	<0.1	<0.1	<0.1
Tri-Cone #4 (0912387-06 A,B,C)	NA	NA	Brine from Salado salt	6010B (ICP-AES)	<0.25	<0.25	<0.25
				6020A (ICP-MS)	<0.1	<0.1	<0.1
HSA Flat #2 (0912387-07 A,B,C)	NA	NA	Deionized water	6010B (ICP-AES)	<0.0050	<0.0050	<0.0050
				6020A (ICP-MS)	<0.1	<0.1	<0.1

Bold indicates detection of lead.
mg/L = Milligrams per liter

major ions in the Salado solution better matched the PZ-13 brine than those in the SSEB brine. A more concentrated mixture was prepared from the Salado salt and determined by laboratory analysis to sufficiently approximate the PZ-13 brine for purposes of the leaching tests. The final leach solution had <0.1 mg/L lead and a 1 percent lower TDS concentration (243,000 mg/L) than the sample in Table 1a, but a 7 percent higher chloride concentration (160,000 mg/L). A small excess of chloride was not undesirable based on a conceptual model in which chloride dominates the geochemistry of SSW at PZ-13. The absence of lead in the initial and final Salado solutions and the SSEB brine provides additional evidence that Salado salt in the SPDV pile does not account for high concentrations of lead in SSW at PZ-13.

9.2 Rock Sample Selection

The XRF testing indicated elevated lead concentrations in the upper Dewey Lake horizon where PZ-13 is screened relative to other horizons. The XRF and confirmatory laboratory analyses detected lower concentrations of lead elsewhere in the Dewey Lake, Santa Rosa, and Gatuña. No other horizons contained lead at concentrations detectable by XRF. The horizon with the highest lead concentrations also had the highest iron concentrations (approximately 3 to 5 percent) measured by the XRF, and the occurrence of lead appeared to be limited to the visibly oxidized (red) portions of the rocks in each horizon.

Samples selected for leaching tests included each of the three types of drill bit teeth and rock samples with the most elevated lead concentrations from PZ-13 and -14. Because a limited number of leaching tests were performed, leaching tests were not performed on rock samples with less total lead; such results would be inconclusive if no lead was detected in solution. Thus, the samples selected were as follows:

- Red portion of the Dewey Lake rock from PZ-13 from 76 to 77 feet bgs leached with brine
- Whole rock from PZ-13 from 74 to 75 feet bgs (across the Santa Rosa/Dewey Lake contact) leached with deionized water
- Whole Dewey Lake rock from PZ-14 from 71 to 72 feet bgs leached with brine

Tests using rock from the Santa Rosa with lead concentrations lower than the Dewey Lake samples were not pursued because the hypothesized desorption of lead from iron oxide surfaces should proceed similarly in the Dewey Lake and the Santa Rosa given the similarity of the iron oxide distributions in the two formations (a summary of the mineralogy observed in previous studies is presented in Appendix B).

9.3 Preparation and Preliminary Tests of Drill Bit Samples

Following XRF screening of the drill bits used at PZ-13, teeth were collected for leaching tests and EPMA. Teeth from the hollow-stem auger could be mechanically removed. Teeth from the tri-cone bit were cut out of the bits using a welding torch. The teeth were sent to Continental Machining Company, Inc. to be cut into usable subsamples and thin sections using electron discharge machining (EDM). DBS&A then delivered the samples to HEAL. Prior to leaching, the drill bit subsamples were sonicated in deionized water for 10 minutes to remove possible surface contamination and to minimize any effects of the cutting process on the exposed surfaces. The sonication water from each of these subsamples was also analyzed to test whether cross-contamination of the bit surfaces could be responsible for the lead detections. Lead was not detected in the sonication water above the PQL of 0.0050 mg/L.

Initial tests for lead concentration in the bits were conducted to verify that an aggressive leach solution was capable of extracting lead from the bits before proceeding with leaching tests in brine. One subsample from each type of drill bit tooth was leached overnight in a 5 percent nitric acid solution, which was then analyzed for lead and other metals to try to validate the XRF detections of lead. The nitric acid solution digested a significant portion of each subsample. However, because the samples were not totally digested, the results are not a reliable measure of the solid concentration of lead in the bits. The bit testing results found no detection of lead in two of the nitric acid leach samples, but EPA method 6020A detected a concentration of 0.0940 mg/L in one bit sample. As expected, cobalt, iron, and tungsten concentrations were orders of magnitude higher.

The low lead concentrations in the nitric acid solution are interpreted as contradicting the high detections from the XRF, yet not completely ruling out the possibility of drill bits containing lead impurities that could be leached by brine and contribute to the concentrations at PZ-13. An early analysis of a drill bit subsample using EPMA similarly produced a small peak in the spectrum that was automatically matched to lead, although it appears the spectra of lead and tungsten overlap (Section 6). Thus, the lead peak could have been a misidentified tungsten peak; conversely, the taller tungsten peaks in other sample spectra could have been masking lead. The decision was made to proceed with leaching tests for the other drill bit subsamples to avoid any doubts that might remain if this possibility were left untested.

9.4 Leaching Procedures

Leaching tests used a modified synthetic precipitation leaching procedure (SPLP; EPA method 1312) with either Salado brine or deionized water as the leaching fluid. Rock samples were crushed and leached using a 20:1 mass ratio of leaching fluid to solid approximated by adding 25 grams of rock to 500 milliliters of leaching fluid. Drill bit subsamples also used a 20:1 mass ratio of leaching fluid to solid. The samples were tumbled for 18 hours, then allowed to sit. Samples of fluid sufficient for laboratory analysis were decanted after 1 day (specifically 18 hours), 5 days, and 28 days. Leachate from rock samples was filtered and digested in acid according to EPA method 3010. Drill bit leachate was acidified without filtering. All the leaching tests were conducted in closed bottles with headspace. No attempt was made to directly control the pH or temperature of the experiments.

Analytes were selected that were expected to be present in the rocks or the bits based on the XRF results, with some emphasis on metals that could distinguish the two potential sources. Due to limited sample volume and the desire to avoid altering the system by decanting too much fluid early in the experiment, a more comprehensive analyte list was used for the 28-day samples and shorter analyte lists were used for the 1-day and 5-day samples.

For the 1-day and 5-day samples for the rock leaching tests, the analyte list included lead, arsenic, barium, cadmium, cobalt, chromium, iron, manganese, nickel, uranium, vanadium, tungsten, and zinc. For the 28-day samples for the rock leaching tests, the analyte list additionally included TDS, electrical conductivity, pH, alkalinity, bromide, calcium, chloride, fluoride, potassium, magnesium, sodium, nitrite, nitrate, phosphate, and sulfate.

Based on the nitric acid and sonication results for the bits, the 1-day and 5-day sample analyte list was limited to lead, cobalt, chromium, iron, nickel, tungsten, and zinc. For the 28-day samples for the bit leaching tests, the analyte list additionally included arsenic, barium, calcium, cadmium, chloride, potassium, magnesium, manganese, sodium, strontium, uranium, and vanadium.

This latter list was intended to include TDS, electrical conductivity, pH, and anions as with the rock leaching tests; however, insufficient sample volume was left for all the analyses intended, so one fraction of the sample was analyzed for metals, including major cations, and the remaining fraction was used to determine the chloride concentration as a coarse check of the ion balance.

9.5 Results

Results are summarized in Table 8. None of the bit subsamples leached any detectable lead into the Salado brine or the deionized water. The PQL for the EPA method 6020A analyses of these samples was 0.1 mg/L, which was lower than all of the lead detections in PZ-13. It is concluded from these results that the drill bits are not the source of the lead in PZ-13.

Leaching the Dewey Lake rock samples with the Salado brine produced lead concentrations from 0.204 to 0.32 mg/L after one day of leaching. These concentrations are similar to those observed in PZ-13, indicating that the mechanism simulated by the leaching tests is a plausible explanation for the occurrence of lead in PZ-13.

These results were produced by both EPA method 6010B and EPA method 6020A. The latter method tended to produce lower concentrations. The two methods involve different corrections for interferences, but there is no clear reason for a systematic difference in laboratory results, and both sets of results are valid based on their respective QA/QC criteria.

Lead concentrations had declined by almost one-half after 5 days and were below PQLs after 28 days. This effect is attributed to rapid dissolution of lead when first contacted by the brine and gradual re-equilibration of the small test system over several days. PQLs for most analytes were elevated due to the salinity of the brine; for example, iron concentrations in the samples were reported as <1.0 mg/L. Dissolved manganese concentrations were estimated at or slightly above the instrument detection limit of 0.014 mg/L through day 5 and were not detectable by day 28. Although it cannot be stated for certain, it is possible that such elements that form sorption sites initially leached into solution and then reprecipitated over the course of the experiment. The crushing of the rock samples could provide fresh surfaces for such a process and might exaggerate the effect relative to the real-world system near PZ-13.

The pH recorded in the Salado brine solution was 7.84, and the pH in the Salado brine leach solution used for the Dewey Lake samples was 8.03 after 28 days. Note that the high ionic strength of the brine may pose difficulties for analysis of pH as well as other analytes. Even so, the measurements indicate little change over the duration of the experiments. The pH measured in PZ-13 water is generally close to 6.1. Had the pH of the experiments been controlled to match this lower value, it is expected that lead solubility might have been even higher than observed. Thus, the difference in pH between the experiments and site conditions, although important to the geochemistry, does not change the conclusion that enhanced solubility of lead due to the salinity of the brine is a plausible mechanism for the occurrence of lead at PZ-13.

Zinc concentrations for day 1 and day 5 reported by the laboratory as estimated values near the PQL ranged from 0.039 mg/L to 0.23 mg/L. The resulting lead:zinc ratios are similar to those obtained from PZ-13 during the repeat sampling event, which are orders of magnitude higher than those obtained from previous corrosion testing of galvanized mesh in which the mesh was similarly leached with a solution of Salado salt (IT, 1996). This fact is consistent with in situ rock being a plausible source of the lead in PZ-13 in contrast to galvanized mesh, which, had it somehow gone undiscovered in the SPDV pile, would be expected to leach much more zinc than lead into the SSW.

Deionized water did not leach any detectable lead from the rock sample from the Santa Rosa/Dewey Lake contact at PZ-13 over the 28 days. The total lead concentration in this rock was measured in the laboratory to be 12 mg/kg, the same concentration as in the sample from PZ-14 that leached lead into the Salado brine. The lack of detectable lead in the deionized water supports the conclusion that the composition of the brine increases the solubility of lead. This implies the enhanced lead solubility would not persist in the event that SSW containing lead mixes with water of much lower salinity.

10. Lead Fate and Transport

Besides examining the potential sources of lead in SSW at PZ-13, an important element of this assessment is evaluating the potential fate and transport of lead to understand the potential for any adverse impacts to groundwater quality. The geochemical modeling results indicate that lead migration is not inhibited by solubility limits. The assessment also considered the hydrogeologic conditions near the SPDV pile and lead adsorption mechanisms that influence lead mobility.

10.1 Potential for Hydrologic Transport

The three monitor wells installed adjacent to the SPDV pile encountered SSW at depths ranging from approximately 40 to 65 feet bgs, in thin perched zones that do not appear to be continuous based on the different levels at which saturation occurs in the Gatuña and Santa Rosa Formations. At PZ-13, the SSW saturated interval as observed during drilling is 2.5 feet thick. The highly saline water in PZ-13 has a TDS concentration of 230,000 to 255,000 mg/L, apparently as a result of infiltration through the SPDV pile prior to construction of a final cover.

Based on the limited thickness of the SSW beneath the SPDV pile, the potential for migration of this water appears limited. Any migration of the saturated lens would be into unsaturated formation materials that will absorb and hold water within the formation's open pore space. Although hydraulic conductivity has not been measured at PZ-13, -14, or -15, the drawdown and slow recovery of these wells during sampling suggest that the local transmissivity values are small. Little potential appears to exist for hydrologic transport of SSW at PZ-13 to a groundwater aquifer over significant distance.

10.2 Lead Adsorption

Lead in solution is susceptible to adsorption onto formation surfaces. Lead adsorption was analyzed using the Dzombak and Morel (1990) model for sorption simulations of HFO coatings on the formation material surfaces. Iron oxide coatings are characteristic of sandstone and siltstone materials in the site formations, causing their red color. It is reasonable to expect that abundant iron mineral surfaces in the Santa Rosa and Dewey Lake provide substantial sorption capacity. Lead transported through the Santa Rosa and Dewey Lake Formations will be strongly affected by adsorption on iron oxide surfaces.

The model results indicate that adsorption of lead by iron oxides reduces the aqueous concentration of lead by over two orders of magnitude at the observed composition of PZ-13 water. In saline solutions like PZ-13 water, adsorption is suppressed because the major ions compete with lead for surface sites. Adsorption of lead decreases somewhat in the event that PZ-13 type water is diluted by water of lower salinity. However, when PZ-13 water is diluted to a TDS concentration of 10,000 mg/L, the combined effects of dilution and net adsorption reduce the dissolved lead concentration by another two orders of magnitude.

Because theoretical sorption isotherms are based on experiments conducted at low ionic strength and because the iron content of the formations near PZ-13 is uncertain, a determination of the sorption capacity of the subsurface formations with respect to lead is difficult. Notwithstanding these limitations, adsorption can be expected to provide a significant barrier to migration of lead.

11. Summary and Conclusions

This assessment of dissolved lead in monitor well PZ-13 considers potential sources of elevated lead concentrations that could be identified and reaches conclusions as to the likelihood of impacts from the various sources. The assessment also considers the geochemical conditions of SSW at PZ-13 with factors controlling solubility and potential mobility of lead. The evidence from testing completed for this assessment shows that dissolution of naturally occurring lead in the upper Dewey Lake Formation by saline SSW is the cause of the lead concentrations measured in PZ-13.

Water quality monitoring performed for PZ-13 has confirmed the detection of dissolved lead at concentrations from 0.13 to 0.40 mg/L during repeat monitoring events completed in 2008 and 2009. The groundwater sampling, laboratory test methods, and QA/QC procedures were evaluated to determine whether lead could possibly be introduced by sampling procedures or incorrectly reported by the laboratories. This review of monitoring methods indicates that the lead concentrations are accurately reported, repeatable, and should be considered reliable results.

11.1 Evaluation of Potential Lead Sources

Table 5 presents a summary of the potential sources of lead that were considered in this assessment and conclusions regarding whether the potential sources are considered plausible or unlikely sources of the lead detected in PZ-13. This assessment has been able to rule out many potential sources that are considered unlikely to be contributors. The evidence points to leaching of naturally occurring lead in the upper Dewey Lake as the source based on testing of core samples under geochemical conditions simulating lead dissolution in the SSW. Thus, the lead detected in PZ-13 is not the result of a release from the SPDV pile; rather, the lead exists in the formation material, where the high ionic strength brine in PZ-13 causes lead dissolution that does not occur in less saline water.

11.1.1 Monitoring Materials and Procedures

Monitoring methods and laboratory procedures used to test the SSW at PZ-13 do not appear to be a likely source of lead. The initial sampling on October 10, 2007 and confirmation sampling in 2008 and 2009 detected relatively consistent concentrations of lead and other water quality parameters. Appropriate sampling and QA/QC procedures have been followed to yield reliable results. Lead has not been detected in a field blank or in the laboratory method blanks at a concentration above the PQL of 0.005 mg/L. Samples have been tested by two independent laboratories, each of which appears to be diligently following QA/QC protocols.

Materials used to construct monitor well PZ-13 are standard materials used for construction of monitor wells used for environmental monitoring purposes, which should not contain a source of lead contamination. However, a hybrid drilling technique was used at PZ-13 involving air-rotary drilling and a hollow-stem auger with a custom-made bit and core barrel. Drilling in well-consolidated rock in the Santa Rosa at PZ-13 caused lost auger teeth, which were replaced by arc welding and brazing new teeth on the bit (Stewart Brothers, 2009). The lost drill bit teeth were thought to be a potential lead source if lead impurities could react in the saline geochemical conditions at PZ-13 in a way that that would not occur under typical environmental conditions.

Testing has shown that the drill bit teeth are not a source of lead. Initial testing of the drill bits by XRF measured lead concentrations of approximately 4,000 mg/kg, with elevated concentrations on the cutting teeth of both bits used. However, subsequent testing by elemental mapping using EPMA and laboratory analytical testing did not detect elevated lead. Instead, high concentrations of tungsten were measured. The tungsten is believed to have caused interference with the XRF, giving a false positive result for lead rather than tungsten. The EPMA and laboratory test results did not identify lead at concentrations above the detection limits of the instruments except for a single detection of 0.094 mg/L obtained by digesting a few grams of one bit in nitric acid. Leaching tests on drill bit tooth samples using brine to simulate SSW water quality did not produce any detectable lead. The laboratory results indicating no lead source in the drill bits are considered much more reliable than the XRF field instrument.

11.1.2 Historical Activities at or Near the WIPP Facility

Historical activities that have occurred in the area near the WIPP facility include ranching, hunting, and trapping, which are no longer permitted within the WIPP exclusion zone. Oil and gas exploration and production activities and potash mining occur outside the WIPP land withdrawal boundary, and leases were active within the WIPP land withdrawal area prior to 1988. These historical activities do not appear likely to have released significant lead to the environment in the vicinity of PZ-13.

11.1.3 SPDV Pile Materials

Materials in the SPDV pile could include plausible sources of lead; however, records do not show actual disposal of lead-bearing materials in the pile. The pile primarily consists of native geologic materials excavated from three 2,150-foot shafts and the first drifts and rooms mined during the WIPP design validation phase (U.S. DOE, 2008). The pile also includes approximately 5 percent construction debris based on visual estimates and investigation trenches (DBS&A, 1996). The SPDV pile is estimated to contain approximately 168,000 cubic yards of material (DBS&A, 1996).

The predominant rock type accounting for at least 60 percent of the SPDV pile is halite from the Salado Formation. The Salado Formation consists of 85 to 90 percent rock salt and smaller amounts of anhydrite, polyhalite, and fine-grained clastic rocks. Based on the relative thickness of the geologic formations penetrated by the shafts, materials that are relatively prominent include Rustler Formation (interbedded sulfates, carbonates, clastics, and halite) and Dewey Lake Redbeds Formation (interbedded reddish-brown fine sandstone, siltstone, mudstone, and claystone). Relatively small amounts of material were removed from the Gatuña Formation (predominantly sandstone with interbedded siltstone), and the Santa Rosa Sandstone Formation (gray and red sandstone with lenses of shale and conglomerate). An unknown amount of surficial soil and caliche may be incorporated with the other geologic material.

Debris in the SPDV pile may contain any of the materials used for construction during the WIPP design validation phase, including concrete, rebar, plastic, electrical cable, miscellaneous pieces of worn or broken equipment, rock bolts, rock bolt plates, petroleum hydrocarbons, and undetonated explosive material (DBS&A, 1996). During this assessment, DBS&A reviewed records regarding material disposition into the SPDV pile; however, little documentation was discovered regarding material disposed in the pile. Materials identified during this assessment that could also feasibly be present include drilling brine obtained from off-site potash mining operations, which was used during shaft construction. Also, galvanized chain link mesh used to line portions of the shafts and drifts for ground control, and lead wool used to seal joints and borings in the cement shaft liners have been identified as sources that impact the quality of SSW that seeps into the Exhaust Shaft (U.S. DOE, 1997a; IT, 1996 and 1997). Monitoring results from PZ-13 do not suggest that the chain link mesh is a source because the lead:zinc ratio is much higher than would be expected. Because lead-bearing materials could have been disposed of in the SPDV pile, which was in use at the time of shaft liner construction, these materials cannot be entirely ruled out as possible sources. However, there is no known evidence that these materials were actually disposed of in the SPDV pile, and the evidence of naturally occurring lead in the upper Dewey Lake and absence of evidence for lead-bearing waste in the SPDV pile greatly diminish the likelihood of construction debris as the lead source at PZ-13.

11.1.4 Mineral Solubility

Review of the available geologic literature on the geologic formation materials placed in the SPDV pile finds no observations of primary lead minerals in any of the site formations, although several minerals occurring in the sediment and bedrock at the site may still contain traces of naturally occurring lead that could plausibly contribute to lead detections at PZ-13. The formation materials that must be considered include (1) all of the geologic materials in the SPDV pile, (2) the vadose zone beneath the SPDV pile, which affects the quality of infiltrating water, and (3) the Santa Rosa and Dewey Lake where the SSW occurs at PZ-13.

Using the PZ-13 water quality data and Pitzer interaction parameters from literature as input, the numerical geochemical model PHREEQC (Parkhurst and Appelo, 1999) was used to calculate saturation indices for primary lead minerals, minerals that may contain trace levels of lead due to cation substitution, and minerals associated with major ions in the water. Because the SSW in PZ-13 is extremely saline, the solubility of lead is elevated, departing from lead behavior reported in most literature for typical low-ionic strength aqueous systems. The PHREEQC aqueous speciation calculations show that PZ-13 water is saturated with respect to lead carbonate (cerussite), but undersaturated with respect to lead sulfates and other lead minerals in this system. Halite, anhydrite, gypsum, calcite, magnesite, and dolomite are also near saturation at the observed composition of PZ-13 water. Fluorite is supersaturated due to chloride-fluoride interactions that increase the activity of fluoride. The geochemical modeling results indicate that dissolution of native geologic materials containing lead-bearing mineral species is a plausible mechanism that may result in lead concentrations in solution at the concentrations observed in PZ-13.

Dilution of the observed PZ-13 water composition was also simulated to consider the behavior of lead if the water were to migrate and mix with less saline water. Progressive dilution was modeled to a final TDS concentration of 10,000 mg/L. The simulated dilution represents the hypothetical migration of the brine into distant groundwater (without considering hydrogeologic limits on migration). The hydrogeologic conditions that limit any potential migration are discussed in Section 7.2. The calculations show that no saturation limit is reached for any lead minerals in the mixed, lower ionic strength water. Therefore, lead would remain in solution and not precipitate as a mineral species if it were mixed with water that is more dilute than observed at PZ-13. However, a mixing ratio of 25:1 is necessary to dilute the TDS concentration of PZ-13 water to 10,000 mg/L, which would simultaneously dilute the lead concentration to the groundwater protection standard of 0.05 mg/L (20.6.2 NMAC Part 3102.A).

11.2 Mineralogy and Lead Distribution

Based on these recent investigations, lead occurs naturally in the Dewey Lake and to a lesser extent the Santa Rosa, with measured lead concentrations of up to 31 mg/kg in whole rock samples. XRF testing of samples from the Dewey Lake, Santa Rosa, Gatuña, and Salado only found detectable lead concentrations in the upper Dewey Lake. Laboratory tests of the upper Dewey Lake horizon measured lead ranging from 8.8 to 16 mg/kg. The XRF, laboratory, and EPMA results indicate that the detectable lead in the Dewey Lake is associated with red, oxidized portions of the formation, while lead concentrations are below detection in the green, reduced “spots” common in the Dewey Lake.

Lead is associated with several minerals in the Dewey Lake. Using EPMA, lead was detected in some igneous minerals including monazite and magnetite, as well as authigenic iron oxides. The majority of the lead detections correlated with authigenic iron oxide minerals. The decomposition of magnetite is probably the source for both iron and lead found in authigenic minerals. The EPMA showed lead associated with authigenic iron oxides distributed throughout the Dewey Lake samples. These iron oxides are fine silt and clay-sized particles.

XRF testing of Dewey Lake samples from ERDA-9 indicates that the lead was present in 1976 before the WIPP site was developed as a repository site. These samples are not impacted by the SSW; therefore, the lead is most likely distributed regionally in the upper Dewey Lake.

11.3 Leaching Tests of Dewey Lake and Drill Bits

To simulate leaching by PZ-13 water, Dewey Lake rock samples from PZ-13 and -14 were leached with brine prepared using Salado salt; this process produced lead concentrations from 0.204 to 0.32 mg/L after one day. These concentrations are similar to those observed in PZ-13, indicating that the mechanism simulated by the leaching tests is a plausible explanation for the occurrence of lead in PZ-13.

Lead concentrations had declined by almost one-half after 5 days and were below PQLs after 28 days. This effect is attributed to rapid dissolution of lead when first contacted by the brine and gradual re-equilibration of the small test system over several days.

Deionized water did not leach any detectable lead from a rock sample from the Santa Rosa/Dewey Lake contact at PZ-13 over the 28 days of the test period. The total lead concentration in this rock was measured in the laboratory to be 12 mg/kg, the same concentration as in the sample from PZ-14 that leached lead into the Salado brine. The lack of detectable lead in the deionized water supports the conclusion that the composition of the brine increases the solubility of lead. This implies that the enhanced lead solubility would not persist in the event that SSW containing lead mixes with water of much lower salinity.

None of the drill bit tooth subsamples leached any detectable lead into the Salado brine or the deionized water. Therefore the drill bits are not the source of the lead in PZ-13.

11.4 Lead Fate and Transport

Besides examining the potential sources of lead in SSW at PZ-13, an important element of this assessment is evaluating the potential fate and transport of lead to understand the potential for any adverse impacts to groundwater quality. The geochemical modeling results indicate that lead migration is not inhibited by mineral solubility limits, but strongly inhibited by lead adsorption by iron oxide coatings on formation materials. The assessment also considered the hydrogeologic conditions of the SSW perched zones near the SPDV pile.

11.4.1 Potential for Hydrologic Transport

The three monitor wells installed adjacent to the SPDV pile encountered SSW in thin perched zones in the Gatuña and Santa Rosa Formations. The perched zones do not appear to be continuous, as each of the monitor wells encountered water at a different horizon in the formations. At PZ-13, the SSW saturated interval observed during drilling is 2.5 feet thick. The water in PZ-13 is highly saline, with a TDS concentration of 230,000 to 255,000 mg/L, apparently as a result of infiltration through the SPDV pile prior to construction of a final cover.

Based on the limited thickness of the SSW beneath the SPDV pile, the potential for migration of this saline water appears to be minimal. Any migration from the thin saturated zones would be into unsaturated formation materials that will absorb and hold water within the formation’s open pore space. Although saturated hydraulic conductivity has not been measured at PZ-13, -14, or -15, the drawdown and slow recovery of these wells during sampling suggest that the local transmissivity values are small. The unsaturated hydraulic conductivity is always orders of magnitude lower than the saturated hydraulic conductivity. Therefore, little potential appears to exist for hydrologic transport of SSW at PZ-13 over significant distance to a groundwater aquifer.

11.4.2 Lead Adsorption

Lead in solution is susceptible to adsorption onto formation surfaces. A geochemical sorption model was used to analyze lead adsorption by HFO coatings on the formation material surfaces. These iron oxide coatings cause the characteristic red color of sandstone and siltstone materials. It is reasonable to expect that abundant iron mineral surfaces in the Santa Rosa and Dewey Lake provide substantial sorption capacity that limits the potential for lead transport.

The model results indicate that adsorption reduces the aqueous concentration of lead by over two orders of magnitude at the observed composition of PZ-13 water. Using the geochemical model, lead behavior was examined for progressively less saline water quality conditions. When PZ-13 water is diluted to a TDS concentration of 10,000 mg/L, the combined effects of dilution and adsorption reduce the dissolved lead concentration by another two orders of magnitude.

Because theoretical sorption isotherms are based on experiments conducted at low ionic strength and because the iron content of the formations near PZ-13 is uncertain, a determination of the formation sorption capacity with respect to lead is difficult. Notwithstanding these limitations, adsorption can be expected to provide a significant barrier to migration of lead.

References

Alpers, C.N. and D.K. Nordstrom. 1999. Geochemical modeling of water rock interactions in mining environments. *Chapter 14 in* Plumlee, G.S. and M.J. Logsdon (eds.), The environmental geochemistry of mineral deposits, Part A: Processes, techniques, and health issues. *Reviews in Economic Geology* (6A):289-323.

Amdouni, R. 2009. Behaviour of trace elements during the natural evaporation of sea water: Case of solar salt works of Sfax saline (S.E. of Tunisia). *Global NEST Journal* 11(1):99-105.

Appelo, C.A.J. and D. Postma. 2005. *Geochemistry, groundwater and pollution. 2nd ed*. A.A. Balkema Publishers, Amsterdam. 649pp.

Bachman, G.O. 1980. *Regional geology and Cenozoic history of Pecos Region, southeastern New Mexico.* U.S. Geological Survey Open-File Report 80-1099. 116p.

Bechtel National, Inc. (Bechtel). 1986. *Waste Isolation Pilot Plant, Design validation final report.* Prepared for U.S. Department of Energy. Job 12484. DOE-WIPP-86-010. October 1986.

Callahan, M.A., M.W. Slimak, N.W. Gabel, I.P. May, C.F. Fowler, J.R. Freed, P. Jennings, R.L. Durfee, F.C. Whitmore, B. Maestri, W.R. Mabey, B.R. Holt, and C. Gould. 1979. *Water-related environmental fate of 129 priority pollutants, Volume I: Introduction and technical background, metals and inorganics, pesticides and PCBs.* Office of Water Planning and Standards, Washington, D.C. EPA-440/4-79-029a. December 1979.

Daniel B. Stephens & Associates, Inc. (DBS&A). 1996. *Characterization of the Site Preliminary Design Validation salt pile*. January 5, 1996.

DBS&A. 2003. *Water budget analysis of shallow subsurface water at the Waste Isolation Pilot Plant.* Prepared for U.S. Department of Energy Carlsbad Field Office. September 30, 2003.

DBS&A. 2008. *Hydrologic assessment of shallow subsurface water, Waste Isolation Pilot Plant, Carlsbad, New Mexico.* Prepared for Washington TRU Solutions LLC. December 18, 2008.

DBS&A. 2009. *[Draft] Assessment of lead in PZ-13 near the Site and Preliminary Design Validation (SPDV) pile at Waste Isolation Pilot Plant*. Prepared for Washington TRU Solutions LLC. June 12, 2009.

Debye, P. and E. Hückel. 1923. On the theory of electrolytes. *Physikalische Zeitschrift* 24(9):185-208, 305-325.

Downes, C.J., and K.S. Pitzer. 1976, Thermodynamics of electrolytes. binary mixtures formed from aqueous NaCl, Na_2S0_4, $CuCl_2$, and $CuSO_4$ at 25 Degrees C. *Journal of Solution Chemistry* 5(6):389-398.

Dzombak, D.A. and F.M.M. Morel. 1990. *Surface complexation modeling, Hydrous ferric oxide.* John Wiley and Sons, New York. 393p.

Faure, G. 1991. *Principles and applications of inorganic geochemistry*. Macmillan, New York. 626p.

Fultz Pumps, Inc. (Fultz). Undated. Instruction manual for sampling pump units.

Gibbs, L.M. 1997. How gasoline has changed. pp. 147-164 in Society of Automotive Engineers, *History of aircraft lubricants*. May 1997.

Harvie, C.E., N. Moller, and J.H. Weare. 1984. The prediction of mineral solubilities in natural waters: The Na-K-Mg-Ca-H-Cl-SO_4-OH-HCO_3-CO_3-CO_2-H_2O system to high ionic strengths at 25°C. *Geochimica Cosmochimica Acta* 48(4):723-751.

Hendrickson, G.E. and R.S. Jones. 1952. *Geology and ground-water resources of Eddy County, New Mexico*. New Mexico Bureau of Mines & Mineral Resources Ground-Water Report 3. Socorro, New Mexico. 169p. and plates.

Holt, R.M. and D.W. Powers. 1990. *Geologic mapping of the air intake shaft at the Waste Isolation Pilot Plant.* Prepared for U.S. Department of Energy. DOE/WIPP 90-051. December 1990.

Intera. 1996. *Exhaust shaft hydraulic assessment data report.* Prepared for Westinghouse. DOE/WIPP 97-2219. November 1996.

Intera. 1997. *Exhaust shaft: Phase II hydraulic assessment data report involving drilling, installation, water-quality sampling, and testing of piezometers 1-12*. Prepared for Westinghouse. DOE/WIPP 97-2219. September 26, 1997.

Ismail, A.E. 2008. *Calculation of new Pitzer parameters for the WIPP FMT and EQ3/6 thermodynamic databases, Analysis plan AP-136.* Sandia National Laboratories, Carlsbad, New Mexico. Effective April 17, 2008.

IT Corporation (IT). 1996. *Analysis of corrosion testing results for galvanized mesh material obtained from the Waste Isolation Pilot Plant, New Mexico.* Prepared for Westinghouse Electric Corporation, Carlsbad, New Mexico. DOE/WIPP 96-2212. December 1996.

IT. 1997. *Composition and origin of nonindigenous brine and water in the vicinity of the exhaust shaft, Waste Isolation Pilot Plant, New Mexico.* Prepared for Westinghouse Electric Corporation, Carlsbad, New Mexico. DOE/WIPP 97-2226. February 1997.

Jones, C.L., M.E. Cooley, and G.O. Bachman. 1973. *Salt deposits of Los Medaños area, Eddy and Lea Counties, New Mexico*. U.S. Geological Survey Open-File Report 73-135. 67p.

Kühn, R. 1966. Geochemistry of the German potash deposits. *In* Geological Society of America, Inc. *Abstracts for 1965.* Special GSA Papers Number 87.

Langmuir, D. 1997. *Aqueous environmental geochemistry*. New Jersey, Prentice-Hall, 600 p.

Mercer, J.W. 1983. *Geohydrology of the proposed Waste Isolation Pilot Plant site, Los Medaños area, southeastern New Mexico*. Prepared in cooperation with the U.S. Department of Energy. U.S. Geological Survey Water-Resources Investigations Report 83-4016.

Miller, D.N. Jr. 1966. Petrology of Pierce Canyon redbeds, Delaware Basin, Texas and New Mexico. *Bulletin of the American Association of Petroleum Geologists* 90(2):289-307.

New Mexico Bureau of Geology and Mineral Resources (NMBGMR). 2008. New Mexico potash–Past, present, and future. *New Mexico Earth Matters*. Summer 2008.

Nordstrom, D.K. and J.L. Munoz. *Geochemical thermodynamics*. Palo Alto, Blackwell Scientific Publications. 477 p.

Orris, G., G. Harvey, D. Tsui, and J. Eldridge. 2003. *Preliminary analyses for perchlorate in selected natural materials and their derivative products*. U.S. Geological Survey Open-File Report 03-314.

Parkhurst, D.L. and A.A.J. Appelo. 1999. *User's guide to PHREEQC (version 2) A computer program for speciation, batch-reaction, one dimensional transport, and inverse geochemical modeling*. USGS Water resources investigation 99-4259.

Pitzer, K.S. 1991. Ion interaction approach: Theory and data correlation. Chapter 3 in Pitzer, K.S. (ed.), *Activity coefficients in electrolyte solutions, 2nd edition*. CRC Press, Boca Raton, Florida.

Powers, D.W. 2003a. *Geohydrological conceptual model for the Dewey Lake Formation in the vicinity of the Waste Isolation Pilot Plant (WIPP), Test plan TP 02-05., Rev. 0.* BOE 1.3.5.3.1, Sandia Corporation. March 17, 2003

Powers, D.W. 2003b. Personal communication between Dr. Dennis W. Powers, consulting geologist, and Derek Blazer, DBS&A. June 2003.

Railsback, L.B. 2008. *An earth scientist's periodic table of the elements and their ions.* Version 4.8d. Department of Geology, University of Georgia, Athens, Georgia. August 2008. Available at <http://www.gly.uga.edu/railsback/PT.html>.

Rimstidt, J.D., J.A. Chermak, and P.M. Gagen. 1994. Rates of reactions of galena, sphalerite, chalcopyrite, and arsenopyrite with Fe(III) in acidic solutions. *In* Alpers, C.N. and D.W. Blowes (eds.), *Environmental geochemistry of sulfide oxidation*. ACS Symposium Series 550.

Salness, R. 2007-2009. Field notes provided by Rick Salness, WTS.

Schueler, S. 2008. *X-ray analysis of overlapping peaks*. Thermoscientific application note 50489. Available at <http://www.thermo.com/eThermo/CMA/PDFs/Articles/articlesFile_10940.pdf>.

Sergent, Hauskins & Beckwith, 1979. *Subsurface exploration and laboratory testing, plant site*, Waste Isolation Pilot Plant, Volume 1. Prepared for Bechtel National, Inc. Bechtel Job No. 12484. May 11, 1979.

Shacklette, H.T. and J.G. Boerngen. 1984. *Element concentrations in soils and other surficial materials of the conterminous United States.* U.S. Geological Survey Professional Paper 1270.

Sidwell, R. and D.T. Gibson. 1940. Mineral study of Santa Rosa sandstone in Guadalupe County, New Mexico. *Journal of Sedimentary Research* 10(1):5-7.

Smith, K.S. 1999. Metal sorption on mineral surfaces: An overview with examples relating to mineral deposits. *Chapter 7 in* Plumlee, G.S. and M.J. Logsdon (eds.), The environmental geochemistry of mineral deposits, Part A: Processes, techniques, and health issues. *Reviews in Economic Geology* (6A):161-182.

Smith, K.S. and H.L.O. Huyck. 1999. An overview of the abundance, relative mobility, bioavailability, and human toxicity of metals. *Chapter 2 in* Plumlee, G.S. and M.J. Logsdon (eds.), The environmental geochemistry of mineral deposits, Part A: Processes, techniques, and health issues. *Reviews in Economic Geology* (6A):29-70.

Sposito, G. 1989. *The chemistry of soils*. Oxford University Press, New York.

Stewart Brothers. 2009. E-mail communication between Randy Stewart and Rick Salness, Washington Regulatory and Environmental Services, regarding Re: steel and welding rods. March 23, 2009.

Sunbelt Geophysics (Sunbelt). 1995. *Magnetometer investigation of the SPDV salt pile, Waste Isolation Pilot Project, Carlsbad, New Mexico.* Prepared for Daniel B. Stephens & Associates, Inc. (DBS&A), Albuquerque, New Mexico. September 1995. Included in Appendix B of DBS&A. 1996. *Characterization of the Site Preliminary Design Validation salt pile*. January 5, 1996.

Suzuki, M. and D. Rohde. 2008. *Resolving overlapping peak problems with NORAN System 7 spectral imaging software*. Thermoscientific application note 51188. Available at <http://camcor.uoregon.edu/pdf/thermo/AN51188_Overlapping-peaks.pdf>.

TraceAnalysis, Inc. (TraceAnalysis). 2007. Analytical and quality control report for WIPP/SSWMP samples collected October 11, 2007. Work order 7101117. October 26, 2007.

Traina, S.J. and V. Laperche. 1999. Contaminant bioavailability in soils, sediments, and aquatic environments. *Proc. Natl Acad. Sci. USA* 96:3365-3371.

Truesdell, A.H. and B.F. Jones. 1974. WATEQ, a computer program for calculating chemical equilibria of natural waters. *U.S. Geological Survey Journal of Research* 2:233-248.

U.S. Department of Energy (DOE). 1997a. WIPP Exhaust Shaft Water and Lead Working Group brine and water database.

U.S. DOE. 1997b. *Exhaust shaft: Phase 2 hydraulic assessment data report involving drilling, installation, water-quality sampling, and testing of piezometers 1-12.* DOE-WIPP 97-2278. December 1997.

U.S. DOE. 2008. *Basic data report for piezometers PZ-13, PZ-14, and PZ-15 and shallow subsurface water.* DOE/WIPP-08-3375, Revision 3. October 2008.

Van Houten. F.B. 1973. Origin of red beds, a review: 1961-1972. p. 39-61 in *Annual review in earth and planetary sciences*, vol 1.

WIPP Exhaust Shaft Water and Lead Working Group (WIPP Lead Working Group). 1996-1997. Scanned documents provided to DBS&A by WTS.

Appendix A

1995 SPDV Pile Photographs

1. View of the SPDV pile from the southwest corner

2. View of SPDV pile from the south

3. View of the western edge of the SPDV pile

4. View of the southeast corner surface of the SPDV pile

5. Trench T-2

6. Trench T-3

Appendix B

Details of Site Geology and Mineralogy

Appendix B. Details of Site Geology and Mineralogy

Aspects of the site geology relevant to the occurrence of lead in the SSW at PZ-13 and its fate and transport are the geologic materials present in and below the SPDV pile. This appendix describes each formation and lists the minerals present based on previous WIPP studies and geologic literature. Existing reports show an absence of lead-bearing minerals, but identify minerals that may contain lead impurities that influence the aqueous concentration of lead. Chemical formulas for minerals discussed in this assessment are provided in Table B-1.

Table B-2 lists the approximate average thicknesses of the major formations from geologic logging and mapping of the shafts (Bechtel, 1986; Holt and Powers, 1990). The total Salado Formation thickness may be close to 2,000 feet (Jones et al., 1973), but the shafts only penetrate the formation to the repository horizon around 2,150 feet below ground surface (bgs). All formations between and including the Salado Formation and the ground surface were mined from the four shafts; materials from these formations were placed in the SPDV pile.

The mined formations, in descending order, are described in more detail in the following subsections.

B.1 Quaternary Dune Sands

Berino series soils make up the sandy surficial soils at the WIPP site (Bachman, 1980). These soils are developed in reddish, noncalcareous, wind-worked deposits, generally about 3 feet in thickness. The Berino soils are classified as loamy fine sands with a sandy clay loam subsoil and are very susceptible to wind and water erosion, often forming hummocks or dunes. Logs of borings near the SPDV pile differentiate between unlithified dune sand and basal argillaceous sand, referring to only the latter as Berino soil (U.S. DOE, 2008), but older references do not make such a distinction.

Table B-1. Mineral Chemical Formulas
Page 1 of 2

Mineral	Chemical Formula	Vocabulary Potentially Referencing Mineral
Albite	$NaAlSi_3O_8$	Plagioclase feldspar
Anglesite	$PbSO_4$	Lead sulfate
Anhydrite	$CaSO_4$	Sulfate
Anorthite	$CaAl_2Si_2O_8$	Plagioclase feldspar
Apatite	$Ca_5(PO_4)_3(OH,F,Cl)$	
Biotite	$K(Mg,Fe)_3AlSi_3O_{10}(OH)_2$	Mica, micaceous
Bloedite	$Na_2Mg(SO_4)_2 \bullet 4H_20$	
Calcite	$CaCO_3$	Caliche, limestone, calcareous, carbonate
Carnallite	$KMgCl_3 \bullet 6H_20$	Potash
Cerrusite	$PbCO_3$	Lead carbonate
Chlorite	$(Mg,Fe,Al)_3(Al,Si)_4O_{10}(OH)_2 \bullet (Mg,Al)_3(OH)_6$	Mica
Chloropyromorphite	$Pb_5(PO_4)_3Cl$	Lead phosphate
Corrensite	$(Ca,Na,K)(Mg,Fe,Al)_9(Si,Al)_8O_{20}(OH)_{10} \bullet n(H_2O)$	
Dolomite	$CaMg(CO_3)_2$	Dolomicrite, carbonate
Epsomite	$MgSO_4 \bullet 7H_2O$	
Fluorite	CaF_2	
Galena	PbS	Lead sulfide
Garnet	$X_3Y_2(SiO_4)_3$; X = Ca,Mg,Fe^{2+},Mn; Y = Al,Fe^{3+},Cr	
Glauberite	$Na_2Ca(SO_4)_2$	
Glauconite	$(K,Na)(Fe^{3+},Al,Mg)_2(Si,Al)_4O_{10}(OH)_2$	
Gypsum	$CaSO_4 \bullet 2H_20$	Sulfate, gypsiferous
Halite	$NaCl$	Rock salt, sylvinite
Hematite	Fe_2O_3	Iron oxide
Hexahydrite	$MgSO_4 \bullet 6H_2O$	
Hydrocerrusite	$Pb_3(CO_3)_2(OH)_2$	Lead carbonate
Hydrous ferric oxide (HFO)	$FeO(OH)$	Iron oxide
Illite	$K_{0-2}Al_4(Al,Si)_8O_{20}(OH)_4$	Mica
Ilmenite	$FeTiO_3$	Iron oxide
Iron manganese carbonate	Fe(-Mn)-CO_3 amorphous	
Kainite	$KMgClSO_4 \bullet 3H_20$	
Kieserite	$MgSO_4 \bullet H_2O$	
Langbeinite	$2MgSO_4 \bullet K_2SO_4$	Potash
Leonite	$K_2Mg(SO_4)_2 \bullet 4H_20$	
Leucoxene	TiO_2	

Table B-1. Mineral Chemical Formulas
Page 2 of 2

Mineral	Chemical Formula	Vocabulary Potentially Referencing Mineral
Litharge	PbO	Lead oxide
Loeweite	$Na_{12}Mg_7(SO_4)_{13} \cdot 15H_20$	
Magnesite	$MgCO_3$	Carbonate
Magnetite	Fe_3O_4	Iron oxide
Manganese oxide	MnO	
Microcline	$KAlSi_3O_8$	Potassium feldspar
Mirabilite	$Na_2SO_4 \cdot 10H_2O$	
Monazite	$(Ce, La, Nd, Th, Y)PO_4$	
Muscovite	$KAl_3Si_3O_{10}(OH)_2$	Mica, micaceous, sericite, sericitization
Nahcolite	$NaHCO_3$	
Nesquehonite	$MgCO_3 \cdot 3H_2O$	
Olivine	$(Mg,Fe)_2SiO_4$	
Orthoclase	$KAlSi_3O_8$	Potassium feldspar
Pentahydrite	$MgSO_4 \cdot 5H_2O$	
Plumbojarosite	$PbFe_2(SO_4)_4(OH)_{12}$	
Polyhalite	$K_2Ca_2Mg(SO_4)_4 \cdot 2H_20$	
Pyrite	FeS_2	Sulfide
Rutile	TiO_2	
Sanidine	$KAlSi_3O_8$	Potassium feldspar
Schoenite	$K_2Mg(SO_4)_2 \cdot 6H_20$	
Silica	SiO_2	Chert, quartz, metaquartzite, siliceous, argillaceous, arenaceous
Smectite	$(Na,Ca)_{0.33}(Al,Mg)_2Si_4O_{10}(OH)_2 \cdot nH_2O$	Montmorillonite
Soda niter (nitratine)	$NaNO_3$	
Syngenite	$K_2Ca(SO_4)_2 \cdot H_2O$	
Sylvite	KCl	Potash, sylvinite
Tourmaline	$(Ca,K,Na)(Al,Fe,Li,Mg,Mn)_3(Al,Cr,Fe,V)_6(BO_3)_3(Si,Al,B)_6O_{18}(O,OH,F)_4$	
Xenotime	YPO_4	
Zinc oxide	ZnO	
Zircon	$ZrSiO_4$	

Table B-2. Formation Thickness and Depth

Formation	Thickness (feet)	Depth (feet below ground surface)
Quaternary dune sand	10	0 to 10
Mescalero caliche	8	10 to18
Gatuña Formation	17	18 to 35
Santa Rosa Sandstone Formation	18	35 to 53
Dewey Lake Redbeds Formation	475	53 to 528
Rustler Formation	308	528 to 836
Salado Formation	>1,370	836 to >2,206

Without regard to soil classification, the compliance certification application (CCA) states that “soils of the region have developed mainly from Quaternary and Permian parent material,” with Quaternary material comprising loamy and sandy sediments with some coarse fragments and Permian material deriving from limestone, dolomite, and gypsum bedrock.

B.2 Mescalero Caliche

The Mescalero caliche is an informal stratigraphic unit consisting of well-lithified deposits of finely crystalline carbonate (caliche) that developed below the surficial soils and in the upper portion of the Gatuña Formation (Mercer, 1983). It is a continuous stratigraphic unit at the WIPP site.

B.3 Gatuña Formation

The Gatuña Formation (the Gatuña) consists of silt, sand, and clay, and is discontinuous, with deposits in localized depressions (Hendrickson and Jones, 1952). Boring logs from on-site drilling by Sergent, Hauskins & Beckwith (1979) describe the Gatuña as predominantly sandstone with interbedded siltstone that is highly weathered, fractured, and moderately hard.

At PZ-13, -14, and -15, the Gatuña was described as argillaceous and calcareous, containing chert pebbles and carbonate clasts as well as carbonate and silica cementation (U.S. DOE, 2008). Altered, bluish-black manganese oxide was observed in the upper portion and as a coating around root casts encountered throughout the formation (U.S. DOE, 2008). Mapping at the Air Intake Shaft was broadly consistent with the above observations and further estimated that the grains are 80 percent quartz, 5 percent "mafic", and 15 percent "other" (Holt and Powers, 1990).

B.4 Santa Rosa Sandstone Formation

The Santa Rosa Sandstone Formation (the Santa Rosa*)* consists of gray and red sandstone with lenses of shale and conglomerate (Hendrickson and Jones, 1952). Miller (1966) described the mineralogy of the Santa Rosa as it occurred at distant locations in Texas and New Mexico. Miller (1966) reported that the Santa Rosa contains 50 to 70 percent quartz, with common overgrowths of authigenic silica separated from the detrital grains by bubbles and flakes of hematite, and with 85 percent of the quartz grains containing abundant rutile needles and sparse tourmaline and zircon microlites. The detritus also contains 5 to 25 percent chert, 10 percent rock fragments including metaquartzite and mineral aggregates with schistose or slaty structure (apparently derived from metamorphic rocks), 10 percent orthoclase with slight to intense sericitization, 2 percent microcline, 1 percent plagioclase altered by sericitization, and less than 1 percent altogether of muscovite, biotite, and chlorite, although these minerals are abundant. The micas are most abundant in the silty beds (Miller, 1966). "Magnetite-ilmenite is the most abundant heavy mineral in the red, hematite-stained part of the Santa Rosa Sandstone," whereas "light gray or gray-green beds are practically devoid of magnetite-ilmenite" (Miller, 1966). Leucoxene is "abundant", zircon and tourmaline are "common", and garnet and rutile are "least abundant" of the heavy minerals (Miller, 1966). A study of the Santa Rosa mineralogy in Guadalupe County (also distant from the WIPP site) similarly reported that the abundant minerals are magnetite, ilmenite, garnet, tourmaline, hematite, olivine, rutile, zircon, quartz, biotite, and muscovite (Sidwell and Gibson, 1940). Cementation by sparry calcite occurs in most places and is much more abundant than the commonly occurring authigenic quartz (Miller, 1966).

Saturation in PZ-13 as encountered during drilling occurred in a sandy argillaceous siltstone interval from 65 to 67.5 feet bgs and decreased with depth as the siltstone became harder and more indurated and as clay content increased (U.S. DOE, 2008). At PZ-13, desiccation cracks in the upper Santa Rosa contain carbonate fill, whereas the lower Santa Rosa is more argillaceous (U.S. DOE, 2008).

B.5 Dewey Lake Redbeds Formation

The Dewey Lake Redbeds Formation (the Dewey Lake*)* consists of interbedded reddish brown fine sandstone, siltstone, mudstone, and claystone (Holt and Powers, 1990). The red color is due to a thin hematite coating deposited uniformly on the surface of the sand and silt grains as a chemical precipitate (Miller, 1966). The Dewey Lake is characterized by abundant greenish-gray reduction spots (Holt and Powers, 1990). Below 164.5 feet bgs in the Air Intake Shaft, locally abundant fractures are filled with fibrous gypsum (Holt and Powers, 1990). A siliceous layer in the upper Dewey Lake at the Santa Rosa/Dewey Lake contact (Intera, 1997; Powers, 2003b) and a sulfate (gypsum) cementation zone in the lower Dewey Lake (Powers, 2003a) form zones of reduced permeability in the otherwise more permeable sandstone. The sulfate cementation zone in the lower Dewey Lake is coincident with the fibrous gypsum-filled fractures and contrasts with carbonate cementation in the upper Dewey Lake (Holt and Powers, 1990). Clear fibrous gypsum is the most abundant cement and forms 10 to 20 percent of the rock, whereas anhydrite occurs only in trace amounts (Miller, 1966). Clear sparry calcite cement constitutes about 5 percent of the volume of the rock, with less than 1 percent in most beds and up to 30 percent in a few beds, whereas dolomite occurs only in trace amounts in a few locations (Miller, 1966). At the U.S. Potash Company mine shaft No. 3, the shift to calcite cementation in the upper Dewey Lake is accompanied by an abrupt increase in the sanidine content (Miller, 1966). Hematite accounts for less than 5 percent of the rock (Miller, 1966).

The Dewey Lake detritus (excluding gypsum, calcite, and hematite cements and thin beds of illite) is composed of the following (Miller, 1966):

- Approximately 60 to 80 percent quartz with all the grains coated with hematite
- 20 to 30 percent orthoclase
- Less than 5 percent microcline

- Hollow grains of sanidine, generally in trace amounts but up to 35 percent in some siltstone lenses
- 4 percent illite
- Up to 3 percent detrital calcite
- 1 to 3 percent magnetite and ilmenite in roughly equal amounts
- 1 percent leucoxene
- 1 percent biotite, occurring sometimes in reduction spots
- Approximately half as much muscovite as biotite, concentrated in fine silt and clay laminae
- Less than 1 percent each of tourmaline, zircon, apatite, plagioclase with unidentified microlites, and metamorphic rock fragments
- Rare flakes of blue-green chlorite, grains of pale green glauconite, garnet in heavy mineral placers, and rutile

More than 99 percent of the quartz grains consist of a single crystal, and about 20 percent of the quartz grains contain mineral inclusions of pale blue tourmaline, zircon, euhedral apatite, and rutile needles (Miller, 1966). Smaller microlites of the same minerals occur in the orthoclase (Miller, 1966). Most of the illite is completely stained with hematite (Miller, 1966).

B.6 Rustler Formation

The most detailed description available of the Rustler Formation with respect to the assembled minerals was found to be that reported from the geologic mapping of the Air Intake Shaft (Holt and Powers, 1990), from which all of the observations in this section are culled. The Rustler Formation is characterized by a variable lithology consisting of interbedded sulfates, carbonates, clastics, and halite. The Rustler Formation comprises, from youngest to oldest, the Forty-Niner Member, the Magenta Dolomite Member, the Tamarisk Member, the Culebra Dolomite Member, and an unnamed lower member.

The Forty-Niner Member has an approximate average thickness of 58 feet in the shafts and contains two anhydrite beds above and below a mudstone bed. The A-5 anhydrite bed is 31 feet thick at the Air Intake Shaft and contains some laminae with anhydrite pseudomorphs after gypsum swallowtail crystals. Stylolites parallel some laminae. A disrupted zone includes boulder-sized clasts of anhydrite, as well as irregular surfaces lined with red claystone. Fibrous gypsum is present in fractures. The Mudstone 4 bed is 14.5 feet thick at the Air Intake Shaft and consists of fine sandstone, siltstone, and mudstone. Coarsely crystalline gypsum occurs in local laminae and thin beds. The A-4 anhydrite bed is 15.5 feet thick at the Air Intake Shaft, and like the A-5 contains anhydrite pseudomorphs after gypsum swallowtail crystals, as well as gypsum-filled fractures. Laminae in one section are intercalated with carbonate laminae.

The Magenta Dolomite is a moderately well-indurated, arenaceous, and gypsiferous dolomite with an approximate average thickness of 28 feet in the shafts. It is thinly laminated to laminated and some strata contain gypsum nodules. The lower 5 feet contain algal stromatolites.

The Tamarisk Member has an approximate average thickness of 86 feet in the shafts and also contains two anhydrite beds above and below a mudstone bed. The A-3 anhydrite bed is 56 feet thick at the Air Intake Shaft. Carbonate interbeds and thin claystone interbeds occur locally, as do fibrous gypsum-filled fractures. Thin beds with anhydrite pseudomorphs after gypsum swallowtail crystals are present in the lower part of the A-3, and the lowermost few feet contain beds of clast-supported, laminated anhydrite and cobble and granule breccia. The M-3 mudstone comprises a 2.5-foot-thick upper mapping unit of anhydrite and gypsum interbedded with calcareous (possibly algal) claystone, a 1.5-foot-thick middle mapping unit of calcareous claystone and argillaceous gypsum and anhydrite, and a 5.5-foot-thick lower mapping unit of interbedded and intermixed claystone, mudstone, and siltstone. The lower mapping unit is mottled to laminated with alternating red and gray colors and contains gypsum-rich zones and anhydrite nodules. Fibrous gypsum-filled fractures are abundant throughout the M-3 and in places are up to 2 inches thick. At the lower contact, a channel is cut into the underlying anhydrite and filled with siltstone, pebble conglomerate. The A-2 anhydrite bed is 21.5 feet thick at the Air Intake Shaft. It is bisected by a 0.5-foot-thick claystone bed. Algal structures are present near the base.

The Culebra Dolomite is an argillaceous dolomicrite with abundant open and gypsum-filled porosity, including extensively fractured portions. It comprises six mapping units with an approximate average combined thickness of 24 feet in the shafts. The upper two units contain argillaceous dolomite with organic matter and with gypsum and sometimes brecciation occurring at fractures. The next three units are characterized by abundant interconnected vugs and fractures that are variously open or partially to completely filled with clay or gypsum. The lowermost unit consists of locally brecciated, thinly laminated to laminated dolomite.

The unnamed lower member consists of interbedded siltstone, sandstone, halitic siltstone, halite, mudstone, and anhydrite. It has an approximate average thickness of 113 feet in the shafts. The uppermost unit, M-2, is a 5.5-foot-thick mudstone displaying some laminae and containing gypsum in some very thin beds and in fractures along slickensided surfaces. The A-1 unit is a 9.5-foot-thick, microcrystalline, hard anhydrite with abundant 1-foot-tall halite pseudomorphs after gypsum swallowtail crystals at its base. The 35.5-foot-thick H-1/M-1 interval contains varying proportions of intermixed siltstone, mudstone, and halite with anhydrite occurring in interbeds, nodules, and laminae. An 11.5-foot-thick “transition zone” contains anhydritic and halitic fine to medium sandstone and siltsone with halite-filled fractures 2 inches thick. A 48.5-foot-thick “bioturbated clastic interval” contains halite-cemented sandstone and siltstone with invertebrate fossil fragments and halite-filled fractures up to 2 inches thick. The lowermost 1.2 feet of the Rustler consist of a thin basal anhydrite and 1 foot of halitic very fine sandstone to siltstone.

B.7 Salado Formation

The Salado Formation consists of halite occurring in thick beds of rock salt that alternate with thinner beds of anhydrite, polyhalite, and glauberite (Jones et al., 1973). Rock salt constitutes 85 to 90 percent of the formation. Anhydrite is the second most abundant rock, and “the remainder of the formation is chiefly polyhalite and other potassium-rich rocks with subordinate glauberite, magnesite, sandstone, and claystone” (Jones et al., 1973). The formation comprises an unnamed upper member, a middle member locally known as the McNutt potash zone, and an unnamed lower member in which the WIPP repository horizon is located. According to Jones et al. (1973), “the three members are about equally rich in rock salt, anhydrite, polyhalite, and fine-grained clastic rocks, and they are generally similar," except in the enrichment in sylvite, carnallite, and other potassium- and magnesium-bearing minerals in the McNutt potash zone, which includes 11 of the 12 potash ore zones in the Salado. Potash production from the federally designated Potash Area from which the WIPP site was withdrawn is approximately 70 percent sylvite and 30 percent langbeinite, and production from this area (in particular, from the Salado) makes New Mexico the source of more than three quarters of U.S. potash production and the only producer of langbeinite in the world (NMBGMR, 2008). Even so, potassic rocks account for no more than 5 percent of the McNutt Member (Jones et al., 1973).

The rock salt throughout the Salado is composed of discrete layers of halite and clayey halite, the latter containing small amounts of detrital debris in small cavities or vugs. The detritus is mostly quartz and clay, including illite, chlorite, and "a corrensite-type of swelling, regular mixed-layered clay mineral" (Jones et al., 1973). The halite is "rarely pure" (Holt and Powers, 1990), and both the halite and clayey halite contain traces to very minor amounts of polyhalite and anhydrite. "Locally, glauberite is present in small amounts, and there are several potassium and magnesium minerals, including sylvite, carnallite, kieserite, and several other equally exotic evaporite minerals that occur in small to large amounts in seams of rock salt in the middle and upper parts of the formation" (Jones et al., 1973). Inclusions of brine and gas fill common, microscopic to very small, cubic and rectangular cavities in grains of halite and other evaporite minerals, as well as less common, larger cavities and pockets (Jones et al., 1973).

The Salado shows numerous cycles in which complete halite sequences consist of clay-poor halite at the base grading upward into argillaceous halite (Holt and Powers, 1990). Holt and Powers (1990) reported detailed mapping of the Salado and constructed an idealized Salado halite sequence consisting of four major lithofacies subdivided into smaller-scale zones, textures, and fabrics.

Fine-scale stratigraphic control in the Salado at the WIPP site relies on a markerbed system of numbering the areally extensive beds of anhydrite and polyhalite, as developed by the U.S. Geological Survey (USGS) and used by local potash mining companies (Holt and Powers, 1990). Beds of anhydrite and polyhalite have variable compositions. Nearly all beds show various stages of lateral replacement of anhydrite by polyhalite. "Locally, anhydrite and polyhalite give way laterally to glauberite, and polyhalite in the middle and upper parts of the Salado is replaced by hartsalz consisting of a coarsely crystalline mixture of anhydrite, kieserite, and carnallite" (Jones et al., 1973). In the lower member, magnesite in thin bands, laminae, and ragged knots form carbonate-rich zones in the lower portions of most anhydrite and polyhalite seams.

Claystone overlies clayey halite and separates it from the beds of anhydrite and polyhalite. A few beds of very fine-grained halitic sandstone are scattered throughout the Salado. A saprolitic unit of clay, broken and shattered gypsum, and fine-grained sandstone lies at the top of the upper member.

The potassic rocks in the McNutt occur at short to long intervals in seams of rock salt. In addition to sylvite and langbeinite, the potassic rocks contain hydrous evaporite minerals including carnallite, schoenite, kainite, bloedite, leonite, loeweite, kieserite, and polyhalite. "Typical mixed sylvinite ore from the Salado contains about 60 percent halite and 30 percent sylvite, 5 percent langbeinite, 2 percent polyhalite, and 3 percent insolubles" (NMBGMR, 2008). Ore processing requires several stages to remove clay minerals and produces a sylvite concentrate with a red color due to occluded iron oxide minerals (NMBGMR, 2008).

References

Bachman, G.O. 1980. *Regional geology and Cenozoic history of Pecos Region, southeastern New Mexico.* U.S. Geological Survey Open-File Report 80-1099. 116p.

Bechtel National, Inc. (Bechtel). 1986. *Waste Isolation Pilot Plant, Design validation final report.* Prepared for U.S. Department of Energy. Job 12484. DOE-WIPP-86-010. October 1986.

Hendrickson, G.E. and R.S. Jones. 1952. *Geology and ground-water resources of Eddy County, New Mexico*. New Mexico Bureau of Mines & Mineral Resources Ground-Water Report 3. Socorro, New Mexico. 169p. and plates.

Holt, R.M. and D.W. Powers. 1990. *Geologic mapping of the air intake shaft at the Waste Isolation Pilot Plant.* Prepared for U.S. Department of Energy. DOE/WIPP 90-051. December 1990.

Intera. 1997. *Exhaust shaft: Phase II hydraulic assessment data report involving drilling, installation, water-quality sampling, and testing of piezometers 1-12*. Prepared for Westinghouse. DOE/WIPP 97-2219. September 26, 1997.

Jones, C.L., M.E. Cooley, and G.O. Bachman. 1973. *Salt deposits of Los Medaños area, Eddy and Lea Counties, New Mexico*. U.S. Geological Survey Open-File Report 73-135. 67p.

Mercer, J.W. 1983. *Geohydrology of the proposed Waste Isolation Pilot Plant site, Los Medaños area, southeastern New Mexico*. Prepared in cooperation with the U.S. Department of Energy. U.S. Geological Survey Water-Resources Investigations Report 83-4016.

Miller, D.N. Jr. 1966. Petrology of Pierce Canyon redbeds, Delaware Basin, Texas and New Mexico. *Bulletin of the American Association of Petroleum Geologists* 90(2):289-307.

New Mexico Bureau of Geology and Mineral Resources (NMBGMR). 2008. New Mexico potash–Past, present, and future. *New Mexico Earth Matters*. Summer 2008.

Powers, D.W. 2003a. *Geohydrological conceptual model for the Dewey Lake Formation in the vicinity of the Waste Isolation Pilot Plant (WIPP), Test plan TP 02-05., Rev. 0.* BOE 1.3.5.3.1, Sandia Corporation. March 17, 2003

Powers, D.W. 2003b. Personal communication between Dr. Dennis W. Powers, consulting geologist, and Derek Blazer, DBS&A. June 2003.

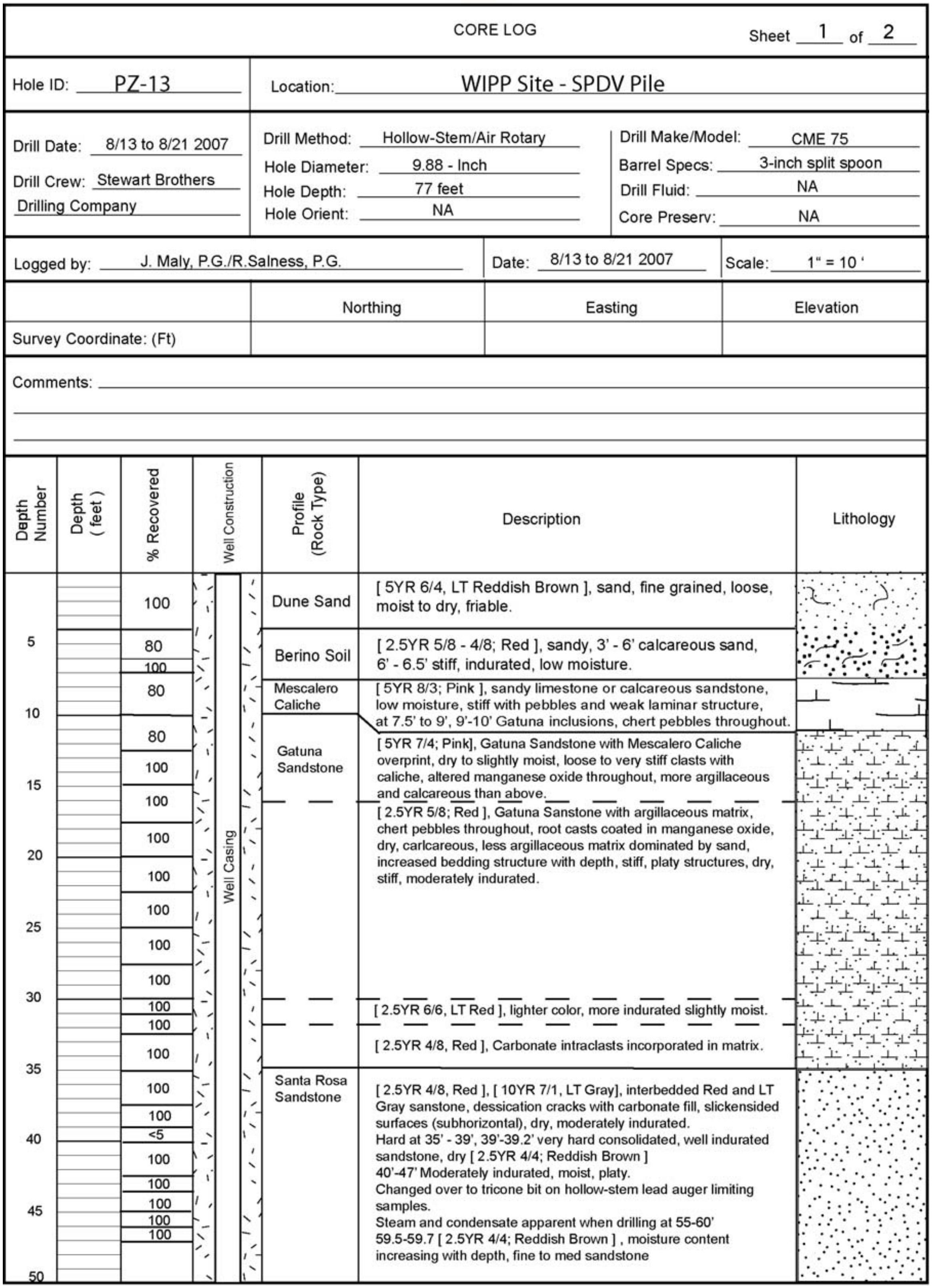
Sergent, Hauskins & Beckwith, 1979. *Subsurface exploration and laboratory testing, plant site*, Waste Isolation Pilot Plant, Volume 1. Prepared for Bechtel National, Inc. Bechtel Job No. 12484. May 11, 1979.

Sidwell, R. and D.T. Gibson. 1940. Mineral study of Santa Rosa sandstone in Guadalupe County, New Mexico. *Journal of Sedimentary Research* 10(1):5-7.

U.S. DOE. 2008. *Basic data report for piezometers PZ-13, PZ-14, and PZ-15 and shallow subsurface water.* DOE/WIPP-08-3375, Revision 3. October 2008.

Appendix C

Well Logs for
PZ-13, -14, and -15



CORE LOG Sheet 1 of 2

Hole ID: PZ-13
Location: WIPP Site - SPDV Pile

Drill Date: 8/13 to 8/21 2007
Drill Crew: Stewart Brothers Drilling Company
Drill Method: Hollow-Stem/Air Rotary
Hole Diameter: 9.88 - Inch
Hole Depth: 77 feet
Hole Orient: NA
Drill Make/Model: CME 75
Barrel Specs: 3-inch split spoon
Drill Fluid: NA
Core Preserv: NA

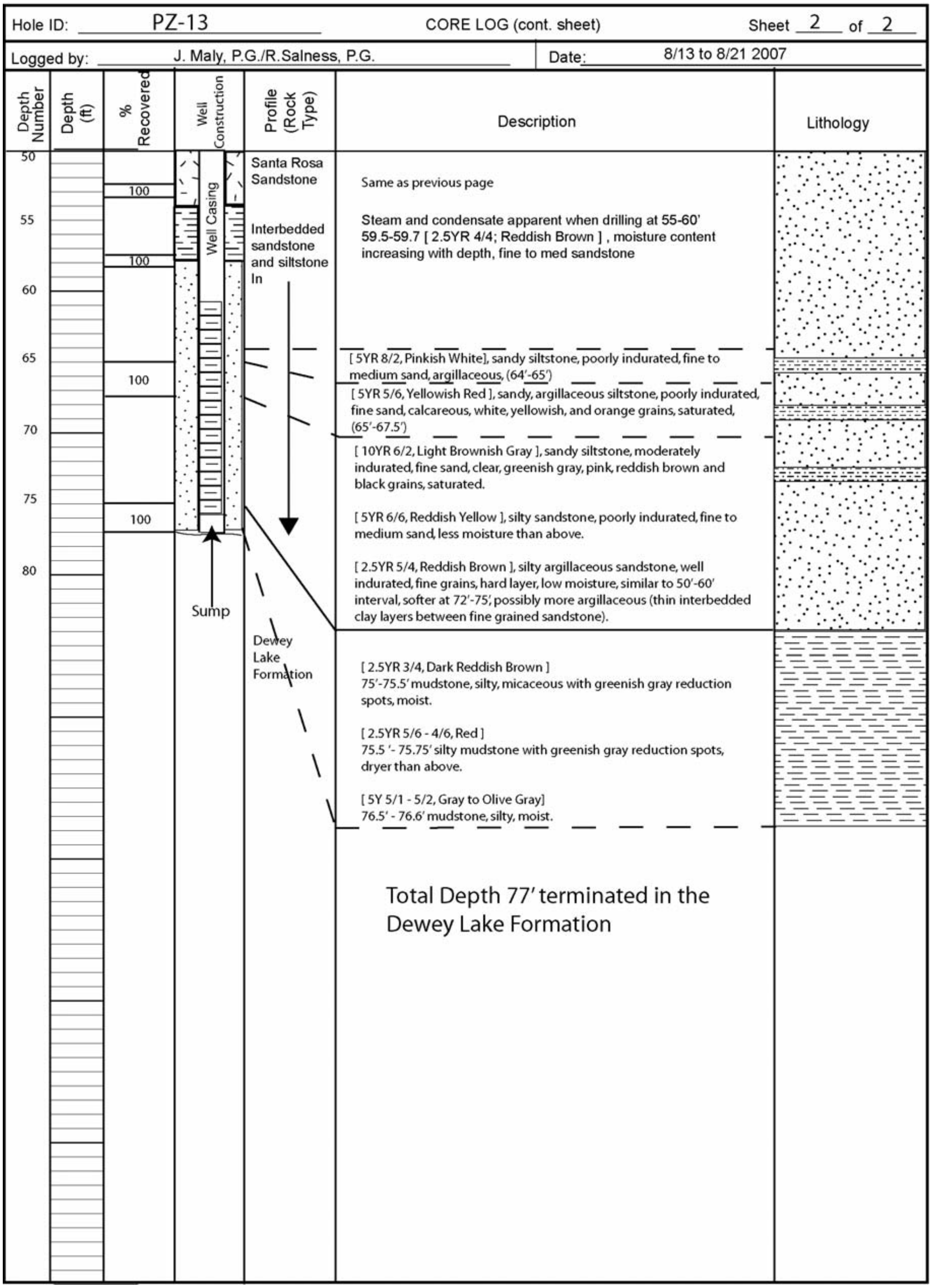
Logged by: J. Maly, P.G./R.Salness, P.G.
Date: 8/13 to 8/21 2007
Scale: 1" = 10 '

	Northing	Easting	Elevation
Survey Coordinate: (Ft)			

Comments:

Depth Number	Depth (feet)	% Recovered	Well Construction	Profile (Rock Type)	Description	Lithology
		100		Dune Sand	[5YR 6/4, LT Reddish Brown], sand, fine grained, loose, moist to dry, friable.	
5		80		Berino Soil	[2.5YR 5/8 - 4/8; Red], sandy, 3' - 6' calcareous sand, 6' - 6.5' stiff, indurated, low moisture.	
		100				
		80		Mescalero Caliche	[5YR 8/3; Pink], sandy limestone or calcareous sandstone, low moisture, stiff with pebbles and weak laminar structure, at 7.5' to 9', 9'-10' Gatuna inclusions, chert pebbles throughout.	
10		80		Gatuna Sandstone	[5YR 7/4; Pink], Gatuna Sandstone with Mescalero Caliche overprint, dry to slightly moist, loose to very stiff clasts with caliche, altered manganese oxide throughout, more argillaceous and calcareous than above.	
		100				
15		100			[2.5YR 5/8; Red], Gatuna Sanstone with argillaceous matrix, chert pebbles throughout, root casts coated in manganese oxide, dry, carlcareous, less argillaceous matrix dominated by sand, increased bedding structure with depth, stiff, platy structures, dry, stiff, moderately indurated.	
		100				
20		100	Well Casing			
		100				
25		100				
		100				
30		100			[2.5YR 6/6, LT Red], lighter color, more indurated slightly moist.	
		100			[2.5YR 4/8, Red], Carbonate intraclasts incorporated in matrix.	
		100				
35		100		Santa Rosa Sandstone	[2.5YR 4/8, Red], [10YR 7/1, LT Gray], interbedded Red and LT Gray sanstone, dessication cracks with carbonate fill, slickensided surfaces (subhorizontal), dry, moderately indurated. Hard at 35' - 39', 39'-39.2' very hard consolidated, well indurated sandstone, dry [2.5YR 4/4; Reddish Brown] 40'-47' Moderately indurated, moist, platy. Changed over to tricone bit on hollow-stem lead auger limiting samples. Steam and condensate apparent when drilling at 55-60' 59.5-59.7 [2.5YR 4/4; Reddish Brown] , moisture content increasing with depth, fine to med sandstone	
		100				
		<5				
40		100				
		100				
45		100				
		100				
		100				
50						

Figure 2-2 - Core Log for PZ-13



Hole ID: PZ-13

CORE LOG (cont. sheet)

Sheet 2 of 2

Logged by: J. Maly, P.G./R.Salness, P.G.

Date: 8/13 to 8/21 2007

Same as previous page

Steam and condensate apparent when drilling at 55-60'
59.5-59.7 [2.5YR 4/4; Reddish Brown] , moisture content increasing with depth, fine to med sandstone

[5YR 8/2, Pinkish White], sandy siltstone, poorly indurated, fine to medium sand, argillaceous, (64′-65′)

[5YR 5/6, Yellowish Red], sandy, argillaceous siltstone, poorly indurated, fine sand, calcareous, white, yellowish, and orange grains, saturated, (65′-67.5′)

[10YR 6/2, Light Brownish Gray], sandy siltstone, moderately indurated, fine sand, clear, greenish gray, pink, reddish brown and black grains, saturated.

[5YR 6/6, Reddish Yellow], silty sandstone, poorly indurated, fine to medium sand, less moisture than above.

[2.5YR 5/4, Reddish Brown], silty argillaceous sandstone, well indurated, fine grains, hard layer, low moisture, similar to 50′-60′ interval, softer at 72′-75′, possibly more argillaceous (thin interbedded clay layers between fine grained sandstone).

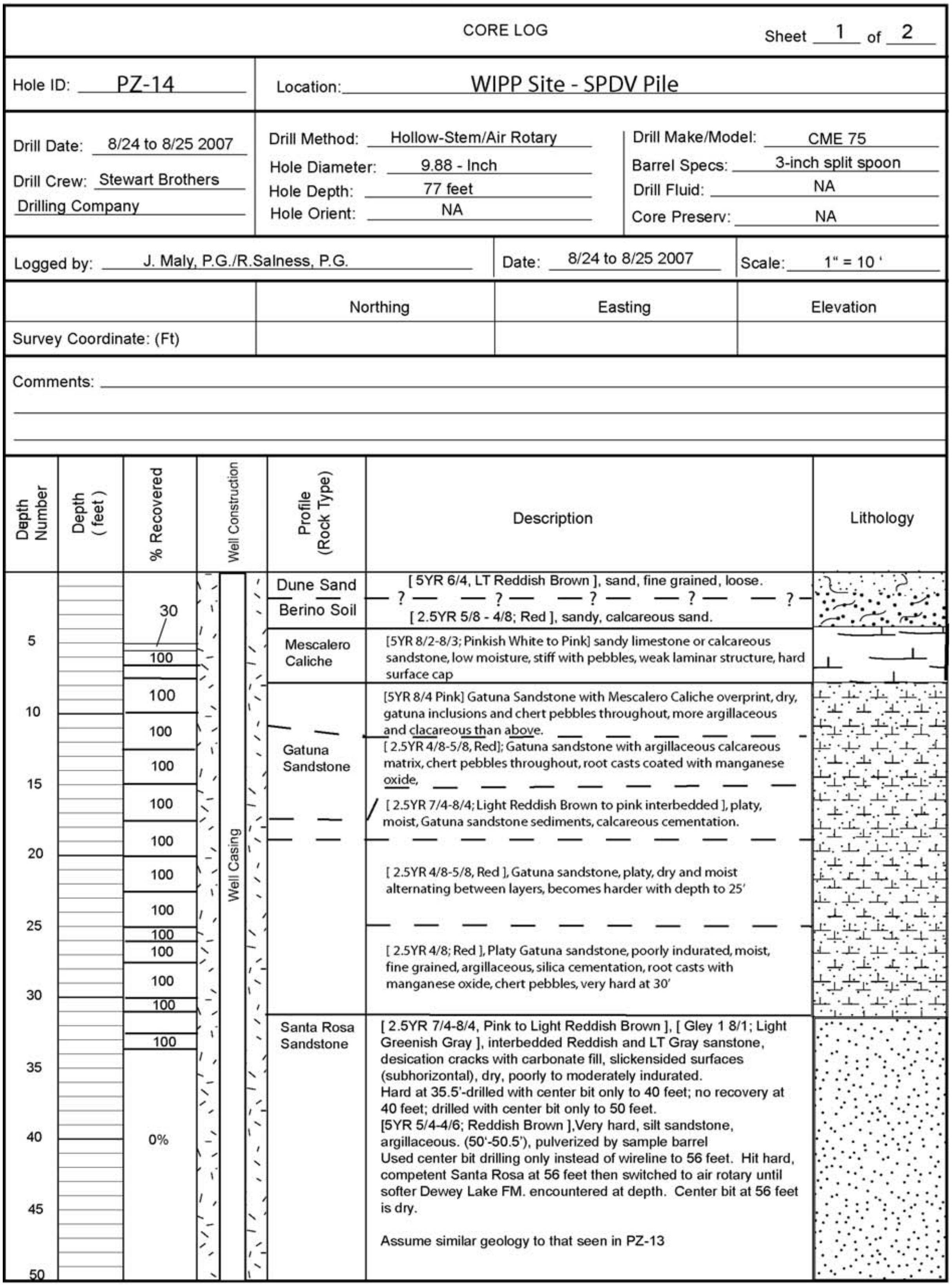
[2.5YR 3/4, Dark Reddish Brown]
75′-75.5′ mudstone, silty, micaceous with greenish gray reduction spots, moist.

[2.5YR 5/6 - 4/6, Red]
75.5 ′- 75.75′ silty mudstone with greenish gray reduction spots, dryer than above.

[5Y 5/1 - 5/2, Gray to Olive Gray]
76.5′ - 76.6′ mudstone, silty, moist.

Total Depth 77′ terminated in the Dewey Lake Formation

Figure 2-2 - Core Log for PZ-13 (Continued)



CORE LOG

Sheet 1 of 2

Hole ID: PZ-14	Location: WIPP Site - SPDV Pile		
Drill Date: 8/24 to 8/25 2007	Drill Method: Hollow-Stem/Air Rotary	Drill Make/Model: CME 75	
Drill Crew: Stewart Brothers Drilling Company	Hole Diameter: 9.88 - Inch	Barrel Specs: 3-inch split spoon	
	Hole Depth: 77 feet	Drill Fluid: NA	
	Hole Orient: NA	Core Preserv: NA	
Logged by: J. Maly, P.G./R.Salness, P.G.	Date: 8/24 to 8/25 2007	Scale: 1" = 10 '	
	Northing	Easting	Elevation
Survey Coordinate: (Ft)			

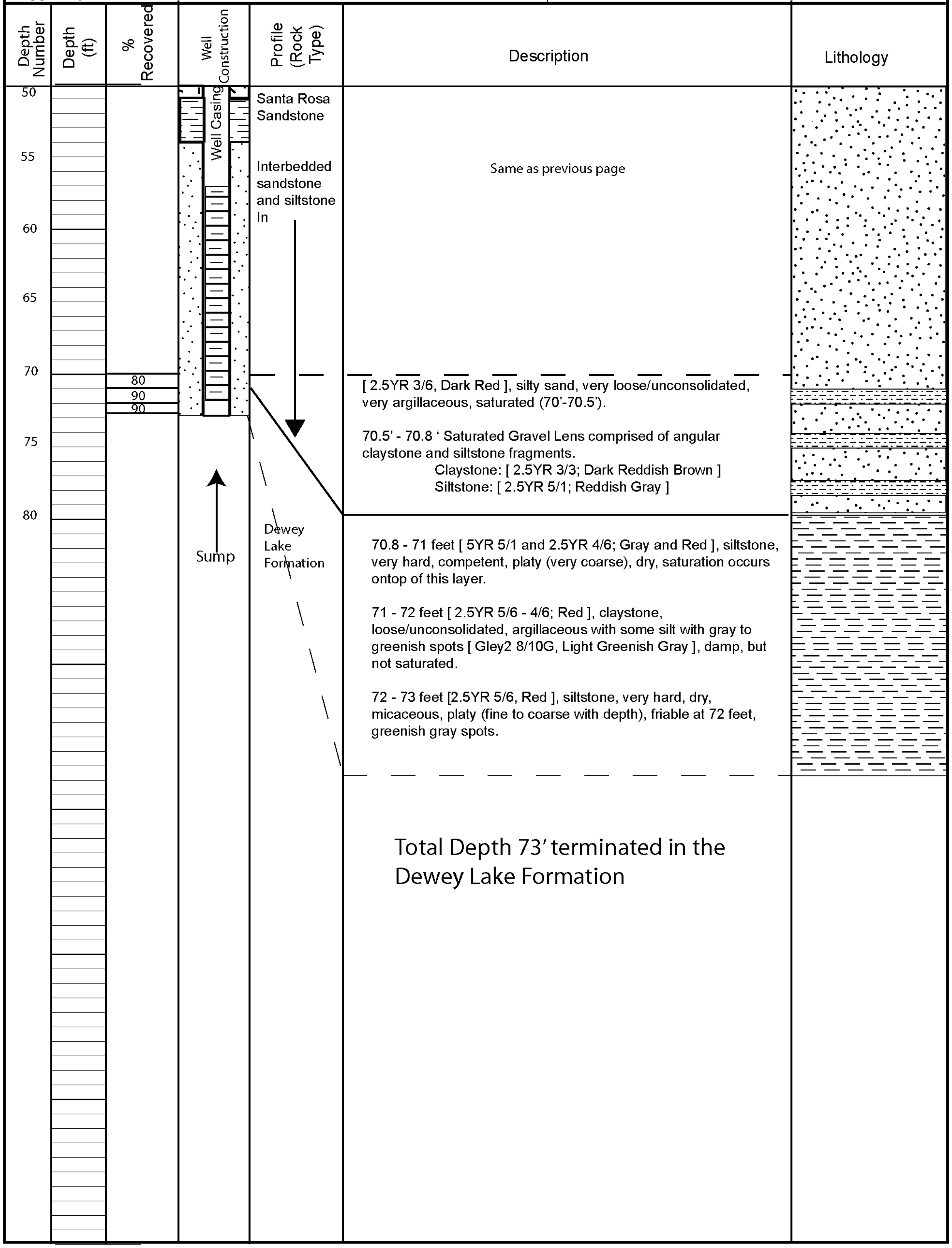
Comments:

Depth Number	Depth (feet)	% Recovered	Well Construction	Profile (Rock Type)	Description	Lithology
		30	Well Casing	Dune Sand	[5YR 6/4, LT Reddish Brown], sand, fine grained, loose.	
					— ? — — ? — — ? — — ? — — ? —	
				Berino Soil	[2.5YR 5/8 - 4/8; Red], sandy, calcareous sand.	
5		100		Mescalero Caliche	[5YR 8/2-8/3; Pinkish White to Pink] sandy limestone or calcareous sandstone, low moisture, stiff with pebbles, weak laminar structure, hard surface cap	
10		100 100		Gatuna Sandstone	[5YR 8/4 Pink] Gatuna Sandstone with Mescalero Caliche overprint, dry, gatuna inclusions and chert pebbles throughout, more argillaceous and clacareous than above.	
15		100 100			[2.5YR 4/8-5/8, Red]; Gatuna sandstone with argillaceous calcareous matrix, chert pebbles throughout, root casts coated with manganese oxide,	
					[2.5YR 7/4-8/4; Light Reddish Brown to pink interbedded], platy, moist, Gatuna sandstone sediments, calcareous cementation.	
20		100 100 100			[2.5YR 4/8-5/8, Red], Gatuna sandstone, platy, dry and moist alternating between layers, becomes harder with depth to 25'	
25		100 100 100			[2.5YR 4/8; Red], Platy Gatuna sandstone, poorly indurated, moist, fine grained, argillaceous, silica cementation, root casts with manganese oxide, chert pebbles, very hard at 30'	
30 35 40 45 50		100 100 0%		Santa Rosa Sandstone	[2.5YR 7/4-8/4, Pink to Light Reddish Brown], [Gley 1 8/1; Light Greenish Gray], interbedded Reddish and LT Gray sanstone, desication cracks with carbonate fill, slickensided surfaces (subhorizontal), dry, poorly to moderately indurated. Hard at 35.5'-drilled with center bit only to 40 feet; no recovery at 40 feet; drilled with center bit only to 50 feet. [5YR 5/4-4/6; Reddish Brown],Very hard, silt sandstone, argillaceous. (50'-50.5'), pulverized by sample barrel Used center bit drilling only instead of wireline to 56 feet. Hit hard, competent Santa Rosa at 56 feet then switched to air rotary until softer Dewey Lake FM. encountered at depth. Center bit at 56 feet is dry. Assume similar geology to that seen in PZ-13	

Figure 2-3 - Core Log for PZ-14

Hole ID: PZ-14 CORE LOG (cont. sheet) Sheet 2 of 2

Logged by: J. Maly, P.G./R.Salness, P.G. Date: 8/24 to 8/25 2007



Same as previous page

[2.5YR 3/6, Dark Red], silty sand, very loose/unconsolidated, very argillaceous, saturated (70'-70.5').

70.5' - 70.8 ' Saturated Gravel Lens comprised of angular claystone and siltstone fragments.
Claystone: [2.5YR 3/3; Dark Reddish Brown]
Siltstone: [2.5YR 5/1; Reddish Gray]

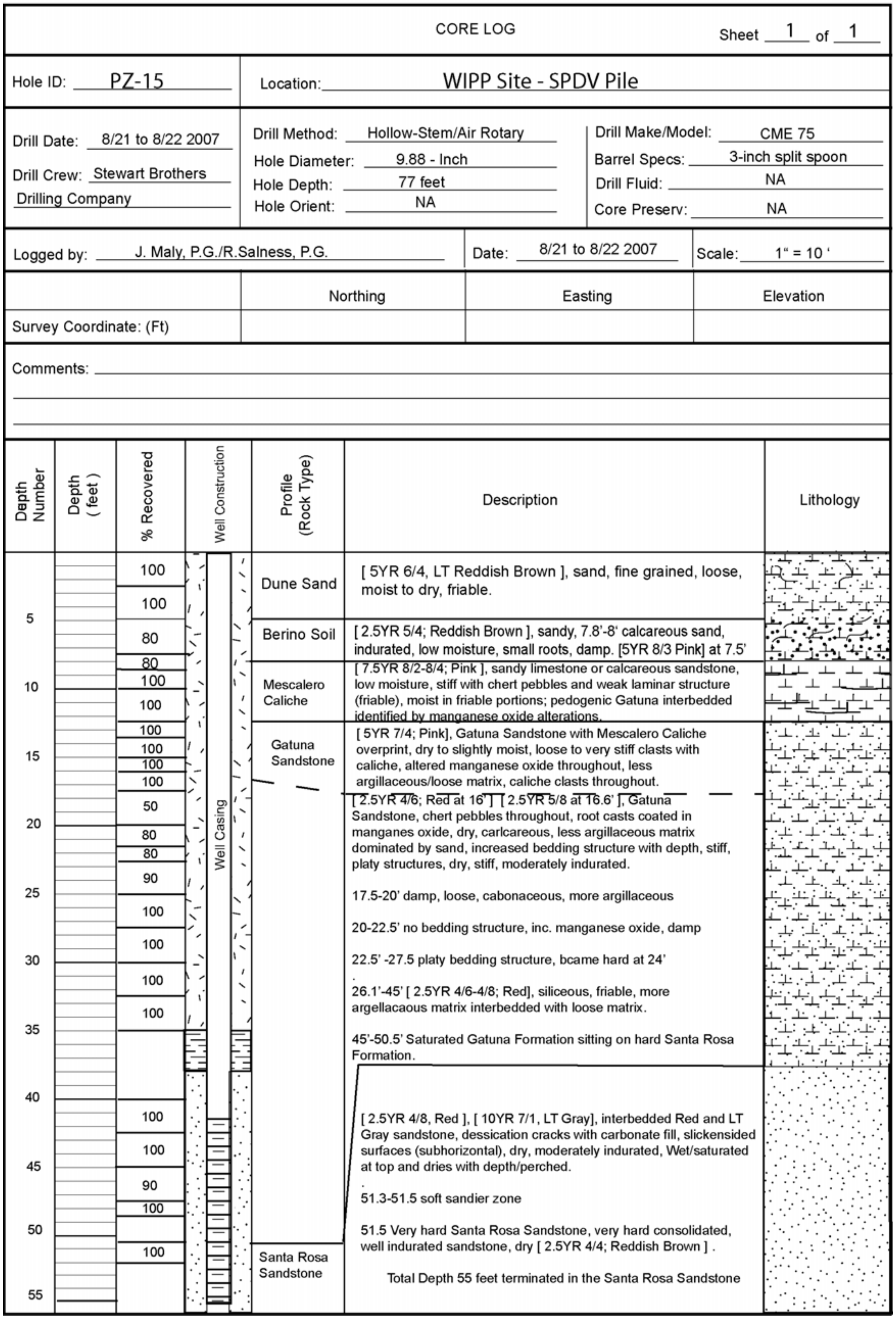
70.8 - 71 feet [5YR 5/1 and 2.5YR 4/6; Gray and Red], siltstone, very hard, competent, platy (very coarse), dry, saturation occurs ontop of this layer.

71 - 72 feet [2.5YR 5/6 - 4/6; Red], claystone, loose/unconsolidated, argillaceous with some silt with gray to greenish spots [Gley2 8/10G, Light Greenish Gray], damp, but not saturated.

72 - 73 feet [2.5YR 5/6, Red], siltstone, very hard, dry, micaceous, platy (fine to coarse with depth), friable at 72 feet, greenish gray spots.

Total Depth 73' terminated in the Dewey Lake Formation

Figure 2-3 - Core Log for PZ-14 (Continued)



CORE LOG

Sheet 1 of 1

Hole ID: PZ-15	Location: WIPP Site - SPDV Pile

Drill Date: 8/21 to 8/22 2007	Drill Method: Hollow-Stem/Air Rotary	Drill Make/Model: CME 75
Drill Crew: Stewart Brothers Drilling Company	Hole Diameter: 9.88 - Inch	Barrel Specs: 3-inch split spoon
	Hole Depth: 77 feet	Drill Fluid: NA
	Hole Orient: NA	Core Preserv: NA

Logged by: J. Maly, P.G./R.Salness, P.G.	Date: 8/21 to 8/22 2007	Scale: 1" = 10 '

	Northing	Easting	Elevation
Survey Coordinate: (Ft)			

Comments:

Profile (Rock Type)	Description
Dune Sand	[5YR 6/4, LT Reddish Brown], sand, fine grained, loose, moist to dry, friable.
Berino Soil	[2.5YR 5/4; Reddish Brown], sandy, 7.8'-8' calcareous sand, indurated, low moisture, small roots, damp. [5YR 8/3 Pink] at 7.5'
Mescalero Caliche	[7.5YR 8/2-8/4; Pink], sandy limestone or calcareous sandstone, low moisture, stiff with chert pebbles and weak laminar structure (friable), moist in friable portions; pedogenic Gatuna interbedded identified by manganese oxide alterations.
Gatuna Sandstone	[5YR 7/4; Pink], Gatuna Sandstone with Mescalero Caliche overprint, dry to slightly moist, loose to very stiff clasts with caliche, altered manganese oxide throughout, less argillaceous/loose matrix, caliche clasts throughout.
	[2.5YR 4/6; Red at 16'] [2.5YR 5/8 at 16.6'], Gatuna Sandstone, chert pebbles throughout, root casts coated in manganes oxide, dry, carlcareous, less argillaceous matrix dominated by sand, increased bedding structure with depth, stiff, platy structures, dry, stiff, moderately indurated. 17.5-20' damp, loose, cabonaceous, more argillaceous 20-22.5' no bedding structure, inc. manganese oxide, damp 22.5' -27.5 platy bedding structure, bcame hard at 24' 26.1'-45' [2.5YR 4/6-4/8; Red], siliceous, friable, more argellacaous matrix interbedded with loose matrix. 45'-50.5' Saturated Gatuna Formation sitting on hard Santa Rosa Formation.
Santa Rosa Sandstone	[2.5YR 4/8, Red], [10YR 7/1, LT Gray], interbedded Red and LT Gray sandstone, dessication cracks with carbonate fill, slickensided surfaces (subhorizontal), dry, moderately indurated, Wet/saturated at top and dries with depth/perched. 51.3-51.5 soft sandier zone 51.5 Very hard Santa Rosa Sandstone, very hard consolidated, well indurated sandstone, dry [2.5YR 4/4; Reddish Brown] . Total Depth 55 feet terminated in the Santa Rosa Sandstone

Figure 2-4 - Core Log for PZ-15

Appendix D

Possible Sources of Lead Detections at PZ-13

Appendix D. Possible Sources of Lead Detections at PZ-13

The dissolved lead observed in SSW at PZ-13 may be derived from lead-bearing construction debris in the SPDV pile, undisturbed strata between the ground surface and the SSW saturated interval, or the monitor wells and sampling activities themselves. Other possible sources of lead were considered in this assessment, but appear unlikely. Whereas Section 5 in the report focused on the likely sources of lead, this appendix describes other potential sources that were considered in the assessment. After evaluation, these potential sources were determined to be unlikely to have caused the lead detections in PZ-13. Table D-1 contains a summary of these potential lead sources considered, which are discussed in the following subsections.

D.1 Historical Activities at or Near the WIPP Facility

Known historical activities at the site other than those associated with the WIPP facility are not likely to have caused lead contamination associated with the detection in PZ-13. Ranching (cattle grazing), hunting, and trapping are permitted within the WIPP land withdrawal area but not inside the exclusion zone in which the SPDV pile and other facilities are located. Fences deter unauthorized access to the site and caps on monitor wells prevent accidental introduction of foreign objects or tampering. There are oil and gas exploration/production activities and potash mining outside the WIPP land withdrawal area, and there were leases that were active within the WIPP land withdrawal area prior to 1988. However, these activities do not occur in the immediate vicinity of PZ-13, and they are not expected to release significant lead to the environment. Furthermore, no SSW was observed at the site during drilling prior to the facility construction.

The SPDV pile is isolated from most other activities conducted at the WIPP site due to its physical location about 1,200 feet east of the main WIPP facilities area. Stormwater transport cannot occur from the facilities area due to the presence of stormwater diversion berms between the SPDV pile and the facilities area. Disposal activities at the SPDV pile ceased as other disposal areas for mine rock were established in the years before the final cover on the SPDV pile was complete.

Table D-1. Summary of Potential Sources of Lead Detections at PZ-13
Page 1 of 3

Item	Conclusion	Main Supporting Factors For Conclusion	Notes/Caveats
Monitoring Materials or Procedures			
Laboratory contamination or false positives	Not the source	Multiple samples, methods, and laboratories, documented QA/QC	
Acidification of sediment in samples	Not the source	Filtering and other precautions, uniqueness to PZ-13, lack of other elevated trace metals	
Contamination from well materials or sampling equipment	Not the source	Materials intended for environmental monitoring, same equipment used at other SSW wells; repeat sampling event data suggest that the source is not located in the well.	PZ-13 brine could corrode some materials more aggressively than other SSW, but presence of lead in equipment unlikely.
Contamination from drilling apparatus	Not the source	Drill bit teeth lost downhole at PZ-13. Tests show lead does not leach from the different drill bit teeth used at PZ-13 and no parts of drilling apparatus contain high lead concentrations.	Drilling method at PZ-13 used custom fabricated equipment.
Historical Activities at or Near the WIPP Facility			
Oil and gas exploration and production	Not the source	No evidence activity occurred in immediate vicinity of PZ-13, and activity not specifically associated with lead contamination.	
Potash mining	Not the source	No evidence activity occurred in immediate vicinity of PZ-13, activity not specifically associated with lead contamination, and calculation shows maximum lead concentration in potash is too low.	Potash brine may have been used for drilling shafts; traces of lead conceivably present in potash but concentrations negligible.
Ranching (cattle grazing)	Not the source	Activity not associated with lead contamination.	
Hunting and trapping	Not the source	No evidence activity occurred in immediate vicinity of PZ-13, measures taken to secure site from trespassing	Lead used in ammunition.
WIPP activities other than SPDV disposal	Not the source	Physical distance between PZ-13 and main campus, natural and engineered transport barriers	

Table D-1. Summary of Potential Sources of Lead Detections at PZ-13
Page 2 of 3

Item	Conclusion	Main Supporting Factors For Conclusion	Notes/Caveats
Geologic Materials in situ or in SPDV Pile			
Halite	Not the source	Lead not detected by XRF screening of halite horizons or by laboratory analysis of Salt Storage Extension Evaporation Basin water with higher salt concentration than PZ-13.	Most abundant material in SPDV pile
Sand, sandstone, siltstone, and similar clastic sediments	Most likely source	Lead adsorption to iron oxides and association with other Dewey Lake minerals shown by quantitative laboratory analysis and electron microprobe imagery, feasibility of enhanced dissolution by brine in PZ-13 proven by leaching tests.	Upper Dewey Lake is the only geologic material with lead levels detectable by XRF.
Sulfate minerals	No evidence of contribution	Elevated lead not generally expected in sulfates, but little relevant site data exists.	
Carbonate minerals	No evidence of contribution	Lead not detected in Mescalero caliche by XRF or 1995 TCLP, but other horizons not tested, and lead concentrations in carbonates conceivably similar to those in sandy sediments.	
Potash minerals	Not the source	Calculation shows maximum lead concentration in potash is too low.	
Other geologic materials	Not the source	No primary lead minerals identified by electron microprobes or in any previous investigations or expected to occur in likely depositional environments, other minerals with potential lead association not likely to exist in significant quantity.	
Construction Wastes in SPDV Pile			
Concrete	No evidence of contribution	Lead not expected in either concrete or rebar	
Steel plate, scrap, and debris	No evidence of contribution	Lead not expected in ordinary steel	

Table D-1. Summary of Potential Sources of Lead Detections at PZ-13
Page 3 of 3

Item	Conclusion	Main Supporting Factors For Conclusion	Notes/Caveats
Construction Wastes in SPDV Pile (cont.)			
Petroleum hydrocarbons	Not the source	No evidence of leaded gasoline, other petroleum products would not have contained enough lead to cause concentrations observed in PZ-13.	
Explosives	No evidence of contribution	Possible presence in pile indicated in personnel interviews, but not directly encountered.	May contain lead
Blasting caps	No evidence of contribution	Possible presence in pile indicated in personnel interviews, but not directly encountered.	May contain lead
Galvanized chain link mesh	No evidence of contribution	No evidence of disposal in pile. Lead to zinc ratios in PZ-13 similar to those in Dewey Lake leaching test. Chain link mesh corrosion testing found much higher zinc concentration not evident at PZ-13.	
Lead wool	No evidence of contribution	No evidence of disposal in pile	Used small amounts during shaft construction, consists of pure lead

D.2 Construction Materials and Wastes in the SPDV Pile

Some materials contained in the SPDV pile are considered to be feasible sources of lead. These are addressed in Section 5. This section addresses sources of lead associated with construction waste types that were considered in the assessment but are not considered to be feasible sources of lead in PZ-13. These unlikely sources include petroleum hydrocarbons and explosives, which may have been disposed of during construction activities.

The 1999 SPDV pile investigation found that total petroleum hydrocarbon (TPH) concentrations ranged from less than 10 mg/kg to 43 mg/kg in solid samples targeted toward locations where a PETREX soil gas survey indicated the highest concentrations should occur (DBS&A, 1996). Therefore, the presence of petroleum hydrocarbons was confirmed but did not appear to represent extensive contamination. The petroleum hydrocarbons are likely attributable to diesel fuel or waste oil (DBS&A, 1996). Lead is not deliberately added to these products, but any petroleum product may contain traces of lead as a result of sharing refining, transport, or storage equipment with leaded gasoline. Because the amount of lead from such cross-contamination in unleaded gasoline in the early 1980s was about 0.003 gram per gallon or 0.8 mg/L (Gibbs, 1997), a somewhat lower concentration of lead, if any, would have been present in diesel fuel or waste oil when the SPDV pile was constructed. Such a low concentration of lead in fuel dissolving into a larger volume of water is unlikely to satisfy the mass balance to account for observed lead concentrations in PZ-13. It should be noted that the geochemical analysis in Section 8 assumes that lead is not present as one or more organic species because such a scenario appears unlikely.

Some of the rock in the SPDV pile was mined using Trimtex and Tovex explosives detonated with Nonel blasting caps; however, no explosive material was encountered during the 1995 activities (DBS&A, 1996). Although DBS&A has not confirmed the exclusive use of and exact formulation of these blasting materials, explosives generally do not use lead (e.g., Trimtex explosives use trinitrotoluene and Tovex explosives use nitrate salts), whereas blasting caps sometimes contain lead ingredients (DBS&A, 1996). The probable concentration of lead that would dissolve from such a source would be difficult to estimate without more information.

D.3 Materials Used in Monitoring Activities

Opportunities exist during monitoring to potentially introduce lead to water samples such that the monitoring results would not be representative of environmental conditions. Drilling fluids or sampling equipment can contaminate water samples directly or by interacting with geologic solids. The high TDS and chloride concentrations in PZ-13 have thermodynamic consequences that may favor and magnify such interactions, as explained in more detail in Section 8.

D.3.1 Drilling Materials

Drilling materials used for PZ-13 are considered a plausible source of lead due to the loss of drill bit teeth when drilling in consolidated rock. The drilling methods and examination of lead concentrations in the drill bits are addressed in Section 9.

D.3.2 Well Construction Materials

The well installed in PZ-13 consists of 2-inch PVC casing surrounded by a sand filter with a bentonite seal and cement grout (U.S. DOE, 2008; Salness, 2007-2009). All of these components are selected for the purpose of environmental monitoring and should not contain lead contamination. The well materials are manufactured for use in environmental monitoring and drinking water wells.

D.3.3 Well Development and Sampling Materials and Procedures

In addition to information used to assess whether lead may occur in the materials used in well development and sampling at PZ-13, some observations recorded in the course of these procedures are worth noting because they have implications for the interpretation of local hydrogeologic conditions and of lead concentrations measured over time.

Equipment used for gauging, well development, and sampling included standard equipment designed for routine environmental monitoring; therefore, it should all, by design, be free of lead and other contaminants. Most of the equipment used at PZ-13 was also used in other SSW wells containing high TDS concentrations (after appropriate decontamination) without detecting similar lead concentrations. It is therefore highly unlikely to be the source of the lead in PZ-13.

Samples have been collected with both Teflon™ bailers and using a portable submersible pump manufactured by Fultz Pumps, Inc. The pump draws water through a wire mesh into a stainless steel cavity and displaces it upward through tubing using Teflon™ rotors (Fultz, Undated). Electrical components would necessarily be sealed from any contact with water inside the pump or in the well. Therefore, water does not contact any pump components that could contain lead. The discharge permit (DP-831) indicates that SSW sampling uses Tygon or similar tubing. Field parameters were recorded using a YSI model 63 multimeter calibrated with standard solutions for pH and electrical conductivity (Salness, 2007-2009). The meter serial number and calibration fluid lot numbers were recorded for each gauging and calibration (Salness, 2007-2009). The water that contacts the meter should not be the same water that is sampled because the tubing must be rerouted through an inline filter between recording field parameters and collecting samples.

Any potential contamination from equipment decontamination or lack thereof, filters, sample containers, preservatives, or other sampling equipment and sample handling in general can be monitored by analysis of field blank and equipment blank samples. Field blank and duplicate samples from PZ-13 for lead analysis have not detected measureable lead.

The review of sampling procedures found no evidence to suggest that gauging and sampling equipment or procedures contributed to the lead detections in samples from PZ-13. Suspended sediment could conceivably be digested by acidification with a preservative in the field or at the laboratory and thus contaminate water samples with lead that would not otherwise be dissolved in the environment. However, several factors argue against this possibility, including exclusion of sediments by the well sandpack, low pumping rate, and sample filtering described in this section.

D.3.4 Laboratory Materials and Data Validation

Samples may have been contaminated at the laboratory or the results may have been false positives. While unlikely to explain repeated detections at similar concentrations in samples collected and analyzed on four different sets of dates, this possibility was evaluated for the sake of completeness. A review of potential quality assurance problems discussed in Appendix B of a 1997 report on brine in the Exhaust Shaft (IT, 1997) is a useful summary and illustration of factors that may affect historical SSW samples and that generally contrast with precautionary measures followed in analyses of samples from PZ-13.

Two laboratories independently detected lead at similar concentrations in different samples from PZ-13. To date, eight samples and two duplicate samples from PZ-13 have been analyzed for lead. TraceAnalysis, Inc. analyzed the initial sample collected on October 10, 2007. Hall Environmental Analysis Laboratory, Inc. (HEAL) analyzed the other samples that were collected in 2008 and 2009.

Samples submitted for lead analysis were collected using either the “low-flow” technique or by bailing. Samples submitted to HEAL were filtered with a 0.45-micron filter and acidified with nitric acid in the field. The sample sent to TraceAnalysis, Inc. was filtered in the field but acidified at the laboratory using U.S. Environmental Protection Agency (EPA) method 3005A for the preparation. All of the samples were analyzed using EPA method 6010B, which is an inductively coupled plasma-atomic emission spectrometry (ICP-AES) method. Because the preparation and analysis methods are intended for quantification of lead, they inherently avoid contaminating samples with lead by avoiding apparatus and reagents that contain lead (except stock solutions used for calibration), and they include quality assurance/quality control (QA/QC) procedures intended to detect cross-contamination or other analytical problems.

Neither laboratory noted any problems or unusual occurrences when the samples were received, during sample preparation, or during sample analysis. HEAL was notified of the likelihood of high TDS concentrations based on the analysis of the initial sample and thus had opportunity to modify procedures, but apparently did not deem it necessary to do so. This may explain why HEAL reported results for each sample at a 50X dilution whereas TraceAnalysis, Inc. reported a result for the undiluted sample. Results for the duplicate samples submitted to HEAL confirm the presence of lead but are in somewhat poor agreement (0.40 mg/L versus 0.34 mg/L on October 22, 2008; 0.25 mg/L versus 0.39 mg/L on September 17, 2009), raising the question of whether better quantitation is perhaps possible with less-diluted samples for lead analysis.

Only one of the lead results was reported with any qualifiers (0.13J mg/L on September 14, 2009). The laboratory reports indicate that all lead results met the laboratories' internal acceptance criteria, and an independent review in accordance with WP 02-EM3003, Revision 5 concluded that the lead results reported by HEAL for the last sample and its duplicate meet data quality objectives (a Level IV QA/QC package was provided for these samples). Lead was not detected in field blanks or in laboratory method blanks at a concentration above the practical quantitation limit (PQL) of 5 µg/L, and recovery in a spiked laboratory control samples was 92.8 to 104 percent. Similar QA/QC results were obtained for the other samples analyzed by HEAL. The field blanks are submitted in blind fashion and therefore have apparently been randomly selected by the laboratory for use in the matrix spike samples.

The TraceAnalysis, Inc. QA/QC report indicated that lead was not detected in the method blank and that laboratory control samples and initial and continuing calibration sample recoveries were within acceptable limits. The laboratory selected the sample from PZ-13 for use as the matrix spike and matrix spike duplicate samples for lead, both of which had recoveries of approximately 99 percent. This initial sample was analyzed for all of the eight RCRA metals; only lead and barium were detected.

Acidification of sediments is an extremely unlikely explanation for the lead detection in the October 10, 2007 sample submitted to TraceAnalysis, Inc. and acidified in the laboratory or by extension, the similar detections in subsequent field-filtered samples. In addition to the lack of mention of sediments either in field notes or in the laboratory reports, the barrier provided by the well sandpack, the low pumping rates used to collect the samples, and the use of filtering in the field, TraceAnalysis, Inc. would have been able to observe sediments large enough to be visible and could have prevented their acidification by first allowing them to settle in the sample container and decanting or further filtering the sample in the laboratory. Had all of these measures failed to prevent samples from containing digested sediments, it is unlikely that the only trace metals detected would have been lead and barium or that the elevated lead concentrations would be unique to PZ-13.

In general, the consistent detections of lead in multiple samples by two independent laboratories each apparently following diligent QA/QC protocols effectively rules out the possibility of laboratory contamination or random false positive detections.

References

Daniel B. Stephens & Associates, Inc. (DBS&A). 1996. *Characterization of the Site Preliminary Design Validation salt pile*. January 5, 1996.

Fultz Pumps, Inc. (Fultz). Undated. Instruction manual for sampling pump units.

Gibbs, L.M. 1997. How gasoline has changed. pp. 147-164 in Society of Automotive Engineers, *History of aircraft lubricants*. May 1997.

Intera. 1997. *Exhaust shaft: Phase II hydraulic assessment data report involving drilling, installation, water-quality sampling, and testing of piezometers 1-12*. Prepared for Westinghouse. DOE/WIPP 97-2219. September 26, 1997.

Salness, R. 2007-2009. Field notes provided by Rick Salness, WTS.

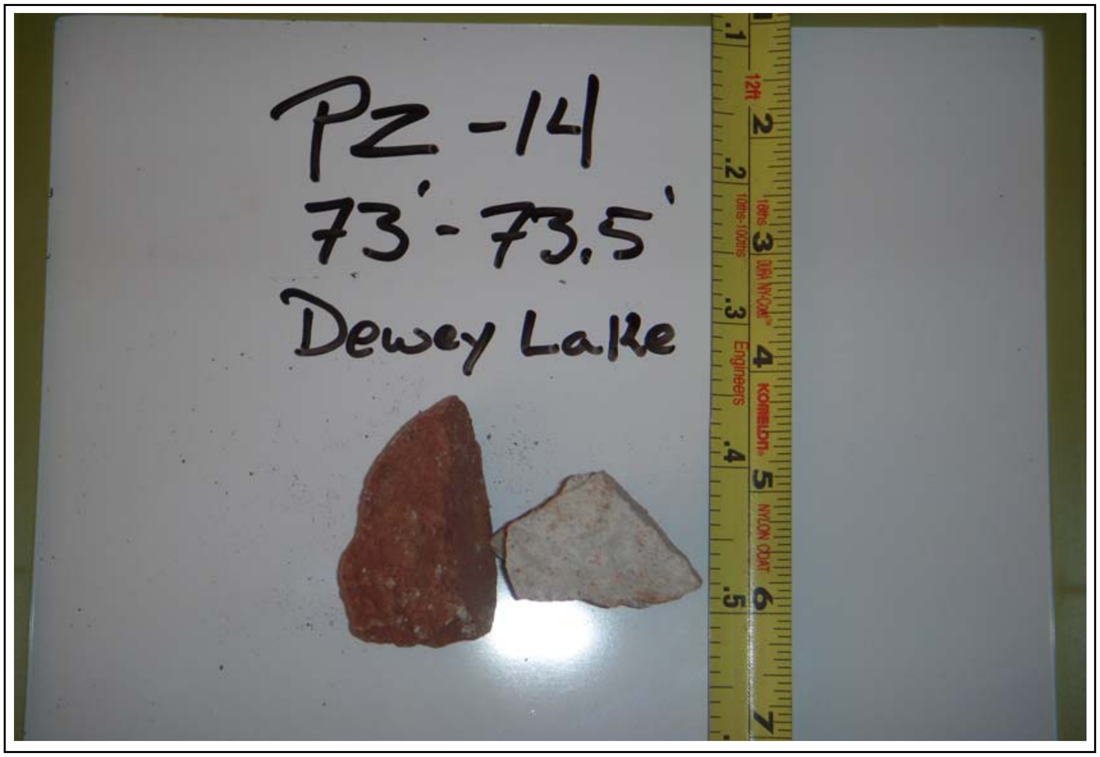
U.S. DOE. 2008. *Basic data report for piezometers PZ-13, PZ-14, and PZ-15 and shallow subsurface water.* DOE/WIPP-08-3375, Revision 3. October 2008.

Appendix E

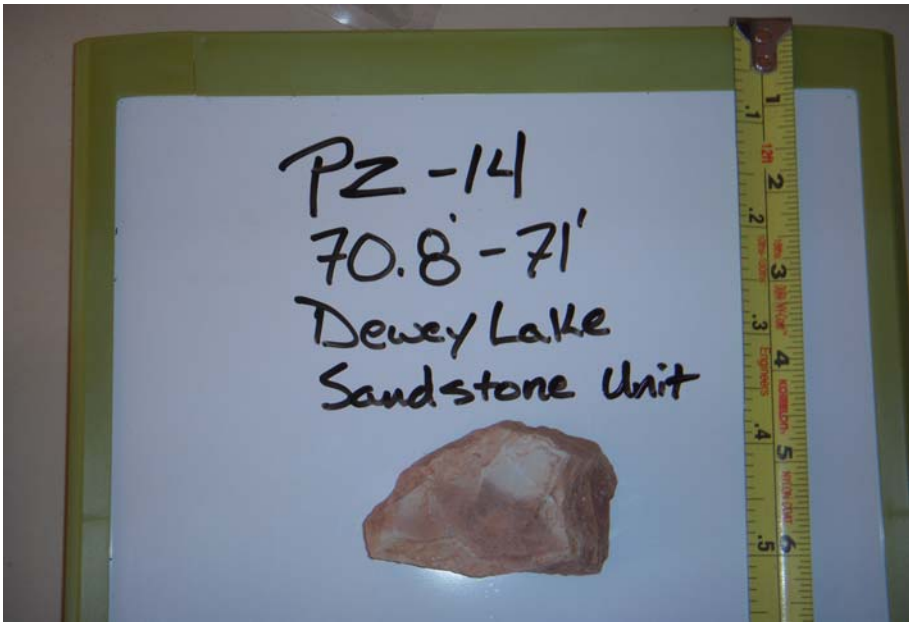
Photographs and Chemical Results from XRF and EPMA

Photographs

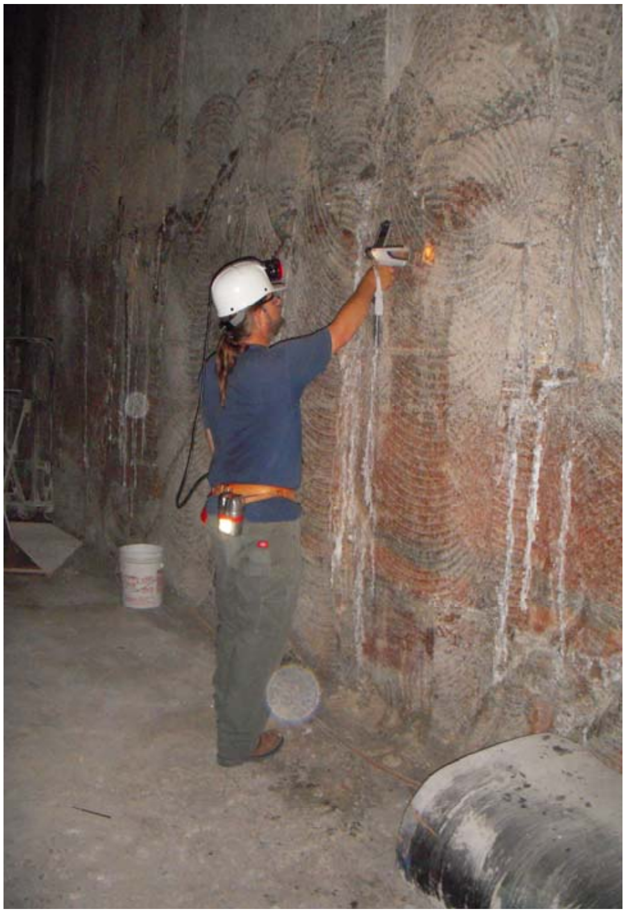
1. Dewey Lake 76 to 77 feet bgs with lead detected in red oxidized portion of sample.



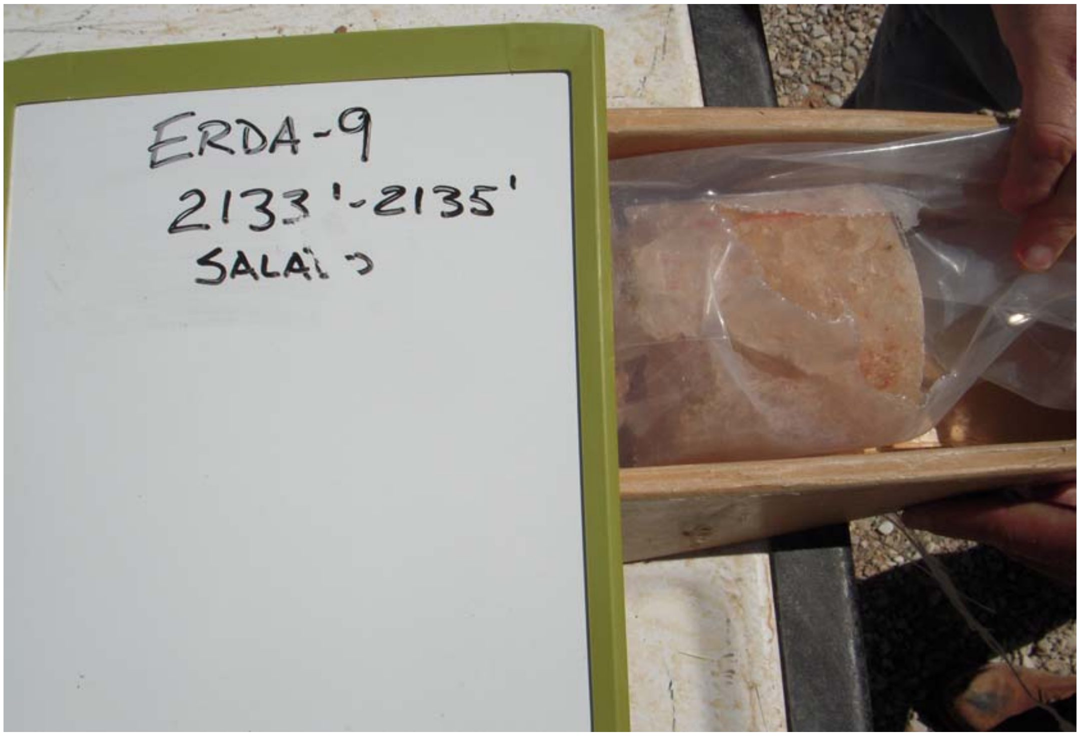
2. Dewey Lake in PZ-14 with lead detected in oxidized portion of sample.



3. Dewey Lake Formation sandstone unit in PZ-14.



4. In situ measurement of Salado Formation in repository.



5. ERDA-9 Salado Formation core samples

6. ERDA-9 cuttings of Dewey Lake. Depth of Dewey Lake in ERDA-9 is 63 to 550 feet below the drill rig kelly table (+12 above ground surface).

7. Dewey Lake at outcrop near Nash Draw

8. Auger bit with flat and bullet teeth that both contain lead with highest concentration in the tips of the teeth (tungsten carbide tips are not rusted).

9. Tri-cone bit with gray teeth containing lead

10. Drill bits from Stewart Brothers Drilling

9. Three drill bits collected for this study. Top = HSA flat bit; bottom left = tricone bit, bottom right = HSA round bit.

Results

Table E-1. XRF Data, PZ-13 Lead Investigation, WIPP Site

Reading No	Time	Type	Duration	Units	SAMPLE	LOCATION	NOTE	Mo	Mo Error	Zr	Zr Error	Sr	Sr Error	U	U Error	Rb	Rb Error	Th	Th Error	Pb *	Pb Error	Se	Se Error	As	As Error
1	7/7/2009 7:45	SHUTTER_CAL	57.96	cps																					
2	7/7/2009 7:47	SOIL	30.14	ppm	sio2 std			< LOD	5.56	< LOD	5.28	< LOD	2.64	< LOD	7.16	< LOD	2.75	< LOD	5.46	< LOD	7.38	< LOD	3.51	< LOD	5.53
3	7/7/2009 7:49	SOIL	0.45	ppm	sio2 std			< LOD	3.36	< LOD	14.58	< LOD	13.32	< LOD	40.46	< LOD	16.35	< LOD	42.5	< LOD	4.79	< LOD	2.5	< LOD	2.37
4	7/7/2009 7:51	SOIL	30.47	ppm	rcra8			< LOD	8.9	303.25	14.67	202.97	10.65	< LOD	17.5	79.42	7.85	< LOD	18.6	490.71	38.97	518.55	24.9	502.3	39.11
5	7/7/2009 7:53	SOIL	30.44	ppm	rock			< LOD	8.82	148.62	15.16	985.11	23.73	< LOD	19.26	31.77	6.06	18.04	8.9	28.56	12.21	< LOD	6.21	19.09	11.04
6	7/7/2009 7:58	SOIL	30.47	ppm	pz-13	0-2.5		< LOD	6.52	113.89	7.61	22.18	3.37	< LOD	9.55	16.87	3.41	< LOD	6.93	< LOD	8.21	< LOD	4.45	< LOD	6.82
7	7/7/2009 8:02	SOIL	30.14	ppm	pz-13	0-2.5		< LOD	6.38	170.17	8.54	23.57	3.31	< LOD	9.07	18.87	3.38	< LOD	6.61	< LOD	7.46	< LOD	3.72	< LOD	6.5
8	7/7/2009 8:06	SOIL	30.15	ppm	pz-13	2.5-3		< LOD	6.16	141.28	7.94	22.97	3.28	< LOD	9.41	23.02	3.63	< LOD	6.36	< LOD	8.34	< LOD	4.38	< LOD	6.4
9	7/7/2009 8:10	SOIL	60.47	ppm	pz-13	3-5	berino	< LOD	7.26	145.73	9.35	41.37	4.71	< LOD	12.02	41.66	5.23	< LOD	8.96	< LOD	11.25	< LOD	4.74	< LOD	9.25
10	7/7/2009 8:15	SOIL	60.43	ppm	pz-13	6.5-7.5	mescalero	< LOD	7.38	59.31	8.52	246.38	10.93	< LOD	12.3	15.98	4	< LOD	7.75	< LOD	11.15	< LOD	5.63	< LOD	9.17
11	7/7/2009 8:19	SOIL	60.3	ppm	pz-13	7.5-8.5	mescalero	< LOD	8.41	35.26	9.68	373.91	15.06	< LOD	13.6	7.35	3.77	< LOD	8.58	< LOD	12.38	< LOD	7.13	< LOD	9.81
12	7/7/2009 8:23	SOIL	60.43	ppm	pz-13	7.5-10	mescalero	< LOD	8	90.91	9.83	225.15	11.11	< LOD	12.26	13.6	3.96	< LOD	8.38	< LOD	12.12	< LOD	5.88	< LOD	9.41
13	7/7/2009 8:27	SOIL	60.15	ppm	pz-13	10-12.5	mescalero	< LOD	7.27	134.54	9.42	146.6	8.09	< LOD	11.85	32.84	4.73	< LOD	7.53	< LOD	10.26	< LOD	4.49	< LOD	8.5
14	7/7/2009 8:33	SOIL	60.36	ppm	pz-13	12.5-15	gatuna	< LOD	7.4	83.61	9.05	214.58	10.26	< LOD	12.13	13.36	3.82	< LOD	8.27	< LOD	9.38	< LOD	5.34	< LOD	7.6
15	7/7/2009 8:38	SOIL	60.38	ppm	pz-13	15-17.5	gatuna	< LOD	8.26	41	8.92	261.7	12.38	< LOD	13.42	7.62	3.77	< LOD	8.26	< LOD	11.33	< LOD	6.25	< LOD	9.82
16	7/7/2009 8:43	SOIL	60.38	ppm	pz-13	17.5-20	gatuna	< LOD	7.89	181.33	10.82	104.6	7.29	< LOD	13.33	49.81	5.85	< LOD	9.58	< LOD	12.11	< LOD	5.27	< LOD	10.21
17	7/7/2009 8:46	SOIL	60.43	ppm	pz-13	20-22.5	gatuna	< LOD	7.15	133.96	9.03	57.29	5.33	< LOD	10.96	34.31	4.74	< LOD	7.93	< LOD	11.54	< LOD	5.3	< LOD	9.42
18	7/7/2009 8:50	SOIL	60.41	ppm	pz-13	25-27.5	gatuna	< LOD	7.12	131.31	9.79	201.19	9.56	< LOD	11.72	33.09	4.78	< LOD	8.86	< LOD	10.38	< LOD	5.29	< LOD	8.47
19	7/7/2009 8:53	SOIL	60.44	ppm	pz-13	27.5-30	gatuna	< LOD	7.21	139.14	9.16	83.32	6.2	< LOD	11.51	29.87	4.53	< LOD	7.24	< LOD	11.08	< LOD	5.07	< LOD	9.33
20	7/7/2009 8:59	SOIL	60.22	ppm	pz-13	22.5-25	gatuna	< LOD	7.42	146.49	9.79	99.95	6.98	< LOD	11.3	31.1	4.68	14.17	6.67	< LOD	10.49	< LOD	5.51	< LOD	8.33
21	7/7/2009 9:02	SOIL	60.29	ppm	pz-13	30-31	gatuna	< LOD	7.17	141.96	9.23	114.12	7.03	< LOD	12.16	40.41	5.02	< LOD	8.76	< LOD	10.9	< LOD	4.42	< LOD	8.68
22	7/7/2009 9:06	SOIL	60.35	ppm	pz-13	30-32.5	gatuna	< LOD	7.55	195.78	10.44	90.5	6.45	< LOD	13.38	46.05	5.46	< LOD	9.12	< LOD	11.38	< LOD	4.87	< LOD	9.35
23	7/7/2009 9:14	SOIL	60.45	ppm	pz-13	32.5-35	gatuna	< LOD	8	254.87	12.32	165.35	8.85	< LOD	13.52	48.71	5.74	< LOD	9.21	< LOD	10.53	< LOD	5.53	< LOD	9.06
24	7/7/2009 9:18	SOIL	60.53	ppm	pz-13	35-37	gatuna	< LOD	7.61	265.37	12.55	294.66	11.26	< LOD	15.71	74.17	6.74	9.97	6.43	< LOD	11.19	< LOD	4.96	< LOD	9.3
25	7/7/2009 9:22	SOIL	0.44	ppm	pz-13	37-39	gatuna	< LOD	6.73	< LOD	0.23	< LOD	20.1	< LOD	85.49	< LOD	13.55	< LOD	3.18	< LOD	52.45	< LOD	125.8	< LOD	22.21
26	7/7/2009 9:23	SOIL	60.24	ppm	pz-13	37-39	gatuna	< LOD	7.59	251.83	12.39	284.96	11.18	< LOD	14.47	58.28	6.09	< LOD	9.26	< LOD	10.87	< LOD	5.63	< LOD	9.13
27	7/7/2009 9:28	SOIL	60.39	ppm	pz-13	39.8-40	santa rosa	< LOD	8.03	104.5	11.3	464.04	15.6	< LOD	15.34	29.38	5.28	< LOD	9.36	< LOD	13.04	< LOD	5.8	< LOD	10.18
28	7/7/2009 9:33	SOIL	60.49	ppm	pz-13	40-42.5	santa rosa	< LOD	7.94	403.19	14.3	96.34	6.75	< LOD	14.31	59	6.16	11.17	6.58	< LOD	12.34	< LOD	5.19	< LOD	10.34
29	7/7/2009 9:40	SOIL	60.4	ppm	pz-13	42.5-43.5	santa rosa	< LOD	7.79	199.39	10.96	97.73	6.93	< LOD	13.66	66.01	6.44	12.06	6.74	< LOD	11.76	< LOD	5.06	< LOD	9.74
30	7/7/2009 9:43	SOIL	60.47	ppm	pz-13	43.5-45	santa rosa	< LOD	7.49	237.69	11.32	114.01	7.14	< LOD	13.92	59.43	6.02	< LOD	9.23	< LOD	11.69	< LOD	4.8	< LOD	9.21
31	7/7/2009 9:47	SOIL	60.23	ppm	pz-13	45-46	santa rosa	< LOD	7.25	139.73	9.45	115.55	7.26	< LOD	14.1	68.26	6.41	13.03	6.69	< LOD	11.97	< LOD	4.69	< LOD	9.51
32	7/7/2009 9:50	SOIL	60.43	ppm	pz-13	46-47	santa rosa	< LOD	7.73	295.76	12.79	118.32	7.51	< LOD	13.77	52.4	5.89	10.01	6.48	< LOD	12.42	< LOD	5.23	< LOD	9.92
33	7/7/2009 9:55	SOIL	60.55	ppm	pz-13	52-53	santa rosa	< LOD	7.65	364.22	13.48	90.16	6.47	< LOD	13.71	52.34	5.77	10.29	6.28	< LOD	11.45	< LOD	5.48	< LOD	9.88
34	7/7/2009 9:59	SOIL	60.31	ppm	pz-13	59.5-59.7	santa rosa	< LOD	6.93	87.82	7.9	78.02	6.06	< LOD	13.29	52.87	5.74	< LOD	7.74	< LOD	10.13	< LOD	4.97	< LOD	8.24
35	7/7/2009 10:03	SOIL	60.5	ppm	pz-13	65-67.5	santa rosa	< LOD	6.39	114.91	7.76	65.59	5.1	< LOD	10.12	33.88	4.27	< LOD	7.48	< LOD	9.9	< LOD	4.17	< LOD	7.41
36	7/7/2009 10:10	SOIL	60.62	ppm	pz-13	67.5	santa rosa	< LOD	6.46	72.85	6.86	38.51	4.25	< LOD	10.17	34.24	4.42	< LOD	7.98	< LOD	8.99	< LOD	4.78	< LOD	7.48
37	7/7/2009 10:21	SOIL	60.58	ppm	pz-13	74-75	dewey lake	< LOD	8.38	181.19	11.67	156.42	9.26	< LOD	19.31	119.58	9.2	11.95	7.9	26.56	11.3	< LOD	5.89	< LOD	14.66
38	7/7/2009 10:34	SOIL	60.57	ppm	pz-13	76-77	dewey lake	< LOD	7.78	167.13	10.91	163.9	9.07	< LOD	17.81	112.73	8.55	13.99	7.65	19.03	10.07	< LOD	5.11	22.39	9.55
39	7/7/2009 10:38	SOIL	60.77	ppm	pz-13	76-77	dewey lake green	< LOD	7.44	169.44	10.68	150.78	8.55	< LOD	17.91	114.42	8.47	13.11	7.17	< LOD	11.56	< LOD	5.33	< LOD	10.29
40	7/7/2009 11:02	SOIL	60.43	ppm	pz-14	70-70.5	dewey lake	< LOD	7.39	139.12	9.36	91.73	6.57	< LOD	13.17	45.45	5.48	< LOD	8.43	< LOD	9.26	< LOD	5.17	< LOD	7.95
41	7/7/2009 11:06	SOIL	60.83	ppm	pz-14	70.5-70.88	dewey lake	< LOD	7.6	264.79	12.14	133.12	7.85	< LOD	15.19	72.42	6.71	< LOD	9.42	< LOD	10.86	< LOD	5.42	< LOD	8.64
42	7/7/2009 11:11	SOIL	60.88	ppm	pz-14	71-72	dewey lake	< LOD	8.21	209.66	12.36	249.1	11.24	< LOD	18.1	95.66	8.15	12.08	7.51	16.72	10.04	< LOD	5.32	< LOD	12.82
43	7/7/2009 11:20	SOIL	60.11	ppm	pz-14	72.5-73	dewey lake	< LOD	7.87	320.47	13.61	135.1	8.19	< LOD	13.71	43.57	5.61	9.93	6.61	< LOD	12.66	< LOD	5.55	< LOD	11.17
44	7/7/2009 11:30	SOIL	60.59	ppm	pz-14	73-73.5	dewey lake	< LOD	8.82	235.87	13.53	157.33	9.78	< LOD	18.33	86.09	8.35	< LOD	11.89	21.41	11.4	< LOD	6.34	< LOD	15.1
45	7/7/2009 11:38	SOIL	61.3	ppm	pz-14	73-73.5	dewey lake green	< LOD	7.52	234.16	11.8	159.72	8.6	< LOD	17.4	96.45	7.76	18.71	7.48	< LOD	11	< LOD	5.01	< LOD	9.47
46	7/7/2009 11:49	SOIL	60.25	ppm	pz-14	70.8-71	dewey lake	< LOD	7.36	215.78	11.23	161.95	8.5	< LOD	17.04	99.37	7.7	12.73	6.76	< LOD	10.48	< LOD	5.4	< LOD	9.27
47	7/7/2009 11:57	SOIL	60.61	ppm	pz-15	45-45.3	gatuna	< LOD	6.85	145.63	9.71	235.86	9.75	< LOD	14.03	61.64	5.97	13.34	6.46	< LOD	11.39	< LOD	4.37	< LOD	9.59
48	7/7/2009 12:04	SOIL	60.55	ppm	pz-15	50.5-52	gatuna green	< LOD	7.48	255.67	11.89	166.2	8.54	< LOD	16.25	103.47	7.69	< LOD	9.64	< LOD	11.24	< LOD	4.97	< LOD	9.89
49	7/7/2009 12:09	SOIL	60.42	ppm	pz-15	50.5-52	gatuna	< LOD	7.5	254.76	11.94	183.08	8.95	< LOD	15.66	89.54	7.23	10.02	6.48	< LOD	11.75	< LOD	5.41	< LOD	9.9
50	7/7/2009 14:03	SHUTTER_CAL	56.04	cps																					
51	7/7/2009 14:09	SOIL	60.21	ppm	erda-9	60-65	dewey lake	< LOD	8.15	194.94	11.82	165.96	9.36	< LOD	19.2	124.48	9.21	11.99	7.84	30.51	11.42	< LOD	5.62	< LOD	14.58
52	7/7/2009 14:13	SOIL	60.17	ppm	erda-9	65-70	dewey lake	< LOD	7.99	152.15	10.76	133.45	8.52	< LOD	16.09	74.07	7.31	< LOD	10.33	< LOD	14.22	< LOD	6.31	< LOD	12.3
53	7/7/2009 14:17	SOIL	60.6	ppm	erda-9	70-75	dewey lake	< LOD	8.05	168.72	11.16	145.38	8.81	< LOD	16.24	77.91	7.43	16.65	7.88	< LOD	14.64	< LOD	5.32	< LOD	12.86
54	7/7/2009 14:21	SOIL	60.38	ppm	erda-9	75-80	dewey lake	< LOD	8.09	271.15	13.73	142.85	9.04	< LOD	18.59	92.62	8.37	16.35	8.26	17	10.74	< LOD	6.54	< LOD	13.73
55	7/7/2009 14:25	SOIL	60.39	ppm	erda-9	80-85	dewey lake	< LOD	8.37	166.01	11.79	152.96	9.54	< LOD	18.71	93.94	8.58	17.19	8.51	< LOD	15.94	< LOD	6.8	< LOD	13.89
56	7/7/2009 14:28	SOIL	60.23	ppm	erda-9	85-90	dewey lake	< LOD	8.04	224.1	12.12	151.27	8.79	< LOD	18.7	109.11	8.58	< LOD	10.56	< LOD	14.5	< LOD	5.47	24.73	9.46
57	7/7/2009 14:31	SOIL	60.66	ppm	erda-9	90-95	dewey lake	< LOD	8.57	182	12.06	138.5	9.09	< LOD	18.7	94.96	8.61	13.39	8.09	< LOD	15.76	< LOD	5.64	< LOD	13.93
58	7/7/2009 14:35	SOIL	60.43	ppm	erda-9	95-100	dewey lake	< LOD	8.12	167.36	11.52	138.17	8.95	< LOD	17.59	79.99	7.88	< LOD	10.42	< LOD	14.07	< LOD	5.73	< LOD	12.41
59	7/7/2009 14:38	SOIL	60.14	ppm	erda-9	100-105	dewey lake	< LOD	8.09	189.72	11.62	139.54	8.66	< LOD	17.69	96.98	8.24	15.23	7.85	< LOD	14.83	< LOD	5.98	< LOD	12.77

Table E-1. XRF Data, PZ-13 Lead Investigation, WIPP Site

Reading No	Time	Type	Duration	Units	SAMPLE	LOCATION	NOTE	Mo	Mo Error	Zr	Zr Error	Sr	Sr Error	U	U Error	Rb	Rb Error	Th	Th Error	Pb *	Pb Error	Se	Se Error	As	As Error
60	7/7/2009 14:41	SOIL	60.25	ppm	erda-9	105-110	dewey lake	< LOD	8.42	178.18	11.91	133.27	8.91	< LOD	18.38	94	8.54	< LOD	11.09	< LOD	15.15	< LOD	6.11	< LOD	13.51
61	7/7/2009 14:45	SOIL	60.95	ppm	erda-9	110-115	dewey lake	< LOD	8.14	159.22	11.35	145.02	9.15	< LOD	17.66	82.93	7.98	< LOD	10.57	< LOD	12.71	< LOD	6.49	< LOD	10.79
62	7/7/2009 14:48	SOIL	60.44	ppm	erda-9	115-120	dewey lake	< LOD	7.75	166.19	10.99	188.3	9.7	< LOD	17.31	90.33	7.81	< LOD	9.97	< LOD	12.14	< LOD	6	< LOD	10.63
63	7/7/2009 14:51	SOIL	60.46	ppm	erda-9	120-125	dewey lake	< LOD	8.19	361.17	14.76	148.19	8.8	< LOD	17.73	81.69	7.66	11.88	7.27	< LOD	13.19	< LOD	5.9	12.96	8
64	7/7/2009 14:55	SOIL	60.57	ppm	erda-9	125-130	dewey lake	< LOD	7.67	149.78	10.55	167.62	9.21	< LOD	16.02	81.21	7.39	< LOD	9.63	< LOD	13.11	< LOD	5.82	< LOD	10.97
65	7/7/2009 15:02	SOIL	60.38	ppm	erda-9	2133-2135	salado	< LOD	8.99	< LOD	9.1	36.13	5.39	< LOD	12.85	7.82	3.8	< LOD	8.58	< LOD	13.73	< LOD	6.68	< LOD	12.45
66	7/7/2009 15:07	SOIL	60.6	ppm	erda-9	2133-2135b	salado	< LOD	8.3	< LOD	10.39	122.34	8.97	< LOD	11.04	14.6	4.07	< LOD	8.98	< LOD	13.05	< LOD	7.33	< LOD	11.31
67	7/7/2009 15:12	SOIL	60.38	ppm	erda-9	485-490	salado	< LOD	7.74	243.35	12.65	206.74	10.14	< LOD	14.8	47.46	5.96	< LOD	9.52	< LOD	13.05	< LOD	5.74	< LOD	10.83
68	7/7/2009 15:15	SOIL	60.69	ppm	erda-9	460-465	salado	< LOD	7.68	325.55	13.55	171.95	8.99	< LOD	14.46	61.95	6.35	< LOD	9.19	< LOD	11.68	< LOD	5.24	10.64	7.04
69	7/7/2009 15:19	SOIL	60.54	ppm	erda-9	430-435	salado	< LOD	8.35	615.29	18.17	195.84	9.76	< LOD	14.91	55.91	6.25	< LOD	9.67	< LOD	11.64	< LOD	5.65	< LOD	9.49
70	7/7/2009 15:23	SOIL	60.37	ppm	erda-9	420-425	salado	< LOD	8.43	447.37	16.18	178.23	9.56	< LOD	14.76	50.28	6.13	< LOD	9.06	< LOD	12.57	< LOD	6.28	< LOD	10.96
71	7/8/2009 8:29	SHUTTER_CAL	58.05	cps																					
72	7/8/2009 8:46	SOIL	60.37	ppm	mu 0	room 2	red arg	< LOD	8.15	< LOD	8.53	11.17	3.52	< LOD	12.52	16.51	4.4	< LOD	8.87	< LOD	11.88	< LOD	7.2	< LOD	9.6
73	7/8/2009 8:50	SOIL	60.46	ppm	mu 0	room 2	mu 1	< LOD	8.52	< LOD	8.78	34.88	5.18	< LOD	11.02	18.11	4.36	< LOD	9.97	< LOD	12.79	< LOD	7.34	< LOD	9.36
74	7/8/2009 8:53	SOIL	60.67	ppm	mu 2	room 2	clay	< LOD	8.97	25.91	7.01	26.31	4.77	< LOD	13.6	31.81	5.61	13.56	7.84	< LOD	13.15	< LOD	7.8	18.32	8.73
75	7/8/2009 8:56	SOIL	61.09	ppm	mu 3	room 2	halite	< LOD	9.12	< LOD	8.92	9.52	3.65	< LOD	12.92	17.28	4.7	< LOD	10.67	< LOD	12.26	< LOD	7.63	< LOD	9.97
76	7/8/2009 8:59	SOIL	60.58	ppm	mu 3	room 2	red vein	< LOD	8.31	< LOD	14.31	490.19	17.19	< LOD	14.69	18.36	4.74	< LOD	9.05	< LOD	11.91	< LOD	6.69	< LOD	9.53
77	7/8/2009 9:02	SOIL	60.58	ppm	mu 4	room 2	clay red	< LOD	9.01	< LOD	9.83	65.37	7.07	< LOD	13.28	33.02	5.8	< LOD	11.86	< LOD	13.48	< LOD	6.87	< LOD	9.58
78	7/8/2009 9:07	SOIL	60.41	ppm	mu 5	room 2	clay gray	< LOD	8.79	< LOD	8.81	5.58	3.19	< LOD	12.84	18.34	4.67	< LOD	10.83	< LOD	12.05	< LOD	7.81	< LOD	9.15
79	7/8/2009 9:10	SOIL	60.33	ppm	map unit 6	room 2		< LOD	8.65	< LOD	8.06	12.78	3.72	< LOD	10.91	15.76	4.22	< LOD	9.96	< LOD	13.34	< LOD	6.74	< LOD	9.99
80	7/8/2009 9:31	SOIL	60.4	ppm	map unit 0	room 4		< LOD	8.6	< LOD	8.69	30.55	5	< LOD	13.43	14.49	4.43	< LOD	9.36	< LOD	13.2	< LOD	7.2	< LOD	9.04
81	7/8/2009 9:33	SOIL	95.25	ppm	map unit 1	room 4		< LOD	6.78	< LOD	6.85	37.17	4.36	< LOD	9.41	13.19	3.31	< LOD	7.81	< LOD	9.19	< LOD	5.46	< LOD	7.65
82	7/8/2009 9:36	SOIL	91	ppm	map unit 2	room 4		< LOD	9.02	< LOD	9.12	18.34	4.33	< LOD	13.29	10.17	4.14	< LOD	9.5	< LOD	13.22	< LOD	7.75	< LOD	10.7
83	7/8/2009 9:40	SOIL	95.59	ppm	map unit 3	room 4		< LOD	7.31	7.58	5.05	17.48	3.52	< LOD	9.89	10.37	3.28	< LOD	7.97	< LOD	9.79	< LOD	6.34	< LOD	7.44
84	7/8/2009 9:43	SOIL	91.85	ppm	map unit 4	room 4		< LOD	7.7	15.85	5.5	6.4	2.83	< LOD	10.71	25.7	4.46	< LOD	8.64	< LOD	10.71	< LOD	6.45	< LOD	8.18
85	7/8/2009 9:47	SOIL	95.37	ppm	map unit 5	room 4		< LOD	7.66	18.13	5.7	21.79	3.84	< LOD	12.5	57.28	6.07	12.96	6.9	< LOD	12.47	< LOD	6.72	< LOD	10.18
86	7/8/2009 9:50	SOIL	91.63	ppm	map unit 6	room 4		< LOD	7.92	< LOD	8.08	26.1	4.39	< LOD	11.54	18.31	4.24	10.63	6.78	< LOD	11.6	< LOD	6.84	< LOD	8.27
87	7/8/2009 9:58	SOIL	93.72	ppm	chain link			< LOD	62.66	< LOD	95.29	< LOD	91.09	< LOD	290.71	92.5	40.76	< LOD	85.78	< LOD	202.98	1359.58	267.88	159.28	94.97
88	7/8/2009 10:01	SOIL	95.58	ppm	chain link b			< LOD	49.14	< LOD	70.85	< LOD	64.85	< LOD	268.26	92.15	39.19	< LOD	100.64	< LOD	212.23	1360.08	245.82	< LOD	143.78
89	7/8/2009 15:02	SOIL	91.15	ppm	dewey lake	nash draw		< LOD	7.08	449.42	13.31	122.7	6.67	< LOD	12.21	42.99	4.82	< LOD	7.84	< LOD	10.21	< LOD	4.75	< LOD	8.19
90	7/8/2009 15:05	SOIL	91.53	ppm	dewey lake b	nash draw		< LOD	13.24	2472.72	37.21	743.59	19.57	< LOD	18.85	31.8	5.88	22.19	8.91	< LOD	14.78	< LOD	6.72	< LOD	12.39
91	7/8/2009 15:08	SOIL	92.16	ppm	dewey lakec	nash draw		< LOD	6.76	263.73	11.32	256.82	9.62	< LOD	13.4	50.79	5.3	10.8	5.81	< LOD	9.65	< LOD	4.61	11.36	5.95
92	7/8/2009 15:10	SOIL	92.34	ppm	dewey lake d	nash draw		< LOD	6.84	236.94	10.84	214.01	8.9	< LOD	12.94	54.35	5.41	< LOD	8.18	< LOD	10.97	< LOD	4.89	< LOD	8.9
93	7/8/2009 15:13	SOIL	61.18	ppm	dewey lake e	nash draw		< LOD	9.47	699.89	20.68	400.35	14.41	< LOD	15.45	23.94	5	< LOD	9.4	< LOD	12.63	< LOD	5.83	< LOD	10.15
94	7/8/2009 15:15	SOIL	60.57	ppm	dewey lake f	nash draw		< LOD	7.82	375.32	13.76	98.15	6.76	15.1	9.9	55.6	6.04	< LOD	8.98	< LOD	11.55	< LOD	5.07	< LOD	9.48
95	7/8/2009 15:18	SOIL	92.51	ppm	dewey lake g	nash draw		< LOD	11.22	2288.84	32.54	292.96	11.51	< LOD	15.24	39.2	5.51	29.5	8.65	< LOD	13.45	< LOD	6.4	< LOD	10.81
96	7/8/2009 15:20	SOIL	91.32	ppm	dewey lake h	nash draw		< LOD	19.94	5812.03	65.05	280.5	14.53	25.46	14.15	15.54	5.98	37.5	12.44	< LOD	19.51	< LOD	10.32	< LOD	16.69
97	7/9/2009 10:57	SHUTTER_CAL	56.06	cps																					
98	7/9/2009 11:04	SHUTTER_CAL	60.07	cps																					
99	7/9/2009 11:06	SOIL	28.52	ppm	tricone *	stewart brothers	diamond teeth	< LOD	68.99	< LOD	57.19	616.74	101.57	2559.16	418.56	< LOD	110.52	< LOD	103.28	4065.79 *	326.31	< LOD	1355.53	< LOD	403.85
100	7/9/2009 11:08	SOIL	30.1	ppm	tricone *	stewart brothers	diamond teeth b	< LOD	75.26	< LOD	56.75	579.19	84.82	2286.91	343.6	< LOD	91.02	< LOD	82.74	3732.54 *	267.85	< LOD	1101.65	< LOD	328.88
101	7/9/2009 11:11	SOIL	91.04	ppm	tricone *	stewart brothers	tricone body	2155.06	68.17	< LOD	28.92	31.37	14.24	< LOD	52.12	< LOD	26.01	167.07	50.86	156.69 *	45.1	< LOD	40.56	< LOD	58.23
102	7/9/2009 11:13	SOIL	60.87	ppm	tricone *	stewart brothers	slag	54.07	14.84	84.92	21.61	267.24	24.86	< LOD	33.45	< LOD	13.49	< LOD	25.84	< LOD	30.82	< LOD	18.1	< LOD	34.47
103	7/9/2009 11:18	SOIL	60.51	ppm	auger *	stewart brothers	round tooth	< LOD	76.65	< LOD	57.53	567.07	96.24	2532.48	403.28	< LOD	103.77	< LOD	87.27	4675.03 *	303.94	< LOD	1265.38	< LOD	373.71
104	7/9/2009 11:20	SOIL	60.68	ppm	auger *	stewart brothers	round tooth body	48.88	23.82	< LOD	41.88	< LOD	24.11	< LOD	65.61	< LOD	34.38	192.74	66.83	138.78 *	50.02	< LOD	40.89	< LOD	64.2
105	7/9/2009 11:23	SOIL	60.37	ppm	auger *	stewart brothers	flat tooth tip	< LOD	87.55	< LOD	56.97	357.44	96.73	1664.25	406.07	< LOD	103.08	< LOD	103.16	4232.11 *	311.48	< LOD	1280.83	< LOD	396.52
106	7/9/2009 11:25	SOIL	60.75	ppm	auger *	stewart brothers	flat tooth body	1453.7	76.52	< LOD	35.31	< LOD	22.92	< LOD	66.07	< LOD	33.26	126.51	62.81	71.97 *	26.06	< LOD	39.71	< LOD	65.95
107	7/9/2009 11:28	SOIL	61.57	ppm	auger *	stewart brothers	slag	12205.42	157.68	< LOD	33.98	23.18	14.2	< LOD	53.24	< LOD	22.09	< LOD	40.92	116.34 *	45.39	< LOD	32.87	< LOD	68.05
108	7/9/2009 11:30	SOIL	60.45	ppm	silica			< LOD	6.07	< LOD	5.49	< LOD	2.69	< LOD	6.77	< LOD	2.74	< LOD	5.91	< LOD	7.12	< LOD	3.63	< LOD	5.82
109	7/9/2009 11:32	SOIL	60.55	ppm	rcra std			< LOD	8.85	277.39	14.17	187.18	10.28	< LOD	18.24	80.43	7.97	20.31	12.6	479.26	38.68	511.99	24.79	510.29	39.12
110	7/9/2009 11:34	SOIL	60.44	ppm	rcra std b			< LOD	8.49	269.04	13.88	182.41	10.07	< LOD	18	76.35	7.75	21.78	12.71	500.24	38.89	508.09	24.49	500.02	38.96
111	7/9/2009 11:36	SOIL	61.37	ppm	rcra std c			< LOD	8.76	305.89	14.68	193.58	10.43	< LOD	16.21	73.82	7.5	< LOD	18.24	499.23	39.2	518.6	24.89	542.71	39.98

* Lead detections in drill bit samples have been determined to be false positive results.

Table E-1. XRF Data, PZ-13 Lead Investigation, WIPP Site

Reading No	Time	Type	Duration	Units	SAMPLE	LOCATION	NOTE	Hg	Hg Error	Zn	Zn Error	W	W Error	Cu	Cu Error	Ni	Ni Error	Co	Co Error	Fe	Fe Error	Mn	Mn Error
1	7/7/2009 7:45	SHUTTER_CAL	57.96	cps																			
2	7/7/2009 7:47	SOIL	30.14	ppm	sio2 std			< LOD	8.08	22.95	9.76	< LOD	56.99	< LOD	20.38	< LOD	43.89	< LOD	20.76	< LOD	48.7	< LOD	59.04
3	7/7/2009 7:49	SOIL	0.45	ppm	sio2 std			< LOD	9.89	< LOD	6.99	< LOD	115.7	< LOD	23.36	< LOD	625.03	< LOD	6001.26	< LOD	59353.77	< LOD	264.13
4	7/7/2009 7:51	SOIL	30.47	ppm	rcra8			< LOD	13.84	81.44	20.39	< LOD	101.62	< LOD	40.93	< LOD	85.83	< LOD	310.03	47593.32	726.05	1090.16	167.05
5	7/7/2009 7:53	SOIL	30.44	ppm	rock			< LOD	13.5	70.45	19.75	< LOD	91.48	< LOD	42.56	< LOD	87.41	< LOD	329.15	49277.83	764.62	1083.4	171.52
6	7/7/2009 7:58	SOIL	30.47	ppm	pz-13	0-2.5		< LOD	9.49	< LOD	12.31	< LOD	60.53	< LOD	24.27	< LOD	48.88	< LOD	53.71	1398.91	112.8	< LOD	68.21
7	7/7/2009 8:02	SOIL	30.14	ppm	pz-13	0-2.5		< LOD	9.15	< LOD	12.48	< LOD	65.59	< LOD	21.68	< LOD	49.57	< LOD	51.36	1525.68	112.15	< LOD	70.79
8	7/7/2009 8:06	SOIL	30.15	ppm	pz-13	2.5-3		< LOD	8.79	< LOD	11.67	< LOD	61.92	< LOD	21.66	< LOD	47.93	< LOD	55.21	1979.05	125.09	< LOD	71.25
9	7/7/2009 8:10	SOIL	60.47	ppm	pz-13	3-5	berino	< LOD	10.96	24.9	12.79	< LOD	82.32	< LOD	29.42	< LOD	63.88	< LOD	136.83	11640.97	328.25	138.29	72.87
10	7/7/2009 8:15	SOIL	60.43	ppm	pz-13	6.5-7.5	mescalero	< LOD	12.04	< LOD	18.63	< LOD	79.82	< LOD	29.09	< LOD	60.41	< LOD	70.89	2491.97	167.89	< LOD	93.6
11	7/7/2009 8:19	SOIL	60.3	ppm	pz-13	7.5-8.5	mescalero	< LOD	13.55	< LOD	18.25	< LOD	90.95	< LOD	38.82	< LOD	79.02	< LOD	80.81	2252.54	184.41	127.47	77.43
12	7/7/2009 8:23	SOIL	60.43	ppm	pz-13	7.5-10	mescalero	< LOD	13.96	< LOD	15.87	< LOD	90.3	< LOD	35.88	< LOD	73.16	< LOD	78.3	2172.62	169.46	< LOD	97.23
13	7/7/2009 8:27	SOIL	60.15	ppm	pz-13	10-12.5	mescalero	< LOD	10.47	< LOD	16.8	< LOD	75.33	< LOD	29.52	< LOD	60.67	142.74	78.07	7076.41	254.58	< LOD	92.76
14	7/7/2009 8:33	SOIL	60.36	ppm	pz-13	12.5-15	gatuna	< LOD	12.06	< LOD	18.96	< LOD	82.72	< LOD	32.63	< LOD	66.31	< LOD	81.37	3557.53	197.15	158.1	71.71
15	7/7/2009 8:38	SOIL	60.38	ppm	pz-13	15-17.5	gatuna	< LOD	12.67	< LOD	20.98	< LOD	89.79	< LOD	37.62	< LOD	69.89	< LOD	74.8	1785.52	164.01	281.64	93.81
16	7/7/2009 8:43	SOIL	60.38	ppm	pz-13	17.5-20	gatuna	< LOD	12.08	< LOD	18.46	< LOD	81.03	< LOD	32.72	< LOD	65.16	< LOD	141.32	10986.91	331.24	348.46	94.43
17	7/7/2009 8:46	SOIL	60.43	ppm	pz-13	20-22.5	gatuna	< LOD	10.07	20.17	11.79	< LOD	73.97	< LOD	31.46	< LOD	61.36	< LOD	118.88	8614.44	280.94	97.11	64.37
18	7/7/2009 8:50	SOIL	60.41	ppm	pz-13	25-27.5	gatuna	< LOD	10.43	< LOD	15.78	< LOD	73.72	< LOD	29.32	< LOD	66.61	< LOD	111.71	7018.49	258.27	140.85	69.38
19	7/7/2009 8:53	SOIL	60.44	ppm	pz-13	27.5-30	gatuna	< LOD	10.39	< LOD	16.48	< LOD	73.39	< LOD	27.81	< LOD	57.47	< LOD	104.58	6670.35	246.13	303.1	82.4
20	7/7/2009 8:59	SOIL	60.22	ppm	pz-13	22.5-25	gatuna	< LOD	10.68	19.08	11.75	< LOD	72.36	< LOD	31.53	< LOD	67.81	< LOD	118.69	7995.49	277.83	199.48	76.04
21	7/7/2009 9:02	SOIL	60.29	ppm	pz-13	30-31	gatuna	< LOD	10.48	27.65	12.18	< LOD	70.11	< LOD	28.56	< LOD	57.08	< LOD	125.02	9436.74	285	305.19	82.54
22	7/7/2009 9:06	SOIL	60.35	ppm	pz-13	30-32.5	gatuna	< LOD	10.99	24.28	12	< LOD	71.28	< LOD	27.75	< LOD	60.64	< LOD	132.4	11218.61	314.73	173.05	72.19
23	7/7/2009 9:14	SOIL	60.45	ppm	pz-13	32.5-35	gatuna	< LOD	11.29	25.18	12.99	< LOD	80.39	< LOD	30.27	< LOD	60.93	< LOD	131.79	10164.77	312.66	154.5	72.72
24	7/7/2009 9:18	SOIL	60.53	ppm	pz-13	35-37	gatuna	< LOD	10.43	40.82	13.94	< LOD	75.66	< LOD	31.77	< LOD	65	< LOD	156.21	15580.88	370.94	210.48	79.55
25	7/7/2009 9:22	SOIL	0.44	ppm	pz-13	37-39	gatuna	< LOD	638.76	< LOD	433.41	< LOD	6888.11	< LOD	1660.93	< LOD	38331.99	< LOD	90.69	< LOD	122.68	< LOD	50
26	7/7/2009 9:23	SOIL	60.24	ppm	pz-13	37-39	gatuna	< LOD	11.19	33.17	13.31	< LOD	73.22	< LOD	31.58	< LOD	58.3	< LOD	134.41	10541	310.23	327.18	88.72
27	7/7/2009 9:28	SOIL	60.39	ppm	pz-13	39.8-40	santa rosa	< LOD	12.97	42.8	16.18	< LOD	91.41	< LOD	35.63	< LOD	72.7	< LOD	138.04	9978.29	333.69	334.38	98.29
28	7/7/2009 9:33	SOIL	60.49	ppm	pz-13	40-42.5	santa rosa	< LOD	10.38	33.85	13.57	< LOD	80.01	< LOD	30.66	< LOD	64.57	< LOD	175.63	19424.88	418.91	331.62	92.88
29	7/7/2009 9:40	SOIL	60.4	ppm	pz-13	42.5-43.5	santa rosa	< LOD	11.39	30.6	13.3	< LOD	76.07	< LOD	30.5	< LOD	62.99	< LOD	142.11	11722.51	334.55	249.57	83.35
30	7/7/2009 9:43	SOIL	60.47	ppm	pz-13	43.5-45	santa rosa	< LOD	10.47	17.22	11.18	< LOD	70.34	< LOD	29.8	< LOD	61.96	< LOD	141.58	12999.57	337.48	313.03	85.24
31	7/7/2009 9:47	SOIL	60.23	ppm	pz-13	45-46	santa rosa	< LOD	10.7	30.6	12.79	< LOD	70.7	< LOD	30.2	< LOD	56.11	< LOD	142.01	12709.64	337.62	292.94	84.77
32	7/7/2009 9:50	SOIL	60.43	ppm	pz-13	46-47	santa rosa	< LOD	11.39	47.32	14.83	< LOD	77.86	< LOD	27.95	< LOD	66.97	< LOD	155.75	14876.06	372.76	302.32	90.31
33	7/7/2009 9:55	SOIL	60.55	ppm	pz-13	52-53	santa rosa	< LOD	10.81	28.21	12.66	< LOD	74.94	< LOD	30.22	< LOD	61.62	< LOD	143.42	12846.53	337.92	464.74	98.71
34	7/7/2009 9:59	SOIL	60.31	ppm	pz-13	59.5-59.7	santa rosa	< LOD	10.92	< LOD	15.99	< LOD	72.61	< LOD	28.86	< LOD	57.43	< LOD	93.96	5260.61	221.38	260.39	77.71
35	7/7/2009 10:03	SOIL	60.5	ppm	pz-13	65-67.5	santa rosa	< LOD	8.55	23.07	10.28	< LOD	55.12	< LOD	25.52	< LOD	49.88	< LOD	67.28	2977.64	154.16	175.72	62.44
36	7/7/2009 10:10	SOIL	60.62	ppm	pz-13	67.5	santa rosa	< LOD	9.7	< LOD	13.15	< LOD	64.37	< LOD	24.56	< LOD	54.2	< LOD	46.9	854.34	96.8	< LOD	75.07
37	7/7/2009 10:21	SOIL	60.58	ppm	pz-13	74-75	dewey lake	< LOD	12.98	118.45	22.21	< LOD	88.42	< LOD	37.72	< LOD	82.9	< LOD	302.6	47468.98	713.64	371.3	116.93
38	7/7/2009 10:34	SOIL	60.57	ppm	pz-13	76-77	dewey lake	< LOD	12.4	128.52	22.1	< LOD	89.15	< LOD	36.46	< LOD	75.9	< LOD	260.11	38121.94	613.9	430.41	112.76
39	7/7/2009 10:38	SOIL	60.77	ppm	pz-13	76-77	dewey lake green	< LOD	12.02	115.96	20.66	< LOD	82.77	< LOD	35.28	< LOD	72.3	< LOD	183.58	18517.82	421.89	276.85	90.65
40	7/7/2009 11:02	SOIL	60.43	ppm	pz-14	70-70.5	dewey lake	< LOD	11.16	< LOD	17.73	< LOD	82.76	< LOD	32.68	< LOD	62.53	< LOD	108.14	6393.5	244.93	245.15	77.74
41	7/7/2009 11:06	SOIL	60.83	ppm	pz-14	70.5-70.88	dewey lake	< LOD	11.49	51.52	14.99	< LOD	74.1	< LOD	32.66	< LOD	68.44	< LOD	165.2	16379.65	386.38	608.85	111.08
42	7/7/2009 11:11	SOIL	60.88	ppm	pz-14	71-72	dewey lake	< LOD	12.72	77.75	18.78	< LOD	90.16	< LOD	33.7	< LOD	75.73	259.24	165.2	31797.24	570.5	489.26	116.44
43	7/7/2009 11:20	SOIL	60.11	ppm	pz-14	72.5-73	dewey lake	< LOD	12.52	22.34	12.93	< LOD	82.67	< LOD	30.23	< LOD	69.95	< LOD	204.66	24856.52	491.85	986.46	141.69
44	7/7/2009 11:30	SOIL	60.59	ppm	pz-14	73-73.5	dewey lake	< LOD	13.32	82.39	20.61	< LOD	94.72	< LOD	40.32	< LOD	84.81	< LOD	270.49	34431.61	641.54	456.28	125.45
45	7/7/2009 11:38	SOIL	61.3	ppm	pz-14	73-73.5	dewey lake green	< LOD	11.22	71.98	17.08	< LOD	82.01	< LOD	31.21	< LOD	67.15	< LOD	149.96	12649.21	343.49	466.06	100.92
46	7/7/2009 11:49	SOIL	60.25	ppm	pz-14	70.8-71	dewey lake	< LOD	12.58	65.55	16.59	< LOD	86.42	< LOD	31.28	< LOD	63.38	< LOD	164.08	16712.69	385.58	275.37	85.83
47	7/7/2009 11:57	SOIL	60.61	ppm	pz-15	45-45.3	gatuna	< LOD	10.36	44.6	13.61	< LOD	69.49	< LOD	28.35	< LOD	56.7	< LOD	158.84	17710.72	380.67	215.42	77.57
48	7/7/2009 12:04	SOIL	60.55	ppm	pz-15	50.5-52	gatuna green	< LOD	10.71	74.23	16.55	< LOD	73.39	< LOD	32.24	< LOD	66.9	< LOD	150.07	14502.3	357.48	455.29	98.34
49	7/7/2009 12:09	SOIL	60.42	ppm	pz-15	50.5-52	gatuna	< LOD	10.84	51.42	14.83	< LOD	76.17	< LOD	29.05	< LOD	63.45	< LOD	161.91	17166.96	388.09	271.05	84.66
50	7/7/2009 14:03	SHUTTER_CAL	56.04	cps																			
51	7/7/2009 14:09	SOIL	60.21	ppm	erda-9	60-65	dewey lake	< LOD	13.18	141.83	23.59	< LOD	91.76	< LOD	36.54	< LOD	76.91	< LOD	288.94	44674.8	680.91	430.98	118.85
52	7/7/2009 14:13	SOIL	60.17	ppm	erda-9	65-70	dewey lake	< LOD	13.61	76.57	19.07	< LOD	93.47	< LOD	35.25	< LOD	76.54	< LOD	213.55	23120.63	497.43	1182.4	158.68
53	7/7/2009 14:17	SOIL	60.6	ppm	erda-9	70-75	dewey lake	< LOD	13.46	100.42	20.86	< LOD	92.64	< LOD	41.94	< LOD	77.61	< LOD	232.4	28433.28	545.89	667.55	127.71
54	7/7/2009 14:21	SOIL	60.38	ppm	erda-9	75-80	dewey lake	< LOD	14.4	86.43	20.28	< LOD	92.57	< LOD	36.65	< LOD	81.01	< LOD	250.26	30990.15	587.82	337.05	109.94
55	7/7/2009 14:25	SOIL	60.39	ppm	erda-9	80-85	dewey lake	< LOD	14.77	103.65	22.24	< LOD	97.13	< LOD	39.55	< LOD	83.34	< LOD	255.09	31353.53	605.5	458.46	122.86
56	7/7/2009 14:28	SOIL	60.23	ppm	erda-9	85-90	dewey lake	< LOD	11.67	145.87	23.31	< LOD	89.32	< LOD	34.29	< LOD	77.97	< LOD	289.3	45116.16	671.58	576.34	126.4
57	7/7/2009 14:31	SOIL	60.66	ppm	erda-9	90-95	dewey lake	< LOD	13.36	109.69	22.56	< LOD	94.28	< LOD	43.09	< LOD	85.71	< LOD	265.93	32393.74	613.86	365.14	114.37
58	7/7/2009 14:35	SOIL	60.43	ppm	erda-9	95-100	dewey lake	< LOD	14.22	69.62	19.35	< LOD	101.5	< LOD	38.56	< LOD	83	< LOD	230.01	25628.28	540.5	861.74	147.09
59	7/7/2009 14:38	SOIL	60.14	ppm	erda-9	100-105	dewey lake	< LOD	12.67	104.01	20.86	< LOD	86.57	< LOD	38.73	< LOD	77.92	< LOD	257.13	35460.59	609.24	446.45	116.31

Table E-1. XRF Data, PZ-13 Lead Investigation, WIPP Site

Reading No	Time	Type	Duration	Units	SAMPLE	LOCATION	NOTE	Hg	Hg Error	Zn	Zn Error	W	W Error	Cu	Cu Error	Ni	Ni Error	Co	Co Error	Fe	Fe Error	Mn	Mn Error
60	7/7/2009 14:41	SOIL	60.25	ppm	erda-9	105-110	dewey lake	< LOD	13.76	96.27	21.71	< LOD	99.16	< LOD	42.68	< LOD	82.14	< LOD	263.88	33990.44	628.17	509.27	126.19
61	7/7/2009 14:45	SOIL	60.95	ppm	erda-9	110-115	dewey lake	< LOD	13.92	63.72	18.55	< LOD	93.63	< LOD	38.63	< LOD	76.95	< LOD	202.36	18973.29	466.34	672.6	131.32
62	7/7/2009 14:48	SOIL	60.44	ppm	erda-9	115-120	dewey lake	< LOD	11.41	39.41	14.85	< LOD	81.1	< LOD	37.12	< LOD	69.58	< LOD	175.37	16883.34	412.95	643.48	119.62
63	7/7/2009 14:51	SOIL	60.46	ppm	erda-9	120-125	dewey lake	< LOD	12.05	64.73	17.54	< LOD	87.95	< LOD	36.74	< LOD	79.87	< LOD	241.34	32736.61	578.61	636.3	126.75
64	7/7/2009 14:55	SOIL	60.57	ppm	erda-9	125-130	dewey lake	< LOD	12.75	54.85	16.53	< LOD	87.22	< LOD	34.16	< LOD	73.75	< LOD	177.38	17087.97	416.6	808.24	130.68
65	7/7/2009 15:02	SOIL	60.38	ppm	erda-9	2133-2135	salado	< LOD	16.97	< LOD	20.24	< LOD	111.16	< LOD	42.54	< LOD	82.78	< LOD	51.69	307.74	105.04	< LOD	103.65
66	7/7/2009 15:07	SOIL	60.6	ppm	erda-9	2133-2135b	salado	< LOD	15.73	< LOD	21.62	< LOD	101.02	< LOD	39.31	< LOD	84.94	< LOD	63.52	1166.38	146.26	< LOD	100.95
67	7/7/2009 15:12	SOIL	60.38	ppm	erda-9	485-490	salado	< LOD	11.87	39.94	14.91	< LOD	82.7	< LOD	34.52	< LOD	72.8	< LOD	164.2	14886.5	388.01	197.06	83.16
68	7/7/2009 15:15	SOIL	60.69	ppm	erda-9	460-465	salado	< LOD	11.55	33.98	13.85	< LOD	81.9	< LOD	30.21	< LOD	70.46	< LOD	173.4	17457.92	405.19	401.23	98.98
69	7/7/2009 15:19	SOIL	60.54	ppm	erda-9	430-435	salado	< LOD	12.39	19.4	12.67	< LOD	81.43	< LOD	32.02	< LOD	66.84	< LOD	164.8	14619.57	378.99	330.27	93.69
70	7/7/2009 15:23	SOIL	60.37	ppm	erda-9	420-425	salado	< LOD	12.43	25.92	14.1	< LOD	90.38	< LOD	36.44	< LOD	69.85	< LOD	167.2	14639.03	389.54	511.98	111.27
71	7/8/2009 8:29	SHUTTER_CAL	58.05	cps																			
72	7/8/2009 8:46	SOIL	60.37	ppm	mu 0	room 2	red arg	< LOD	14.54	< LOD	16.47	< LOD	107.6	< LOD	41.07	< LOD	84.97	< LOD	75.29	1421.13	152.81	< LOD	94.72
73	7/8/2009 8:50	SOIL	60.46	ppm	mu 0	room 2	mu 1	< LOD	15.12	< LOD	19.31	< LOD	107.72	< LOD	37.47	< LOD	83.42	< LOD	42.94	< LOD	101.29	< LOD	92.79
74	7/8/2009 8:53	SOIL	60.67	ppm	mu 2	room 2	clay	< LOD	16.24	< LOD	23.17	< LOD	112.95	< LOD	42.49	< LOD	92.95	< LOD	97.25	3505.97	227.73	127.44	77.83
75	7/8/2009 8:56	SOIL	61.09	ppm	mu 3	room 2	halite	< LOD	17.3	< LOD	20.56	< LOD	123.45	< LOD	45.44	< LOD	92.76	< LOD	47.21	< LOD	114.44	< LOD	113.22
76	7/8/2009 8:59	SOIL	60.58	ppm	mu 3	room 2	red vein	< LOD	13.98	< LOD	19.38	< LOD	96.26	< LOD	42.46	< LOD	86.15	< LOD	47.19	< LOD	117.51	< LOD	92.34
77	7/8/2009 9:02	SOIL	60.58	ppm	mu 4	room 2	clay red	< LOD	15.63	< LOD	20.09	< LOD	113.93	< LOD	45.45	< LOD	89.88	< LOD	93.65	2785.99	214.83	179.34	89.52
78	7/8/2009 9:07	SOIL	60.41	ppm	mu 5	room 2	clay gray	< LOD	16.77	< LOD	19.41	< LOD	112.44	< LOD	40.73	< LOD	82.56	< LOD	61.43	761.46	130.84	< LOD	114.86
79	7/8/2009 9:10	SOIL	60.33	ppm	map unit 6	room 2		< LOD	15.31	< LOD	22.45	< LOD	118.03	< LOD	41.02	< LOD	87.61	< LOD	45.1	< LOD	108.85	< LOD	94.92
80	7/8/2009 9:31	SOIL	60.4	ppm	map unit 0	room 4		< LOD	15.24	< LOD	18.42	< LOD	106.55	< LOD	42.95	< LOD	85.01	< LOD	50.66	141.4	93.37	< LOD	108.44
81	7/8/2009 9:33	SOIL	95.25	ppm	map unit 1	room 4		< LOD	12.6	< LOD	16.78	< LOD	90.45	< LOD	33.38	< LOD	71.32	< LOD	41.12	129.18	73	< LOD	77.36
82	7/8/2009 9:36	SOIL	91	ppm	map unit 2	room 4		< LOD	16.17	< LOD	21.57	< LOD	115.35	< LOD	49.86	< LOD	97.16	< LOD	45.52	< LOD	126.63	< LOD	107.78
83	7/8/2009 9:40	SOIL	95.59	ppm	map unit 3	room 4		< LOD	13.9	< LOD	18.39	< LOD	96.77	< LOD	33.42	< LOD	78.21	< LOD	35.22	< LOD	88.71	< LOD	85.96
84	7/8/2009 9:43	SOIL	91.85	ppm	map unit 4	room 4		< LOD	13.06	< LOD	19.22	< LOD	91.25	< LOD	36.56	< LOD	78.52	< LOD	88.75	3536.89	200.39	< LOD	97.5
85	7/8/2009 9:47	SOIL	95.37	ppm	map unit 5	room 4		< LOD	13.11	< LOD	18.98	< LOD	95.54	< LOD	36.56	< LOD	76.62	< LOD	119.71	7543.67	277.62	119.95	71.08
86	7/8/2009 9:50	SOIL	91.63	ppm	map unit 6	room 4		< LOD	15.61	< LOD	18.17	< LOD	107.52	< LOD	38.41	< LOD	85.74	< LOD	42.45	< LOD	112.49	< LOD	97.4
87	7/8/2009 9:58	SOIL	93.72	ppm	chain link			5199.65	1377.66	4383420.5	21852.24	< LOD	21322.28	3309	1674.08	< LOD	3282.98	6461.65	1886.77	< LOD	4878.6	< LOD	3947.71
88	7/8/2009 10:01	SOIL	95.58	ppm	chain link b			4897.57	1261.68	4496555.5	20040.16	< LOD	19591.07	< LOD	2114.25	< LOD	2974.29	6888.67	1749.52	5930.25	3023.35	< LOD	3514.52
89	7/8/2009 15:02	SOIL	91.15	ppm	dewey lake	nash draw		< LOD	10.4	34.19	12.11	< LOD	70.34	< LOD	26.91	< LOD	54.69	< LOD	132.15	12578.1	299.74	303.61	76.94
90	7/8/2009 15:05	SOIL	91.53	ppm	dewey lake b	nash draw		< LOD	14.81	< LOD	21.33	< LOD	101.04	< LOD	42.06	< LOD	82.07	< LOD	224.51	25309.2	520.97	566.43	126.66
91	7/8/2009 15:08	SOIL	92.16	ppm	dewey lakec	nash draw		< LOD	9.65	34.55	12.32	< LOD	71.37	< LOD	27.1	< LOD	58.16	< LOD	133.62	12875.39	309.38	300.79	77.76
92	7/8/2009 15:10	SOIL	92.34	ppm	dewey lake d	nash draw		< LOD	10.36	35.69	12.52	< LOD	71.75	< LOD	26.91	< LOD	58.88	< LOD	131.35	12857.83	312.21	330.93	81.2
93	7/8/2009 15:13	SOIL	61.18	ppm	dewey lake e	nash draw		< LOD	13.45	< LOD	20.9	< LOD	95.02	< LOD	33.85	< LOD	73.67	< LOD	147.86	10113.15	332.92	219.25	86.27
94	7/8/2009 15:15	SOIL	60.57	ppm	dewey lake f	nash draw		< LOD	11.23	31.49	13.3	< LOD	81.15	< LOD	28.69	< LOD	65.3	< LOD	150.8	14166.35	356.46	374.24	92.35
95	7/8/2009 15:18	SOIL	92.51	ppm	dewey lake g	nash draw		< LOD	13.46	< LOD	18.7	< LOD	91.94	< LOD	38.76	< LOD	79.39	< LOD	264.97	44163.55	631.76	988.73	145.19
96	7/8/2009 15:20	SOIL	91.32	ppm	dewey lake h	nash draw		< LOD	21.37	36.93	21.09	< LOD	138.19	< LOD	56.02	< LOD	121.18	< LOD	397.46	62903.63	958.88	1029.31	199.65
97	7/9/2009 10:57	SHUTTER_CAL	56.06	cps																			
98	7/9/2009 11:04	SHUTTER_CAL	60.07	cps																			
99	7/9/2009 11:06	SOIL	28.52	ppm	tricone *	stewart brothers	diamond teeth	< LOD	4648.14	< LOD	4578.45	2196541.5	22137.1	< LOD	2772.44	5548.04	3646.39	369867.66	7042.15	27715.8	2677.29	4871.67	2108.75
100	7/9/2009 11:08	SOIL	30.1	ppm	tricone *	stewart brothers	diamond teeth b	< LOD	3822.87	< LOD	3818.28	1826207.25	18256.21	< LOD	2314.21	4517.31	2999.76	293990.22	5721.99	60807.93	3333.53	< LOD	2201.1
101	7/9/2009 11:11	SOIL	91.04	ppm	tricone *	stewart brothers	tricone body	< LOD	127.31	< LOD	139.63	< LOD	1153.05	678.35	278.77	24632.57	1164.02	< LOD	6021.64	3002109.75	14574.85	35672.63	2491.55
102	7/9/2009 11:13	SOIL	60.87	ppm	tricone *	stewart brothers	slag	< LOD	46.01	157.66	60.09	< LOD	314.78	< LOD	154.87	< LOD	386.52	< LOD	2683.83	899885.44	6381.7	26129.02	1529.82
103	7/9/2009 11:18	SOIL	60.51	ppm	auger *	stewart brothers	round tooth	< LOD	4458.99	< LOD	4445.67	2199785.5	21212.24	< LOD	2606.36	< LOD	4675.13	204896.66	5101.68	60399.17	3516.55	4404.09	1952.4
104	7/9/2009 11:20	SOIL	60.68	ppm	auger *	stewart brothers	round tooth body	< LOD	89.64	1180.79	211.02	< LOD	662.9	720.1	276.33	2209.49	674.06	< LOD	8150.28	3709354	20094.39	62173.61	3863.58
105	7/9/2009 11:23	SOIL	60.37	ppm	auger *	stewart brothers	flat tooth tip	< LOD	4490.53	< LOD	4468.6	2166685.5	21161.36	< LOD	2601.88	< LOD	4838.66	253646.66	5638.69	29621.36	2626.31	< LOD	2744.21
106	7/9/2009 11:25	SOIL	60.75	ppm	auger *	stewart brothers	flat tooth body	< LOD	108.83	< LOD	177.83	< LOD	714.54	1696.57	378.89	2819.98	831.52	< LOD	9631.76	4319783.5	23555.28	52680.71	4512
107	7/9/2009 11:28	SOIL	61.57	ppm	auger *	stewart brothers	slag	< LOD	69.17	584.66	124.88	< LOD	489.86	502.04	195.97	1771.26	479.96	< LOD	3738.98	1153783.88	9013.92	55613.91	5347.1
108	7/9/2009 11:30	SOIL	60.45	ppm	silica			< LOD	8.81	< LOD	10.74	< LOD	60.69	< LOD	23.7	< LOD	48.2	< LOD	25.5	< LOD	52.72	< LOD	59.25
109	7/9/2009 11:32	SOIL	60.55	ppm	rcra std			< LOD	14.43	63.97	18.89	< LOD	99.05	< LOD	42.55	< LOD	87.97	< LOD	307.37	46747.31	721.02	963.41	161.23
110	7/9/2009 11:34	SOIL	60.44	ppm	rcra std b			< LOD	13.6	72.9	19.32	< LOD	95.32	< LOD	41.16	< LOD	85.27	< LOD	300.85	46123.29	710.16	822.74	151.49
111	7/9/2009 11:36	SOIL	61.37	ppm	rcra std c			< LOD	14.24	78.49	19.84	< LOD	92.88	< LOD	41.94	< LOD	84.81	< LOD	305.76	47469.1	725.32	897.07	156.59

* Lead detections in drill bit samples have been determined to be false positive results.

Table E-1. XRF Data, PZ-13 Lead Investigation, WIPP Site

Reading No	Time	Type	Duration	Units	SAMPLE	LOCATION	NOTE	Cr	Cr Error	V	V Error	Ti	Ti Error	Sc	Sc Error	Ca	Ca Error	K	K Error	S	S Error	Ba	Ba Error	Cs
1	7/7/2009 7:45	SHUTTER_CAL	57.96	cps																				
2	7/7/2009 7:47	SOIL	30.14	ppm	sio2 std																			
3	7/7/2009 7:49	SOIL	0.45	ppm	sio2 std																			
4	7/7/2009 7:51	SOIL	30.47	ppm	rcra8			< LOD	1534.9	< LOD	3319.97	< LOD	10332.63	< LOD	350.46	32003.68	17394.18	< LOD	22741.27	< LOD	1806.93			
5	7/7/2009 7:53	SOIL	30.44	ppm	rock			< LOD	547.15	< LOD	1097.05	< LOD	5237.5	< LOD	951.19	24199.12	11977.23	< LOD	21000.37	< LOD	1420.76			
6	7/7/2009 7:58	SOIL	30.47	ppm	pz-13	0-2.5		< LOD	187.98	< LOD	99.2	< LOD	1410.15	< LOD	51.92	< LOD	4012.15	< LOD	13578.89	< LOD	659.31			
7	7/7/2009 8:02	SOIL	30.14	ppm	pz-13	0-2.5																		
8	7/7/2009 8:06	SOIL	30.15	ppm	pz-13	2.5-3																		
9	7/7/2009 8:10	SOIL	60.47	ppm	pz-13	3-5	berino	< LOD	28.98	< LOD	44.97	1328.11	103.98	< LOD	11.32	1618.78	210.21	10538.59	503	< LOD	961.38			
10	7/7/2009 8:15	SOIL	60.43	ppm	pz-13	6.5-7.5	mescalero	< LOD	26.38	< LOD	42.54	207.98	126.84	< LOD	124.85	386172.16	2298.35	2151.42	601.13	4836.79	2896.07			
11	7/7/2009 8:19	SOIL	60.3	ppm	pz-13	7.5-8.5	mescalero	< LOD	25	< LOD	30.76	279.88	109.17	< LOD	126.98	400783.44	2342.1	2091.44	608.74	< LOD	4319.22			
12	7/7/2009 8:23	SOIL	60.43	ppm	pz-13	7.5-10	mescalero	< LOD	47.51	< LOD	60.55	359.82	189.23	< LOD	205.75	328371.66	3821.68	3306.58	1070.26	< LOD	7109.04			
13	7/7/2009 8:27	SOIL	60.15	ppm	pz-13	10-12.5	mescalero	< LOD	57.53	< LOD	83.87	1040.6	207.89	< LOD	136.15	146733.59	2564.73	9593.32	1139.28	< LOD	5000.68			
14	7/7/2009 8:33	SOIL	60.36	ppm	pz-13	12.5-15	gatuna	< LOD	25.04	< LOD	38.13	465.32	100.72	< LOD	84.46	207945.67	1559.96	3978.86	493.48	< LOD	2912.18			
15	7/7/2009 8:38	SOIL	60.38	ppm	pz-13	15-17.5	gatuna	< LOD	56.22	< LOD	119.75	690.04	318.82	< LOD	272.81	500590.34	5139.71	3555.92	1364.35	< LOD	8250.85			
16	7/7/2009 8:43	SOIL	60.38	ppm	pz-13	17.5-20	gatuna	< LOD	30.55	< LOD	50.47	1636.87	120.18	< LOD	33.6	31330.79	611.34	13903.59	595.96	< LOD	1537.84			
17	7/7/2009 8:46	SOIL	60.43	ppm	pz-13	20-22.5	gatuna	< LOD	28.13	< LOD	44.05	1466.43	103.61	< LOD	12.75	3358.77	243.39	9686.18	477.14	< LOD	823.88			
18	7/7/2009 8:50	SOIL	60.41	ppm	pz-13	25-27.5	gatuna	< LOD	30.82	< LOD	47.71	1219.45	120.44	< LOD	81.2	180967.22	1503.05	12700.54	681.08	< LOD	2857.41			
19	7/7/2009 8:53	SOIL	60.44	ppm	pz-13	27.5-30	gatuna	< LOD	28.02	< LOD	43.7	1137.79	102.07	< LOD	33.73	35330.11	631.63	10669.7	522.34	< LOD	1521.05			
20	7/7/2009 8:59	SOIL	60.22	ppm	pz-13	22.5-25	gatuna	< LOD	27.21	< LOD	42.05	1068.14	99.04	< LOD	37.84	43902.22	702.79	10477.81	525.8	< LOD	1539.88			
21	7/7/2009 9:02	SOIL	60.29	ppm	pz-13	30-31	gatuna	86.47	49.17	< LOD	116.08	1583.9	266.09	< LOD	94.17	64165	1718.36	16331.86	1310.39	< LOD	4417.05			
22	7/7/2009 9:06	SOIL	60.35	ppm	pz-13	30-32.5	gatuna	< LOD	31.53	< LOD	56.17	1943.71	131.84	< LOD	22.13	11327.29	400.67	15527.89	621.51	< LOD	1526.67			
23	7/7/2009 9:14	SOIL	60.45	ppm	pz-13	32.5-35	gatuna	< LOD	28.86	< LOD	48.8	1713.37	118.56	< LOD	40.74	48451.25	750.99	12676.82	582.43	< LOD	1653.07			
24	7/7/2009 9:18	SOIL	60.53	ppm	pz-13	35-37	gatuna	< LOD	69.12	< LOD	117.91	2313.42	296.17	< LOD	124.39	116176.88	2310.34	15823.87	1353.22	16385.75	4919.39			
25	7/7/2009 9:22	SOIL	0.44	ppm	pz-13	37-39	gatuna																	
26	7/7/2009 9:23	SOIL	60.24	ppm	pz-13	37-39	gatuna	< LOD	64.53	< LOD	121.94	2475.08	294.38	< LOD	91.45	60558.2	1673.13	18636.78	1384.84	< LOD	3211.71			
27	7/7/2009 9:28	SOIL	60.39	ppm	pz-13	39.8-40	santa rosa	< LOD	31.21	< LOD	51.45	1569.57	145.97	< LOD	109.28	288129.06	2003.01	14364.84	804.02	< LOD	3684.98			
28	7/7/2009 9:33	SOIL	60.49	ppm	pz-13	40-42.5	santa rosa	< LOD	36.44	< LOD	81.18	6102.23	211.07	< LOD	23.17	11350.37	428.63	17944.6	702.39	< LOD	1507.67	< LOD	1295.6	< LOD
29	7/7/2009 9:40	SOIL	60.4	ppm	pz-13	42.5-43.5	santa rosa	< LOD	29.66	< LOD	54.59	1940	129.88	< LOD	20.13	10360.01	380.35	16189.21	624.66	< LOD	1336.98			
30	7/7/2009 9:43	SOIL	60.47	ppm	pz-13	43.5-45	santa rosa	< LOD	32.63	< LOD	59.2	2548.46	144.95	< LOD	29.62	22235.88	547.76	20908.5	734.72	< LOD	1428.48			
31	7/7/2009 9:47	SOIL	60.23	ppm	pz-13	45-46	santa rosa	< LOD	41.78	< LOD	76.09	2348.96	188.92	< LOD	39.71	22909.53	724.26	20080.22	943.97	< LOD	1919.61			
32	7/7/2009 9:50	SOIL	60.43	ppm	pz-13	46-47	santa rosa	< LOD	32.39	< LOD	64.83	3542.34	166.27	< LOD	34.06	28513.5	613.45	17982.05	694.12	< LOD	1657.9			
33	7/7/2009 9:55	SOIL	60.55	ppm	pz-13	52-53	santa rosa	< LOD	64.41	< LOD	115.36	2717.04	281.4	< LOD	55.13	22708.85	1004.14	19273.36	1287.85	< LOD	3327.01			
34	7/7/2009 9:59	SOIL	60.31	ppm	pz-13	59.5-59.7	santa rosa	< LOD	28.13	< LOD	42.53	862.16	98.74	< LOD	28.3	23919.31	523.18	15343.55	598.43	< LOD	1218.53			
35	7/7/2009 10:03	SOIL	60.5	ppm	pz-13	65-67.5	santa rosa	< LOD	27.34	< LOD	41.93	927.2	94.61	< LOD	29.23	25058.06	531.82	10677.66	507.94	4367	1280.34			
36	7/7/2009 10:10	SOIL	60.62	ppm	pz-13	67.5	santa rosa	27.82	18.19	< LOD	24.03	173.78	51.23	< LOD	12.42	3663.48	231	3182	289.96	17378.63	1949.28	1458.39	878.53	< LOD
37	7/7/2009 10:21	SOIL	60.58	ppm	pz-13	74-75	dewey lake	< LOD	56.98	< LOD	111.46	3895.87	262.16	< LOD	25.29	5130.43	488.43	32964.45	1281.46	< LOD	2330.89	< LOD	1567.4	< LOD
38	7/7/2009 10:34	SOIL	60.57	ppm	pz-13	76-77	dewey lake	< LOD	57.89	< LOD	115.93	3843.89	270.96	< LOD	28.25	7827.17	574.94	35156.62	1377.66	< LOD	2609.18	< LOD	956.31	< LOD
39	7/7/2009 10:38	SOIL	60.77	ppm	pz-13	76-77	dewey lake green	< LOD	49.56	< LOD	96.51	3457.59	234.48	< LOD	24.7	6825.56	492.26	30246.83	1184.35	< LOD	2152.58	788.52	423.15	< LOD
40	7/7/2009 11:02	SOIL	60.43	ppm	pz-14	70-70.5	dewey lake	< LOD	35.79	< LOD	58.02	871.14	131.94	< LOD	33.79	17241.93	620.97	9539.19	666	< LOD	1867.55			
41	7/7/2009 11:06	SOIL	60.83	ppm	pz-14	70.5-70.88	dewey lake	< LOD	44.75	< LOD	80.73	2430.73	194.15	< LOD	41.62	24466.63	769.13	20159.71	976.69	3010.7	1800.61	< LOD	679.41	< LOD
42	7/7/2009 11:11	SOIL	60.88	ppm	pz-14	71-72	dewey lake	< LOD	51.08	< LOD	100.31	3382.53	241.88	< LOD	34.55	14274.37	659.16	26960.3	1173.77	< LOD	2116.03	< LOD	558.55	< LOD
43	7/7/2009 11:20	SOIL	60.11	ppm	pz-14	72.5-73	dewey lake	< LOD	50.38	< LOD	126.67	6879.92	323.28	69.3	44.28	57356.79	1179.1	19955.26	1030.7	< LOD	2905.19			
44	7/7/2009 11:30	SOIL	60.59	ppm	pz-14	73-73.5	dewey lake	< LOD	61.21	< LOD	112.42	2954.35	280.51	< LOD	43.32	11341.07	760.79	19507.21	1301.1	< LOD	3061.59	< LOD	1875.96	< LOD
45	7/7/2009 11:38	SOIL	61.3	ppm	pz-14	73-73.5	dewey lake green	< LOD	48.46	< LOD	100.06	4564.04	248.02	< LOD	42.59	22911.85	767.28	34298.11	1257.92	< LOD	2139.41	1262.34	347.38	195.09
46	7/7/2009 11:49	SOIL	60.25	ppm	pz-14	70.8-71	dewey lake	< LOD	50.11	< LOD	106.4	4347.09	256.31	< LOD	26.97	6805.99	514.14	34400.28	1293.36	< LOD	2536.11			
47	7/7/2009 11:57	SOIL	60.61	ppm	pz-15	45-45.3	gatuna	< LOD	48.62	< LOD	91.41	2767.8	217.13	< LOD	47.93	28467.15	856.67	18757.84	985.92	< LOD	2285.41	< LOD	1164.69	< LOD
48	7/7/2009 12:04	SOIL	60.55	ppm	pz-15	50.5-52	gatuna green	39.08	25.14	< LOD	75.58	4222.35	185.83	< LOD	31.78	23812.34	587.88	27707.45	864.59	< LOD	1699.06			
49	7/7/2009 12:09	SOIL	60.42	ppm	pz-15	50.5-52	gatuna	< LOD	37.4	< LOD	73.85	3954.58	180.9	< LOD	34.13	27237.94	633.59	24684.66	837.32	< LOD	1859.57			
50	7/7/2009 14:03	SHUTTER_CAL	56.04	cps																				
51	7/7/2009 14:09	SOIL	60.21	ppm	erda-9	60-65	dewey lake	< LOD	52.93	< LOD	111.99	3863.22	265.91	< LOD	34.56	13519.26	670.04	33751.47	1328.63	< LOD	2547.09			
52	7/7/2009 14:13	SOIL	60.17	ppm	erda-9	65-70	dewey lake	< LOD	49.07	< LOD	98.2	2327.71	230.21	< LOD	67.62	62144.29	1229.22	22077.03	1084.16	< LOD	2826.71			
53	7/7/2009 14:17	SOIL	60.6	ppm	erda-9	70-75	dewey lake	< LOD	49.5	< LOD	95.53	3609.35	235.33	< LOD	47.27	32377.53	905.68	30557	1222.08	< LOD	2383.34			
54	7/7/2009 14:21	SOIL	60.38	ppm	erda-9	75-80	dewey lake	< LOD	49.18	< LOD	91.85	2960.74	220.58	< LOD	32.8	12197.55	610	26393.13	1146.07	< LOD	2145.55			
55	7/7/2009 14:25	SOIL	60.39	ppm	erda-9	80-85	dewey lake	< LOD	44.64	< LOD	83.9	2275.76	196.46	< LOD	31.44	12445.54	597.67	24519.62	1087.48	< LOD	1904.65			
56	7/7/2009 14:28	SOIL	60.23	ppm	erda-9	85-90	dewey lake	< LOD	61.07	135.4	81.93	4987.33	291.85	< LOD	40.37	15807.59	745.74	43770.81	1537.69	< LOD	2592.11			
57	7/7/2009 14:31	SOIL	60.66	ppm	erda-9	90-95	dewey lake	< LOD	49.28	< LOD	86.62	2643.72	210.29	< LOD	33.24	12220.19	607.8	26027.83	1136	< LOD	2134.15	< LOD	1038.53	< LOD
58	7/7/2009 14:35	SOIL	60.43	ppm	erda-9	95-100	dewey lake	< LOD	39.12	< LOD	71.17	1911.94	167.59	< LOD	43.35	29778.3	788.05	19935.28	919.3	< LOD	1868.25			
59	7/7/2009 14:38	SOIL	60.14	ppm	erda-9	100-105	dewey lake	< LOD	51.16	< LOD	100.14	3569.23	242.51	< LOD	39.72	19774.85	762.53	32397.42	1290.19	< LOD	2649.6			

Table E-1. XRF Data, PZ-13 Lead Investigation, WIPP Site

Reading No	Time	Type	Duration	Units	SAMPLE	LOCATION	NOTE	Cr	Cr Error	V	V Error	Ti	Ti Error	Sc	Sc Error	Ca	Ca Error	K	K Error	S	S Error	Ba	Ba Error	Cs
60	7/7/2009 14:41	SOIL	60.25	ppm	erda-9	105-110	dewey lake	< LOD	46.39	< LOD	91.77	2476.72	211.53	< LOD	32.55	12132.78	607.87	27074.86	1157.46	< LOD	2182.79			
61	7/7/2009 14:45	SOIL	60.95	ppm	erda-9	110-115	dewey lake	< LOD	55.53	< LOD	105	2134.87	247.17	< LOD	54.72	23187.13	1013.33	24076.15	1427.06	< LOD	2896.6	937.83	530.77	< LOD
62	7/7/2009 14:48	SOIL	60.44	ppm	erda-9	115-120	dewey lake	< LOD	28.41	< LOD	51.8	1771.38	124.1	< LOD	27.62	20332.1	516.84	29156.27	834.14	< LOD	1388.55			
63	7/7/2009 14:51	SOIL	60.46	ppm	erda-9	120-125	dewey lake	< LOD	49.68	< LOD	103.27	3737.73	246.23	< LOD	40.5	20366.47	755.83	30859.63	1243.1	< LOD	2405.49			
64	7/7/2009 14:55	SOIL	60.57	ppm	erda-9	125-130	dewey lake	< LOD	30.87	< LOD	53.92	1798.42	130.02	43.02	22.23	28039.83	601.23	30414.21	864.47	< LOD	1599.29	2106.68	1028.66	< LOD
65	7/7/2009 15:02	SOIL	60.38	ppm	erda-9	2133-2135	salado	248.52	32.44	< LOD	36.6	< LOD	113.17	< LOD	17.77	4756.18	329.64	1500.74	300.11	32908.88	3494.48			
66	7/7/2009 15:07	SOIL	60.6	ppm	erda-9	2133-2135b	salado	46.56	25.52	< LOD	46.41	< LOD	152.89	< LOD	23.89	8487.25	442.31	2978.63	404.96	35081.45	3818.02			
67	7/7/2009 15:12	SOIL	60.38	ppm	erda-9	485-490	salado	< LOD	40.89	< LOD	75.73	2184.09	179.64	< LOD	41.12	25591.27	778.43	12682.34	797.8	3286.3	1782.91			
68	7/7/2009 15:15	SOIL	60.69	ppm	erda-9	460-465	salado	< LOD	52.72	< LOD	105.93	3008.04	257.51	< LOD	63.67	39281.62	1193.84	23265.16	1317.08	7293	2948.97			
69	7/7/2009 15:19	SOIL	60.54	ppm	erda-9	430-435	salado	< LOD	37.75	< LOD	73.68	2689.88	182.21	< LOD	48.19	40050.66	888.89	17143.19	852.65	5559.82	1996.58			
70	7/7/2009 15:23	SOIL	60.37	ppm	erda-9	420-425	salado	< LOD	40.23	< LOD	73.25	2379.14	188.53	< LOD	53.5	41377.06	978.1	14942.9	872.43	8581.85	2451.83			
71	7/8/2009 8:29	SHUTTER_CAL	58.05	cps																				
72	7/8/2009 8:46	SOIL	60.37	ppm	mu 0	room 2	red arg	< LOD	23.73	< LOD	20.94	97.94	43.73	< LOD	10.09	1894.22	185.44	3478.51	297.82	14659.54	1784.16			
73	7/8/2009 8:50	SOIL	60.46	ppm	mu 0	room 2	mu 1	< LOD	29.2	< LOD	24.22	< LOD	66.05	< LOD	11.27	1123.29	221.59	4925.35	456.54	19616.67	2716.31			
74	7/8/2009 8:53	SOIL	60.67	ppm	mu 2	room 2	clay	< LOD	34.96	< LOD	37.7	342.52	79.81	< LOD	13.79	1860.32	281.08	9991.92	663.47	17327.07	2749.74	< LOD	1266.64	< LOD
75	7/8/2009 8:56	SOIL	61.09	ppm	mu 3	room 2	halite	< LOD	27.31	< LOD	25.41	< LOD	70.82	< LOD	13.68	2044.66	252.19	5104.02	461.82	22512.99	2881.61	< LOD	2156.29	< LOD
76	7/8/2009 8:59	SOIL	60.58	ppm	mu 3	room 2	red vein	< LOD	22.57	< LOD	15.54	60.93	32.86	21.24	13.5	11253.69	368.6	16902.25	604.12	36277.84	2774.94			
77	7/8/2009 9:02	SOIL	60.58	ppm	mu 4	room 2	clay red	< LOD	27.9	< LOD	31.43	181.67	72.38	< LOD	37.1	21557.43	667.39	4931.12	503.15	30950.11	3623.49			
78	7/8/2009 9:07	SOIL	60.41	ppm	mu 5	room 2	clay gray	< LOD	19.44	< LOD	20.45	182.4	41.8	< LOD	8.72	1103.59	163.41	3907.38	312.21	26858.19	2368.44			
79	7/8/2009 9:10	SOIL	60.33	ppm	map unit 6	room 2		118.81	36.93	< LOD	34.46	< LOD	93.16	< LOD	25.88	5500.6	488.41	4178.14	598.86	36513.91	5087.2			
80	7/8/2009 9:31	SOIL	60.4	ppm	map unit 0	room 4		< LOD	22.5	< LOD	17.93	109.66	34.65	< LOD	10.61	2571.62	200.6	4199.99	319.14	15680.39	1824.7			
81	7/8/2009 9:33	SOIL	95.25	ppm	map unit 1	room 4		< LOD	25.24	< LOD	19.51	< LOD	56.15	< LOD	10.79	2426.46	202.17	5048.49	346.86	18821.29	2004.52	389.11	57.63	107.67
82	7/8/2009 9:36	SOIL	91	ppm	map unit 2	room 4		< LOD	28.48	< LOD	26.62	< LOD	70.2	< LOD	11.8	1423.1	222.57	2461.09	345.22	17922.58	2580.19	464.06	64.32	158.39
83	7/8/2009 9:40	SOIL	95.59	ppm	map unit 3	room 4		52.96	17.2	< LOD	17.14	< LOD	45.56	< LOD	9.42	1713.98	173.48	1765.25	231.44	20361.23	2056.81	616.62	66.06	182.59
84	7/8/2009 9:43	SOIL	91.85	ppm	map unit 4	room 4		< LOD	23.27	< LOD	23	236.09	49.58	< LOD	7.65	251.58	148.95	7662.02	418.54	15889.49	1873.45	429.54	59.71	129.8
85	7/8/2009 9:47	SOIL	95.37	ppm	map unit 5	room 4		< LOD	22.18	< LOD	28.11	378.72	59.66	< LOD	9.87	1507.46	191.78	10028.57	474.09	16278.96	1908.99	511.61	78.6	159.74
86	7/8/2009 9:50	SOIL	91.63	ppm	map unit 6	room 4		< LOD	28.92	< LOD	25.18	< LOD	69.75	< LOD	16.64	3384.55	321.98	9314.88	639	28971.04	3457.56	551.07	67.33	184.42
87	7/8/2009 9:58	SOIL	93.72	ppm	chain link			184.82	38.89	< LOD	39.94	< LOD	107.98	< LOD	18.37	2099.35	342.44	984.01	393.17	< LOD	2385.4	22593.39	8103.36	7889.71
88	7/8/2009 10:01	SOIL	95.58	ppm	chain link b			222.45	43.17	< LOD	54.25	< LOD	140.44	< LOD	16.54	1448.65	319.44	1913.73	485.15	4561.84	2138.96	11345.78	2755.03	3974.93
89	7/8/2009 15:02	SOIL	91.15	ppm	dewey lake	nash draw		< LOD	60.95	< LOD	123.36	3656.56	304.58	< LOD	60.63	30551.85	1155.59	23876.71	1434.85	4360.46	2728.78	799.94	62.33	92.02
90	7/8/2009 15:05	SOIL	91.53	ppm	dewey lake b	nash draw		< LOD	60.74	< LOD	139.93	5809.2	367.22	< LOD	81.97	56186	1508.68	13373.27	1125.08	22900.46	4784.46	1348.72	72.61	128.82
91	7/8/2009 15:08	SOIL	92.16	ppm	dewey lakec	nash draw		< LOD	39.37	< LOD	71.57	2081.38	185.04	< LOD	74.29	78700.2	1341.14	15514.13	918.26	43165.03	4761	694.7	61.82	124.83
92	7/8/2009 15:10	SOIL	92.34	ppm	dewey lake d	nash draw		< LOD	35.32	< LOD	61.15	1866.28	158.92	< LOD	65.8	72760.48	1183.33	14014.32	803.81	41962.24	4293.67	654.12	54.19	104.55
93	7/8/2009 15:13	SOIL	61.18	ppm	dewey lake e	nash draw		< LOD	52.17	< LOD	98.04	2680.02	251.54	< LOD	91.32	77400.77	1657.76	12875.77	1060.39	33845.75	5350.42	803.01	504.67	< LOD
94	7/8/2009 15:15	SOIL	60.57	ppm	dewey lake f	nash draw		< LOD	45.97	< LOD	95.35	4339.06	240.29	< LOD	43.4	25925.14	814.42	22587.01	1058.72	3122.58	1903.66	< LOD	1097.05	< LOD
95	7/8/2009 15:18	SOIL	92.51	ppm	dewey lake g	nash draw		146.49	43.35	< LOD	173.5	16073.12	463.52	< LOD	56.32	36506.58	994.22	17210.99	991.08	4850.27	2406.63	1149.14	65.83	167.67
96	7/8/2009 15:20	SOIL	91.32	ppm	dewey lake h	nash draw		121.18	41.66	< LOD	165.65	11924.61	447.27	< LOD	165.59	345681.53	3053.62	10729.01	1070.94	< LOD	6070.75	2839.48	115.03	271.15
97	7/9/2009 10:57	SHUTTER_CAL	56.06	cps																				
98	7/9/2009 11:04	SHUTTER_CAL	60.07	cps																				
99	7/9/2009 11:06	SOIL	28.52	ppm	tricone *	stewart brothers	diamond teeth																	
100	7/9/2009 11:08	SOIL	30.1	ppm	tricone *	stewart brothers	diamond teeth b																	
101	7/9/2009 11:11	SOIL	91.04	ppm	tricone *	stewart brothers	tricone body	349.86	141.54	< LOD	232.17	< LOD	715.65	< LOD	79.06	6586.44	1137.9	4218.38	1152.7	< LOD	7592.08	874.62	259.18	341.58
102	7/9/2009 11:13	SOIL	60.87	ppm	tricone *	stewart brothers	slag	64.32	39.76	< LOD	89.91	1918.7	220.9	< LOD	91.57	97783.06	1660.19	8824.34	845.4	< LOD	3814.89	< LOD	1020.51	< LOD
103	7/9/2009 11:18	SOIL	60.51	ppm	auger *	stewart brothers	round tooth	316.13	38.99	< LOD	54.9	651.3	123.68	< LOD	24.45	7297.31	442.55	2804.47	426.6	3704.68	1605.49	< LOD	2140.52	< LOD
104	7/9/2009 11:20	SOIL	60.68	ppm	auger *	stewart brothers	round tooth body	245.52	131.08	< LOD	236.51	< LOD	755.88	< LOD	82.21	13122.98	1315.39	2846.08	1001.43	< LOD	7133.93	< LOD	9499.25	< LOD
105	7/9/2009 11:23	SOIL	60.37	ppm	auger *	stewart brothers	flat tooth tip	555.22	49.38	< LOD	54.72	452.45	117.61	< LOD	30.62	11650.05	569.42	3309.91	483.16	< LOD	2149.06			
106	7/9/2009 11:25	SOIL	60.75	ppm	auger *	stewart brothers	flat tooth body	12513.63	461.49	< LOD	292.83	< LOD	906.92	< LOD	73.39	< LOD	1197.68	2161.61	1094.8	< LOD	8406	1366.32	751.82	353.18
107	7/9/2009 11:28	SOIL	61.57	ppm	auger *	stewart brothers	slag	118551.32	1018.76	< LOD	309.01	12033.75	754.29	< LOD	67.92	9013.49	1029.55	5635.8	1137.91	< LOD	6297.61	2386.72	1040.99	682.65
108	7/9/2009 11:30	SOIL	60.45	ppm	silica			< LOD	24.17	< LOD	20.52	< LOD	49.32	< LOD	7.82	330.59	136.74	< LOD	185.46	< LOD	772.39			
109	7/9/2009 11:32	SOIL	60.55	ppm	rcra std			357.99	67.05	< LOD	144.37	3933.71	346.41	< LOD	72.62	36622.63	1306.91	20250.02	1393.15	< LOD	3459.63	< LOD	1305.75	< LOD
110	7/9/2009 11:34	SOIL	60.44	ppm	rcra std b			441.41	55.89	< LOD	120.68	3882.71	283.79	< LOD	55.51	35653.49	1014.89	21927.82	1132.21	< LOD	3019.51	< LOD	1309.9	< LOD
111	7/9/2009 11:36	SOIL	61.37	ppm	rcra std c			388.19	51.47	< LOD	112.8	3972.68	269.11	< LOD	53.84	36124.85	973.62	20857.25	1057.11	< LOD	2722.94	< LOD	477.13	< LOD

* Lead detections in drill bit samples have been determined to be false positive results.

Table E-1. XRF Data, PZ-13 Lead Investigation, WIPP Site

Reading No	Time	Type	Duration	Units	SAMPLE	LOCATION	NOTE	Cs Error	Te	Te Error	Sb	Sb Error	Sn	Sn Error	Cd	Cd Error	Ag	Ag Error	Pd	Pd Error
1	7/7/2009 7:45	SHUTTER_CAL	57.96	cps																
2	7/7/2009 7:47	SOIL	30.14	ppm	sio2 std															
3	7/7/2009 7:49	SOIL	0.45	ppm	sio2 std															
4	7/7/2009 7:51	SOIL	30.47	ppm	rcra8															
5	7/7/2009 7:53	SOIL	30.44	ppm	rock															
6	7/7/2009 7:58	SOIL	30.47	ppm	pz-13	0-2.5														
7	7/7/2009 8:02	SOIL	30.14	ppm	pz-13	0-2.5														
8	7/7/2009 8:06	SOIL	30.15	ppm	pz-13	2.5-3														
9	7/7/2009 8:10	SOIL	60.47	ppm	pz-13	3-5	berino													
10	7/7/2009 8:15	SOIL	60.43	ppm	pz-13	6.5-7.5	mescalero													
11	7/7/2009 8:19	SOIL	60.3	ppm	pz-13	7.5-8.5	mescalero													
12	7/7/2009 8:23	SOIL	60.43	ppm	pz-13	7.5-10	mescalero													
13	7/7/2009 8:27	SOIL	60.15	ppm	pz-13	10-12.5	mescalero													
14	7/7/2009 8:33	SOIL	60.36	ppm	pz-13	12.5-15	gatuna													
15	7/7/2009 8:38	SOIL	60.38	ppm	pz-13	15-17.5	gatuna													
16	7/7/2009 8:43	SOIL	60.38	ppm	pz-13	17.5-20	gatuna													
17	7/7/2009 8:46	SOIL	60.43	ppm	pz-13	20-22.5	gatuna													
18	7/7/2009 8:50	SOIL	60.41	ppm	pz-13	25-27.5	gatuna													
19	7/7/2009 8:53	SOIL	60.44	ppm	pz-13	27.5-30	gatuna													
20	7/7/2009 8:59	SOIL	60.22	ppm	pz-13	22.5-25	gatuna													
21	7/7/2009 9:02	SOIL	60.29	ppm	pz-13	30-31	gatuna													
22	7/7/2009 9:06	SOIL	60.35	ppm	pz-13	30-32.5	gatuna													
23	7/7/2009 9:14	SOIL	60.45	ppm	pz-13	32.5-35	gatuna													
24	7/7/2009 9:18	SOIL	60.53	ppm	pz-13	35-37	gatuna													
25	7/7/2009 9:22	SOIL	0.44	ppm	pz-13	37-39	gatuna													
26	7/7/2009 9:23	SOIL	60.24	ppm	pz-13	37-39	gatuna													
27	7/7/2009 9:28	SOIL	60.39	ppm	pz-13	39.8-40	santa rosa													
28	7/7/2009 9:33	SOIL	60.49	ppm	pz-13	40-42.5	santa rosa	385.36	< LOD	1167.98	< LOD	425.03	< LOD	379.31	< LOD	129.88	< LOD	128.04	< LOD	195.07
29	7/7/2009 9:40	SOIL	60.4	ppm	pz-13	42.5-43.5	santa rosa													
30	7/7/2009 9:43	SOIL	60.47	ppm	pz-13	43.5-45	santa rosa													
31	7/7/2009 9:47	SOIL	60.23	ppm	pz-13	45-46	santa rosa													
32	7/7/2009 9:50	SOIL	60.43	ppm	pz-13	46-47	santa rosa													
33	7/7/2009 9:55	SOIL	60.55	ppm	pz-13	52-53	santa rosa													
34	7/7/2009 9:59	SOIL	60.31	ppm	pz-13	59.5-59.7	santa rosa													
35	7/7/2009 10:03	SOIL	60.5	ppm	pz-13	65-67.5	santa rosa													
36	7/7/2009 10:10	SOIL	60.62	ppm	pz-13	67.5	santa rosa	382.43	< LOD	1218.3	< LOD	480.76	< LOD	406.97	< LOD	223.56	< LOD	153.52	< LOD	155.18
37	7/7/2009 10:21	SOIL	60.58	ppm	pz-13	74-75	dewey lake	462.41	< LOD	1463.92	< LOD	482.12	< LOD	408.25	< LOD	287.7	< LOD	215.8	< LOD	230.88
38	7/7/2009 10:34	SOIL	60.57	ppm	pz-13	76-77	dewey lake	277.12	< LOD	823.84	< LOD	302.5	< LOD	240.04	< LOD	116.14	< LOD	117.72	< LOD	174.01
39	7/7/2009 10:38	SOIL	60.77	ppm	pz-13	76-77	dewey lake green	188.61	< LOD	613.81	< LOD	216.85	< LOD	164.97	< LOD	110.89	< LOD	61.84	< LOD	143.94
40	7/7/2009 11:02	SOIL	60.43	ppm	pz-14	70-70.5	dewey lake													
41	7/7/2009 11:06	SOIL	60.83	ppm	pz-14	70.5-70.88	dewey lake	210.02	< LOD	653.8	< LOD	241.2	< LOD	190.83	< LOD	126.56	< LOD	79.15	< LOD	141.93
42	7/7/2009 11:11	SOIL	60.88	ppm	pz-14	71-72	dewey lake	171.63	< LOD	477.9	< LOD	178.01	< LOD	155.37	< LOD	96.43	< LOD	63.08	< LOD	93.11
43	7/7/2009 11:20	SOIL	60.11	ppm	pz-14	72.5-73	dewey lake													
44	7/7/2009 11:30	SOIL	60.59	ppm	pz-14	73-73.5	dewey lake	602.31	< LOD	2044.76	< LOD	688.75	< LOD	566.47	< LOD	359.53	< LOD	219.29	< LOD	336.64
45	7/7/2009 11:38	SOIL	61.3	ppm	pz-14	73-73.5	dewey lake green	101.14	< LOD	429.86	< LOD	156.53	< LOD	143.7	< LOD	79.37	< LOD	57.86	< LOD	88.55
46	7/7/2009 11:49	SOIL	60.25	ppm	pz-14	70.8-71	dewey lake													
47	7/7/2009 11:57	SOIL	60.61	ppm	pz-15	45-45.3	gatuna	351.91	< LOD	1017.61	< LOD	361.06	< LOD	311.33	< LOD	228.97	< LOD	134.07	< LOD	185.66
48	7/7/2009 12:04	SOIL	60.55	ppm	pz-15	50.5-52	gatuna green													
49	7/7/2009 12:09	SOIL	60.42	ppm	pz-15	50.5-52	gatuna													
50	7/7/2009 14:03	SHUTTER_CAL	56.04	cps																
51	7/7/2009 14:09	SOIL	60.21	ppm	erda-9	60-65	dewey lake													
52	7/7/2009 14:13	SOIL	60.17	ppm	erda-9	65-70	dewey lake													
53	7/7/2009 14:17	SOIL	60.6	ppm	erda-9	70-75	dewey lake													
54	7/7/2009 14:21	SOIL	60.38	ppm	erda-9	75-80	dewey lake													
55	7/7/2009 14:25	SOIL	60.39	ppm	erda-9	80-85	dewey lake													
56	7/7/2009 14:28	SOIL	60.23	ppm	erda-9	85-90	dewey lake													
57	7/7/2009 14:31	SOIL	60.66	ppm	erda-9	90-95	dewey lake	300.94	< LOD	959.54	< LOD	304.79	< LOD	247.26	< LOD	133.99	< LOD	107.74	< LOD	229.11
58	7/7/2009 14:35	SOIL	60.43	ppm	erda-9	95-100	dewey lake													
59	7/7/2009 14:38	SOIL	60.14	ppm	erda-9	100-105	dewey lake													

Table E-1. XRF Data, PZ-13 Lead Investigation, WIPP Site

Reading No	Time	Type	Duration	Units	SAMPLE	LOCATION	NOTE	Cs Error	Te	Te Error	Sb	Sb Error	Sn	Sn Error	Cd	Cd Error	Ag	Ag Error	Pd	Pd Error
60	7/7/2009 14:41	SOIL	60.25	ppm	erda-9	105-110	dewey lake													
61	7/7/2009 14:45	SOIL	60.95	ppm	erda-9	110-115	dewey lake	234.23	< LOD	690.75	< LOD	254.49	< LOD	219.73	< LOD	117.47	< LOD	85.57	< LOD	105.53
62	7/7/2009 14:48	SOIL	60.44	ppm	erda-9	115-120	dewey lake													
63	7/7/2009 14:51	SOIL	60.46	ppm	erda-9	120-125	dewey lake													
64	7/7/2009 14:55	SOIL	60.57	ppm	erda-9	125-130	dewey lake	444.85	< LOD	1238.23	< LOD	497.34	< LOD	436.17	< LOD	305.07	< LOD	194.74	< LOD	248.34
65	7/7/2009 15:02	SOIL	60.38	ppm	erda-9	2133-2135	salado													
66	7/7/2009 15:07	SOIL	60.6	ppm	erda-9	2133-2135b	salado													
67	7/7/2009 15:12	SOIL	60.38	ppm	erda-9	485-490	salado													
68	7/7/2009 15:15	SOIL	60.69	ppm	erda-9	460-465	salado													
69	7/7/2009 15:19	SOIL	60.54	ppm	erda-9	430-435	salado													
70	7/7/2009 15:23	SOIL	60.37	ppm	erda-9	420-425	salado													
71	7/8/2009 8:29	SHUTTER_CAL	58.05	cps																
72	7/8/2009 8:46	SOIL	60.37	ppm	mu 0	room 2	red arg													
73	7/8/2009 8:50	SOIL	60.46	ppm	mu 0	room 2	mu 1													
74	7/8/2009 8:53	SOIL	60.67	ppm	mu 2	room 2	clay	376.07	< LOD	1158.18	< LOD	378.57	< LOD	297.99	< LOD	201.95	< LOD	181.15	< LOD	168.22
75	7/8/2009 8:56	SOIL	61.09	ppm	mu 3	room 2	halite	698.3	< LOD	2045.77	< LOD	781.28	< LOD	664.87	< LOD	247.2	< LOD	312.66	< LOD	677.85
76	7/8/2009 8:59	SOIL	60.58	ppm	mu 3	room 2	red vein													
77	7/8/2009 9:02	SOIL	60.58	ppm	mu 4	room 2	clay red													
78	7/8/2009 9:07	SOIL	60.41	ppm	mu 5	room 2	clay gray													
79	7/8/2009 9:10	SOIL	60.33	ppm	map unit 6	room 2														
80	7/8/2009 9:31	SOIL	60.4	ppm	map unit 0	room 4														
81	7/8/2009 9:33	SOIL	95.25	ppm	map unit 1	room 4		18.34	162.2	55.11	40.47	19.61	53.23	16.71	< LOD	15.25	< LOD	10.28	< LOD	16.77
82	7/8/2009 9:36	SOIL	91	ppm	map unit 2	room 4		20.62	302.89	62.63	70.61	22.15	47.53	18.37	21.61	11.65	< LOD	11.44	< LOD	19.49
83	7/8/2009 9:40	SOIL	95.59	ppm	map unit 3	room 4		20.9	315.81	63.23	92.52	22.65	95.43	19.32	24.02	11.83	< LOD	11.47	23.7	13.46
84	7/8/2009 9:43	SOIL	91.85	ppm	map unit 4	room 4		19.04	217.61	57.44	50.71	20.37	58.32	17.31	< LOD	16.06	< LOD	10.59	< LOD	17.93
85	7/8/2009 9:47	SOIL	95.37	ppm	map unit 5	room 4		25.04	232.58	75.01	92.06	27.33	90.89	23.24	27.98	14.42	15.84	9.72	29.89	16.64
86	7/8/2009 9:50	SOIL	91.63	ppm	map unit 6	room 4		21.53	397.58	66.01	106.17	23.5	97.14	19.91	29.8	12.33	13.39	8.17	23.14	13.8
87	7/8/2009 9:58	SOIL	93.72	ppm	chain link			2708.13	16339.05	7573.1	< LOD	3769.77	4610.59	2202.32	< LOD	1928.6	1399.83	924.89	< LOD	2224.92
88	7/8/2009 10:01	SOIL	95.58	ppm	chain link b			897.7	8584.97	2639.71	2156.78	906.17	2313.76	794.2	< LOD	700.88	< LOD	436	< LOD	772.58
89	7/8/2009 15:02	SOIL	91.15	ppm	dewey lake	nash draw		18.63	149.91	56.21	41.68	20.08	33.64	16.83	< LOD	15.53	< LOD	10.52	< LOD	16.73
90	7/8/2009 15:05	SOIL	91.53	ppm	dewey lake b	nash draw		20.91	243.46	63.02	65.78	22.42	46.7	18.7	< LOD	17.4	< LOD	11.31	24.76	13.52
91	7/8/2009 15:08	SOIL	92.16	ppm	dewey lakec	nash draw		18.95	213.28	57.33	63.68	20.54	55.49	17.29	< LOD	15.89	< LOD	10.48	< LOD	18.15
92	7/8/2009 15:10	SOIL	92.34	ppm	dewey lake d	nash draw		16.59	175.83	50.1	40.81	17.8	60.35	15.29	< LOD	14.06	< LOD	9.34	< LOD	15.42
93	7/8/2009 15:13	SOIL	61.18	ppm	dewey lake e	nash draw		226.3	< LOD	755.27	< LOD	259.42	< LOD	219.27	< LOD	135.27	< LOD	90.26	< LOD	155.83
94	7/8/2009 15:15	SOIL	60.57	ppm	dewey lake f	nash draw		336.97	< LOD	1024.98	< LOD	373.96	< LOD	300.33	< LOD	214.38	< LOD	130.86	< LOD	243.79
95	7/8/2009 15:18	SOIL	92.51	ppm	dewey lake g	nash draw		19.52	282.48	58.77	73.58	20.89	62.8	17.58	21.42	10.93	< LOD	10.68	22.67	12.47
96	7/8/2009 15:20	SOIL	91.32	ppm	dewey lake h	nash draw		31.41	487.15	93.92	131.27	33.23	114.19	28.18	33.82	17.11	18.26	11.49	30.51	19.41
97	7/9/2009 10:57	SHUTTER_CAL	56.06	cps																
98	7/9/2009 11:04	SHUTTER_CAL	60.07	cps																
99	7/9/2009 11:06	SOIL	28.52	ppm	tricone *	stewart brothers	diamond teeth													
100	7/9/2009 11:08	SOIL	30.1	ppm	tricone *	stewart brothers	diamond teeth b													
101	7/9/2009 11:11	SOIL	91.04	ppm	tricone *	stewart brothers	tricone body	85.26	886.01	255.37	231.62	89.71	321.99	79.28	92.54	47.73	55.55	32.11	114.4	58.15
102	7/9/2009 11:13	SOIL	60.87	ppm	tricone *	stewart brothers	slag	338.27	< LOD	981.72	< LOD	355.87	< LOD	250.95	< LOD	164.45	< LOD	133.61	< LOD	285.71
103	7/9/2009 11:18	SOIL	60.51	ppm	auger *	stewart brothers	round tooth	736.58	< LOD	2105.08	< LOD	602.92	< LOD	610.93	< LOD	352.1	< LOD	99.73	< LOD	119.98
104	7/9/2009 11:20	SOIL	60.68	ppm	auger *	stewart brothers	round tooth body	3277.87	< LOD	10854.81	< LOD	2699.6	< LOD	3809.69	< LOD	740.78	< LOD	398.23	< LOD	3453.44
105	7/9/2009 11:23	SOIL	60.37	ppm	auger *	stewart brothers	flat tooth tip													
106	7/9/2009 11:25	SOIL	60.75	ppm	auger *	stewart brothers	flat tooth body	217.41	< LOD	1067.11	< LOD	464.45	< LOD	404.55	< LOD	314.26	< LOD	157.93	< LOD	422.91
107	7/9/2009 11:28	SOIL	61.57	ppm	auger *	stewart brothers	slag	317.15	1630.98	962.35	< LOD	499.41	601.34	336.48	< LOD	277.65	< LOD	212.85	< LOD	67.64
108	7/9/2009 11:30	SOIL	60.45	ppm	silica															
109	7/9/2009 11:32	SOIL	60.55	ppm	rcra std			424.3	< LOD	1330.55	< LOD	454.52	< LOD	443.4	608.63	301.06	805.71	300.43	< LOD	241.84
110	7/9/2009 11:34	SOIL	60.44	ppm	rcra std b			386.77	< LOD	1167.39	< LOD	444.11	< LOD	411.34	483.88	263.3	744.71	275.99	< LOD	305.32
111	7/9/2009 11:36	SOIL	61.37	ppm	rcra std c			150.37	< LOD	460.75	< LOD	168.7	< LOD	157.56	524.6	114.28	501.6	99	< LOD	118.82

* Lead detections in drill bit samples have been determined to be false positive results.

Table E-2. Microprobe Quantitative Analyses on Mineral Grains

Location	No.	Comment	Mass percent									
			SiO_2	P_2O_5	Al_2O_3	Fe_2O_3	K_2O	PbO	MgO	ZnO	CaO	Total
PZ-13 76'-77'	2	Hematite std	0.000	0.000	0.000	99.944	0.013	0.000	0.000	0.000	0.000	99.957
	3	DB76-77 Fe-oxide	2.528	0.153	0.693	85.221	0.151	0.156	0.302	0.011	0.136	89.351
	4	DB76-77 Fe-oxide Image 2	1.543	0.026	0.482	89.899	0.122	0.056	0.089	0.030	0.057	92.304
	5	DB76-77 Image 2 Clay ball	46.152	0.013	19.407	11.284	3.026	0.000	13.129	0.161	0.426	93.598
	6	DB76-77 Image 2 2nd Fe-oxide	6.193	0.112	2.144	66.691	0.289	0.006	3.593	0.041	0.586	79.655
	7	DB76-77 Image 2 monazite	2.709	23.417	0.671	0.611	0.258	0.049	0.055	0.000	0.243	28.013
	8	DB76-77 Image 1 Fe-oxide	3.587	0.003	0.778	90.455	0.137	0.036	0.318	0.637	0.068	96.019
	9	DB76-77 Fe-oxide	18.349	0.034	5.698	69.967	0.931	0.049	1.146	0.046	0.224	96.444
	10	DB76-77 Image 4 Fe-oxide 2	0.815	0.000	0.242	95.653	0.114	0.000	0.037	0.016	0.037	96.914
	11	DB76-77 Image 4 Zn 3	44.076	0.230	11.007	2.714	1.388	0.000	2.366	67.339	0.860	129.98
PZ-13 74'-75'	12	DB74-75 Image 1 round Fe-ox	1.806	0.042	0.464	87.317	0.092	0.087	0.003	0.062	0.256	90.129
	13	DB74-75 Image 1 round Fe-ox	2.298	0.074	1.608	83.336	0.072	0.057	0.635	0.035	0.343	88.458
	14	DB74-75 Image 1 round Fe-ox	10.949	0.291	0.499	75.901	0.099	0.142	0.152	0.100	1.174	89.307
	15	DB74-75 Image 1 round Fe-ox	0.191	0.007	0.993	94.532	0.074	0.000	0.140	0.000	0.063	96
	16	DB74-75 Image 1 round apatite	0.203	39.622	0.031	0.136	0.057	0.000	0.000	0.037	48.077	88.163
	17	DB74-75 Image 2 magnetite	0.322	0.007	0.705	93.918	0.048	0.025	0.361	0.083	0.047	95.516
	18	DB74-75 Image 2 blade Fe-ox	0.304	0.006	2.090	86.069	0.137	0.000	0.507	0.160	0.147	89.42
	19	DB74-75 Image 2 Fe-ox	2.732	0.009	1.546	86.168	0.157	0.026	1.208	0.027	0.107	91.98
	20	DB74-75 Image 2 Fe-ox core	0.863	0.003	0.657	87.093	0.058	0.038	0.000	0.000	0.022	88.734
	21	DB74-75 Image 2 Fe-ox rim	1.740	0.011	1.189	74.270	0.056	0.032	0.067	0.062	0.081	77.508
	22	DB74-75 Image 3 grunge Fe-ox	10.254	0.019	1.576	78.426	0.264	0.072	0.198	0.043	0.235	91.087
	23	DB74-75 Image 3 grunge Fe-ox	3.060	0.025	1.249	80.497	0.162	0.078	0.207	0.062	0.405	85.745
	24	DB74-75 Image 3 Fe-ox	0.163	0.000	0.126	96.709	0.096	0.000	0.000	0.008	0.012	97.114
	25	DB74-75 Image 3 Fe-ox	1.481	0.253	0.764	70.153	0.142	0.032	0.227	0.074	0.353	73.479
	26	DB74-75 Image 3 Fe-ox	3.552	0.026	0.539	79.925	0.122	0.086	0.322	0.035	0.185	84.792
		Minimum	0.000	0.000	0.000	0.136	0.013	0.000	0.000	0.000	0.000	---
		Maximum	46.152	39.622	19.407	99.944	3.026	0.156	13.129	67.339	48.077	---
		Average	6.635	2.575	2.206	71.476	0.323	0.041	1.002	2.763	2.166	---
		Sigma	12.326	9.020	4.248	31.449	0.639	0.044	2.660	13.454	9.569	---
		1-sigma Detection Limit Elm Wt%	0.019	0.007	0.012	0.011	0.008	0.012	0.028	0.017	0.010	---
		1-sigma DL Oxide Wt%	0.040	0.016	0.023	0.016	0.010	0.013	0.046	0.021	0.014	---

Appendix F

Laboratory Report for PZ-13 Repeat Sampling Event

HALL
ENVIRONMENTAL
ANALYSIS
LABORATORY

COVER LETTER

Monday, October 12, 2009

Rick Salness
Waste Isolation Pilot Plant
P.O. Box 2078
Carlsbad, NM 88221-2078

TEL: (575) 234-8966
FAX

RE: SSW PZ-13

Order No.: 0909384

Dear Rick Salness:

Hall Environmental Analysis Laboratory, Inc. received 7 sample(s) on 9/18/2009 for the analyses presented in the following report.

These were analyzed according to EPA procedures or equivalent. Below is a list of our accreditations. To access our accredited tests please go to www.hallenvironmental.com or the state specific web sites.

Reporting limits are determined by EPA methodology. No determination of compounds below these (denoted by the ND or < sign) has been made.

Please don't hesitate to contact HEAL for any additional information or clarifications.

Sincerely,

Andy Freeman, Laboratory Manager

NM Lab # NM9425
AZ license # AZ0682
ORELAP Lab # NM100001
Texas Lab# T104704424-08-TX

CLIENT: Waste Isolation Pilot Plant
Project: SSW PZ-13
Lab Order: 0909384

Work Order Sample Summary

Lab Sample ID	Client Sample ID	Batch ID	Test Name	Collection Date
0909384-01A	SSWPZ13091409N1	R35530	EPA Method 6010B: Dissolved Metals	9/14/2009 10:12:00 AM
0909384-01A	SSWPZ13091409N1	R35530	EPA Method 6010B: Dissolved Metals	9/14/2009 10:12:00 AM
0909384-01A	SSWPZ13091409N1	R35537	EPA Method 6010B: Dissolved Metals	9/14/2009 10:12:00 AM
0909384-01A	SSWPZ13091409N1	R35537	EPA Method 6010B: Dissolved Metals	9/14/2009 10:12:00 AM
0909384-01A	SSWPZ13091409N1	R35537	EPA Method 6010B: Dissolved Metals	9/14/2009 10:12:00 AM
0909384-01A	SSWPZ13091409N1	R35537	EPA Method 6010B: Dissolved Metals	9/14/2009 10:12:00 AM
0909384-01A	SSWPZ13091409N1	R35539	EPA Method 6010B: Dissolved Metals	9/14/2009 10:12:00 AM
0909384-01A	SSWPZ13091409N1	R35539	EPA Method 6010B: Dissolved Metals	9/14/2009 10:12:00 AM
0909384-01A	SSWPZ13091409N1	R35544	EPA Method 6010B: Dissolved Metals	9/14/2009 10:12:00 AM
0909384-01A	SSWPZ13091409N1	R35530	EPA Method 6010B: Dissolved Metals	9/14/2009 10:12:00 AM
0909384-01B	SSWPZ13091409N1	R35681	EPA Method 6020: Dissolved	9/14/2009 10:12:00 AM
0909384-02A	SSWPZ13091509N1	R35537	EPA Method 6010B: Dissolved Metals	9/15/2009 10:53:00 AM
0909384-02A	SSWPZ13091509N1	R35539	EPA Method 6010B: Dissolved Metals	9/15/2009 10:53:00 AM
0909384-02A	SSWPZ13091509N1	R35537	EPA Method 6010B: Dissolved Metals	9/15/2009 10:53:00 AM
0909384-02A	SSWPZ13091509N1	R35537	EPA Method 6010B: Dissolved Metals	9/15/2009 10:53:00 AM
0909384-02A	SSWPZ13091509N1	R35530	EPA Method 6010B: Dissolved Metals	9/15/2009 10:53:00 AM
0909384-02A	SSWPZ13091509N1	R35530	EPA Method 6010B: Dissolved Metals	9/15/2009 10:53:00 AM
0909384-02A	SSWPZ13091509N1	R35530	EPA Method 6010B: Dissolved Metals	9/15/2009 10:53:00 AM
0909384-02A	SSWPZ13091509N1	R35539	EPA Method 6010B: Dissolved Metals	9/15/2009 10:53:00 AM
0909384-02A	SSWPZ13091509N1	R35537	EPA Method 6010B: Dissolved Metals	9/15/2009 10:53:00 AM
0909384-02B	SSWPZ13091509N1	R35681	EPA Method 6020: Dissolved	9/15/2009 10:53:00 AM
0909384-03A	SSWPZ13091609N1	R35537	EPA Method 6010B: Dissolved Metals	9/16/2009 11:40:00 AM
0909384-03A	SSWPZ13091609N1	R35539	EPA Method 6010B: Dissolved Metals	9/16/2009 11:40:00 AM
0909384-03A	SSWPZ13091609N1	R35539	EPA Method 6010B: Dissolved Metals	9/16/2009 11:40:00 AM
0909384-03A	SSWPZ13091609N1	R35537	EPA Method 6010B: Dissolved Metals	9/16/2009 11:40:00 AM
0909384-03A	SSWPZ13091609N1	R35537	EPA Method 6010B: Dissolved Metals	9/16/2009 11:40:00 AM
0909384-03A	SSWPZ13091609N1	R35530	EPA Method 6010B: Dissolved Metals	9/16/2009 11:40:00 AM
0909384-03A	SSWPZ13091609N1	R35530	EPA Method 6010B: Dissolved Metals	9/16/2009 11:40:00 AM
0909384-03A	SSWPZ13091609N1	R35530	EPA Method 6010B: Dissolved Metals	9/16/2009 11:40:00 AM
0909384-03A	SSWPZ13091609N1	R35537	EPA Method 6010B: Dissolved Metals	9/16/2009 11:40:00 AM
0909384-03B	SSWPZ13091609N1	R35681	EPA Method 6020: Dissolved	9/16/2009 11:40:00 AM
0909384-04A	SSWPZ13091709N1	R35530	EPA Method 6010B: Dissolved Metals	9/17/2009 12:20:00 PM
0909384-04A	SSWPZ13091709N1	R35530	EPA Method 6010B: Dissolved Metals	9/17/2009 12:20:00 PM
0909384-04A	SSWPZ13091709N1	R35530	EPA Method 6010B: Dissolved Metals	9/17/2009 12:20:00 PM
0909384-04A	SSWPZ13091709N1	R35537	EPA Method 6010B: Dissolved Metals	9/17/2009 12:20:00 PM
0909384-04A	SSWPZ13091709N1	R35537	EPA Method 6010B: Dissolved Metals	9/17/2009 12:20:00 PM
0909384-04A	SSWPZ13091709N1	R35537	EPA Method 6010B: Dissolved Metals	9/17/2009 12:20:00 PM
0909384-04A	SSWPZ13091709N1	R35537	EPA Method 6010B: Dissolved Metals	9/17/2009 12:20:00 PM

CLIENT: Waste Isolation Pilot Plant
Project: SSW PZ-13
Lab Order: 0909384

Work Order Sample Summary

Lab Sample ID	Client Sample ID	Batch ID	Test Name	Collection Date
0909384-04A	SSWPZ13091709N1	R35539	EPA Method 6010B: Dissolved Metals	9/17/2009 12:20:00 PM
0909384-04A	SSWPZ13091709N1	R35539	EPA Method 6010B: Dissolved Metals	9/17/2009 12:20:00 PM
0909384-04A	SSWPZ13091709N1	R35544	EPA Method 6010B: Dissolved Metals	9/17/2009 12:20:00 PM
0909384-04A	SSWPZ13091709N1	R35544	EPA Method 6010B: Dissolved Metals	9/17/2009 12:20:00 PM
0909384-04A	SSWPZ13091709N1	R35544	EPA Method 6010B: Dissolved Metals	9/17/2009 12:20:00 PM
0909384-04A	SSWPZ13091709N1	R35530	EPA Method 6010B: Dissolved Metals	9/17/2009 12:20:00 PM
0909384-04B	SSWPZ13091709N1	R35681	EPA Method 6020: Dissolved	9/17/2009 12:20:00 PM
0909384-05A	SSWPZ13091709N1	R35539	EPA Method 6010B: Dissolved Metals	9/17/2009 12:24:00 PM
0909384-05A	SSWPZ13091709N1	R35544	EPA Method 6010B: Dissolved Metals	9/17/2009 12:24:00 PM
0909384-05A	SSWPZ13091709N1	R35539	EPA Method 6010B: Dissolved Metals	9/17/2009 12:24:00 PM
0909384-05A	SSWPZ13091709N1	R35537	EPA Method 6010B: Dissolved Metals	9/17/2009 12:24:00 PM
0909384-05A	SSWPZ13091709N1	R35537	EPA Method 6010B: Dissolved Metals	9/17/2009 12:24:00 PM
0909384-05A	SSWPZ13091709N1	R35530	EPA Method 6010B: Dissolved Metals	9/17/2009 12:24:00 PM
0909384-05A	SSWPZ13091709N1	R35530	EPA Method 6010B: Dissolved Metals	9/17/2009 12:24:00 PM
0909384-05A	SSWPZ13091709N1	R35530	EPA Method 6010B: Dissolved Metals	9/17/2009 12:24:00 PM
0909384-05A	SSWPZ13091709N1	R35544	EPA Method 6010B: Dissolved Metals	9/17/2009 12:24:00 PM
0909384-05A	SSWPZ13091709N1	R35537	EPA Method 6010B: Dissolved Metals	9/17/2009 12:24:00 PM
0909384-05B	SSWPZ13091709N1	R35681	EPA Method 6020: Dissolved	9/17/2009 12:24:00 PM
0909384-06A	SSWPZ13091709EB	R35530	EPA Method 6010B: Dissolved Metals	9/17/2009 1:33:00 PM
0909384-06A	SSWPZ13091709EB	R35539	EPA Method 6010B: Dissolved Metals	9/17/2009 1:33:00 PM
0909384-06A	SSWPZ13091709EB	R35537	EPA Method 6010B: Dissolved Metals	9/17/2009 1:33:00 PM
0909384-06A	SSWPZ13091709EB	R35530	EPA Method 6010B: Dissolved Metals	9/17/2009 1:33:00 PM
0909384-06A	SSWPZ13091709EB	R35530	EPA Method 6010B: Dissolved Metals	9/17/2009 1:33:00 PM
0909384-06A	SSWPZ13091709EB	R35539	EPA Method 6010B: Dissolved Metals	9/17/2009 1:33:00 PM
0909384-06B	SSWPZ13091709EB	R35681	EPA Method 6020: Dissolved	9/17/2009 1:33:00 PM
0909384-07A	SSWPZ13091709FB	R35530	EPA Method 6010B: Dissolved Metals	9/17/2009 1:27:00 PM
0909384-07A	SSWPZ13091709FB	R35530	EPA Method 6010B: Dissolved Metals	9/17/2009 1:27:00 PM
0909384-07A	SSWPZ13091709FB	R35530	EPA Method 6010B: Dissolved Metals	9/17/2009 1:27:00 PM
0909384-07A	SSWPZ13091709FB	R35537	EPA Method 6010B: Dissolved Metals	9/17/2009 1:27:00 PM
0909384-07A	SSWPZ13091709FB	R35539	EPA Method 6010B: Dissolved Metals	9/17/2009 1:27:00 PM
0909384-07A	SSWPZ13091709FB	R35539	EPA Method 6010B: Dissolved Metals	9/17/2009 1:27:00 PM
0909384-07B	SSWPZ13091709FB	R35681	EPA Method 6020: Dissolved	9/17/2009 1:27:00 PM

Hall Environmental Analysis Laboratory, Inc. **Date:** *13-Oct-09*

CLIENT:	Waste Isolation Pilot Plant
Project:	SSW PZ-13
Lab Order:	0909384

CASE NARRATIVE

METHOD: 6010B

HOLDING TIMES: All holding times for Analysis were met.

METHOD: Preparations: none
Analysis: 6010B

PREPARATION: Sample preparation proceeded normally.

ANALYSIS:
1. Calibration: All acceptance criteria were met.
2. Blanks: All acceptance criteria were met.
3. Internal Standards: All acceptance criteria were met.
4. Duplicates: All acceptance criteria were met.
5. Spikes: All acceptance criteria were met.
6. Samples: All acceptance criteria were met.

CLIENT:	Waste Isolation Pilot Plant		**Client Sample ID:**	SSWPZ13091409N1
Lab Order:	0909384		**Tag Number:**	
Project:	SSW PZ-13		**Collection Date:**	9/14/2009 10:12:00 AM
Lab ID:	0909384-01A	**Date Received:** 9/18/2009	**Matrix:**	AQUEOUS

EPA METHOD 6010B: DISSOLVED METALS Analyst: **RAGS**

CAS #	Analyses	Result	Qual	MDL	PQL	Units	DF	Date Analyzed
7429-90-5	Aluminum	ND		0.065	1.0	mg/L	50	10/1/2009 11:13:23 AM
7440-36-0	Antimony	ND		0.44	2.5	mg/L	50	10/1/2009 1:13:06 PM
7440-38-2	Arsenic	ND		0.84	1.0	mg/L	50	10/1/2009 11:13:23 AM
7440-39-3	Barium	ND		0.082	1.0	mg/L	50	10/1/2009 11:13:23 AM
7440-41-7	Beryllium	0.039	J	0.0061	0.15	mg/L	50	10/1/2009 11:13:23 AM
7440-42-8	Boron	0.26	J	0.14	2.0	mg/L	50	10/1/2009 11:13:23 AM
7440-43-9	Cadmium	ND		0.029	0.10	mg/L	50	10/1/2009 11:13:23 AM
7440-70-2	Calcium	2300		0.99	50	mg/L	50	10/1/2009 11:13:23 AM
7440-47-3	Chromium	ND		0.056	0.30	mg/L	50	10/1/2009 11:13:23 AM
7440-48-4	Cobalt	ND		0.056	0.30	mg/L	50	10/1/2009 2:40:53 PM
7440-50-8	Copper	ND		0.13	0.30	mg/L	50	10/1/2009 11:13:23 AM
7439-89-6	Iron	ND		0.23	1.0	mg/L	50	10/1/2009 11:13:23 AM
7439-92-1	Lead	0.13	J	0.11	0.25	mg/L	50	10/1/2009 11:13:23 AM
7439-95-4	Magnesium	1300		0.82	50	mg/L	50	10/1/2009 11:13:23 AM
7439-96-5	Manganese	0.23		0.021	0.10	mg/L	50	10/1/2009 11:13:23 AM
7439-98-7	Molybdenum	ND		0.067	0.40	mg/L	50	10/1/2009 11:13:23 AM
7440-02-0	Nickel	ND		0.034	0.50	mg/L	50	10/1/2009 11:13:23 AM
7440-09-7	Potassium	460		2.6	50	mg/L	50	10/1/2009 11:13:23 AM
7782-49-2	Selenium	ND		1.8	2.5	mg/L	50	10/1/2009 11:13:23 AM
7631-86-9	Silica	15		0	8.0	mg/L	50	10/1/2009 11:13:23 AM
7440-22-4	Silver	ND		0.030	0.25	mg/L	50	10/2/2009 8:02:55 AM
7440-23-5	Sodium	85000		27	1000	mg/L	1000	10/1/2009 10:07:52 AM
7440-24-6	Strontium	36		1.2	1.2	mg/L	200	10/1/2009 11:55:18 AM
7440-28-0	Thallium	ND		0.64	2.5	mg/L	50	10/1/2009 11:13:23 AM
7440-62-2	Vanadium	0.25	J	0.055	2.5	mg/L	50	10/1/2009 11:13:23 AM
7440-66-6	Zinc	0.42	J	0.018	2.5	mg/L	50	10/1/2009 1:13:06 PM

Qualifiers:

*	Value exceeds Maximum Contaminant Level	B	Analyte detected in the associated Method Blank
E	Estimated value	H	Holding times for preparation or analysis exceeded
J	Analyte detected below quantitation limits	MCL	Maximum Contaminant Level
ND	Not Detected at the Reporting Limit	RL	Reporting Limit
S	Spike recovery outside accepted recovery limits		

CLIENT:	Waste Isolation Pilot Plant	**Client Sample ID:**	SSWPZ13091509N1
Lab Order:	0909384	**Tag Number:**	
Project:	SSW PZ-13	**Collection Date:**	9/15/2009 10:53:00 AM
Lab ID:	0909384-02A **Date Received:** 9/18/2009	**Matrix:**	AQUEOUS

Analyses		**Result**	**Qual**	**MDL**	**PQL**	**Units**	**DF**	**Date Analyzed**
CAS #	**EPA METHOD 6010B: DISSOLVED METALS**							Analyst: **SNV**
7429-90-5	Aluminum	ND		0.065	1.0	mg/L	50	9/30/2009 5:50:05 PM
7440-36-0	Antimony	ND		0.44	2.5	mg/L	50	10/1/2009 1:15:53 PM
7440-38-2	Arsenic	ND		0.84	1.0	mg/L	50	9/30/2009 5:50:05 PM
7440-39-3	Barium	0.11	J	0.082	1.0	mg/L	50	9/30/2009 5:50:05 PM
7440-41-7	Beryllium	ND		0.0061	0.15	mg/L	50	9/30/2009 5:50:05 PM
7440-42-8	Boron	0.19	J	0.14	2.0	mg/L	50	9/30/2009 5:50:05 PM
7440-43-9	Cadmium	ND		0.029	0.10	mg/L	50	9/30/2009 5:50:05 PM
7440-70-2	Calcium	2000		0.99	50	mg/L	50	9/30/2009 5:50:05 PM
7440-47-3	Chromium	ND		0.056	0.30	mg/L	50	9/30/2009 5:50:05 PM
7440-48-4	Cobalt	ND		0.056	0.30	mg/L	50	9/30/2009 5:50:05 PM
7440-50-8	Copper	ND		0.13	0.30	mg/L	50	9/30/2009 5:50:05 PM
7439-89-6	Iron	ND		0.23	1.0	mg/L	50	9/30/2009 5:50:05 PM
7439-92-1	Lead	0.28		0.11	0.25	mg/L	50	9/30/2009 5:50:05 PM
7439-95-4	Magnesium	1200		0.82	50	mg/L	50	9/30/2009 5:50:05 PM
7439-96-5	Manganese	0.19		0.021	0.10	mg/L	50	9/30/2009 5:50:05 PM
7439-98-7	Molybdenum	ND		0.067	0.40	mg/L	50	9/30/2009 5:50:05 PM
7440-02-0	Nickel	ND		0.034	0.50	mg/L	50	9/30/2009 5:50:05 PM
7440-09-7	Potassium	370		2.6	50	mg/L	50	9/30/2009 5:50:05 PM
7782-49-2	Selenium	ND		1.8	2.5	mg/L	50	9/30/2009 5:50:05 PM
7631-86-9	Silica	11		0	8.0	mg/L	50	9/30/2009 5:50:05 PM
7440-22-4	Silver	ND		0.030	0.25	mg/L	50	9/30/2009 5:50:05 PM
7440-23-5	Sodium	81000		27	1000	mg/L	1000	10/1/2009 10:11:11 AM
7440-24-6	Strontium	29		1.2	1.2	mg/L	200	10/1/2009 11:57:36 AM
7440-28-0	Thallium	ND		0.64	2.5	mg/L	50	9/30/2009 5:50:05 PM
7440-62-2	Vanadium	0.061	J	0.055	2.5	mg/L	50	9/30/2009 5:50:05 PM
7440-66-6	Zinc	0.22	J	0.018	2.5	mg/L	50	10/1/2009 1:15:53 PM

Qualifiers:				
	*	Value exceeds Maximum Contaminant Level	B	Analyte detected in the associated Method Blank
	E	Estimated value	H	Holding times for preparation or analysis exceeded
	J	Analyte detected below quantitation limits	MCL	Maximum Contaminant Level
	ND	Not Detected at the Reporting Limit	RL	Reporting Limit
	S	Spike recovery outside accepted recovery limits		

CLIENT:	Waste Isolation Pilot Plant	**Client Sample ID:**	SSWPZ13091609N1
Lab Order:	0909384	**Tag Number:**	
Project:	SSW PZ-13	**Collection Date:**	9/16/2009 11:40:00 AM
Lab ID:	0909384-03A **Date Received:** 9/18/2009	**Matrix:**	AQUEOUS

Analyses		Result	Qual	MDL	PQL	Units	DF	Date Analyzed
CAS #	**EPA METHOD 6010B: DISSOLVED METALS**							Analyst: **SNV**
7429-90-5	Aluminum	ND		0.065	1.0	mg/L	50	9/30/2009 5:54:29 PM
7440-36-0	Antimony	0.49	J	0.44	2.5	mg/L	50	10/1/2009 1:18:35 PM
7440-38-2	Arsenic	ND		0.84	1.0	mg/L	50	9/30/2009 5:54:29 PM
7440-39-3	Barium	0.11	J	0.082	1.0	mg/L	50	9/30/2009 5:54:29 PM
7440-41-7	Beryllium	ND		0.0061	0.15	mg/L	50	9/30/2009 5:54:29 PM
7440-42-8	Boron	0.17	J	0.14	2.0	mg/L	50	9/30/2009 5:54:29 PM
7440-43-9	Cadmium	ND		0.029	0.10	mg/L	50	9/30/2009 5:54:29 PM
7440-70-2	Calcium	1700		0.99	50	mg/L	50	9/30/2009 5:54:29 PM
7440-47-3	Chromium	ND		0.056	0.30	mg/L	50	9/30/2009 5:54:29 PM
7440-48-4	Cobalt	ND		0.056	0.30	mg/L	50	9/30/2009 5:54:29 PM
7440-50-8	Copper	ND		0.13	0.30	mg/L	50	9/30/2009 5:54:29 PM
7439-89-6	Iron	ND		0.23	1.0	mg/L	50	9/30/2009 5:54:29 PM
7439-92-1	Lead	0.31		0.11	0.25	mg/L	50	9/30/2009 5:54:29 PM
7439-95-4	Magnesium	1000		0.82	50	mg/L	50	9/30/2009 5:54:29 PM
7439-96-5	Manganese	0.16		0.021	0.10	mg/L	50	9/30/2009 5:54:29 PM
7439-98-7	Molybdenum	ND		0.067	0.40	mg/L	50	9/30/2009 5:54:29 PM
7440-02-0	Nickel	ND		0.034	0.50	mg/L	50	9/30/2009 5:54:29 PM
7440-09-7	Potassium	310		2.6	50	mg/L	50	9/30/2009 5:54:29 PM
7782-49-2	Selenium	ND		1.8	2.5	mg/L	50	9/30/2009 5:54:29 PM
7631-86-9	Silica	11		0	8.0	mg/L	50	9/30/2009 5:54:29 PM
7440-22-4	Silver	ND		0.030	0.25	mg/L	50	9/30/2009 5:54:29 PM
7440-23-5	Sodium	98000		27	1000	mg/L	1000	10/1/2009 10:26:19 AM
7440-24-6	Strontium	40		1.2	1.2	mg/L	200	10/1/2009 11:59:55 AM
7440-28-0	Thallium	ND		0.64	2.5	mg/L	50	9/30/2009 5:54:29 PM
7440-62-2	Vanadium	0.064	J	0.055	2.5	mg/L	50	9/30/2009 5:54:29 PM
7440-66-6	Zinc	0.19	J	0.018	2.5	mg/L	50	10/1/2009 1:18:35 PM

Qualifiers:				
	*	Value exceeds Maximum Contaminant Level	B	Analyte detected in the associated Method Blank
	E	Estimated value	H	Holding times for preparation or analysis exceeded
	J	Analyte detected below quantitation limits	MCL	Maximum Contaminant Level
	ND	Not Detected at the Reporting Limit	RL	Reporting Limit
	S	Spike recovery outside accepted recovery limits		

CLIENT:	Waste Isolation Pilot Plant	**Client Sample ID:**	SSWPZ13091709N1
Lab Order:	0909384	**Tag Number:**	
Project:	SSW PZ-13	**Collection Date:**	9/17/2009 12:20:00 PM
Lab ID:	0909384-04A **Date Received:** 9/18/2009	**Matrix:**	AQUEOUS

Analyses		**Result**	**Qual**	**MDL**	**PQL**	**Units**	**DF**	**Date Analyzed**
CAS #	**EPA METHOD 6010B: DISSOLVED METALS**							Analyst: **RAGS**
7429-90-5	Aluminum	ND		0.065	1.0	mg/L	50	10/1/2009 11:28:24 AM
7440-36-0	Antimony	ND		0.44	2.5	mg/L	50	10/1/2009 1:21:21 PM
7440-38-2	Arsenic	ND		0.84	1.0	mg/L	50	10/1/2009 11:28:24 AM
7440-39-3	Barium	ND		0.082	1.0	mg/L	50	10/1/2009 11:28:24 AM
7440-41-7	Beryllium	0.036	J	0.0061	0.15	mg/L	50	10/1/2009 11:28:24 AM
7440-42-8	Boron	0.25	J	0.14	2.0	mg/L	50	10/1/2009 11:28:24 AM
7440-43-9	Cadmium	ND		0.029	0.10	mg/L	50	10/1/2009 11:28:24 AM
7440-70-2	Calcium	2600		0.99	50	mg/L	50	10/1/2009 11:28:24 AM
7440-47-3	Chromium	ND		0.056	0.30	mg/L	50	10/1/2009 11:28:24 AM
7440-48-4	Cobalt	ND		0.056	0.30	mg/L	50	10/1/2009 2:48:45 PM
7440-50-8	Copper	ND		0.13	0.30	mg/L	50	10/1/2009 11:28:24 AM
7439-89-6	Iron	ND		0.23	1.0	mg/L	50	10/1/2009 11:28:24 AM
7439-92-1	Lead	0.25		0.11	0.25	mg/L	50	10/1/2009 11:28:24 AM
7439-95-4	Magnesium	1500		0.82	50	mg/L	50	10/1/2009 11:28:24 AM
7439-96-5	Manganese	0.24		0.021	0.10	mg/L	50	10/1/2009 11:28:24 AM
7439-98-7	Molybdenum	0.080	J	0.067	0.40	mg/L	50	10/1/2009 11:28:24 AM
7440-02-0	Nickel	ND		0.034	0.50	mg/L	50	10/1/2009 11:28:24 AM
7440-09-7	Potassium	480		2.6	50	mg/L	50	10/1/2009 11:28:24 AM
7782-49-2	Selenium	ND		1.8	2.5	mg/L	50	10/1/2009 11:28:24 AM
7631-86-9	Silica	19		0	8.0	mg/L	50	10/1/2009 11:28:24 AM
7440-22-4	Silver	ND		0.030	0.25	mg/L	50	10/2/2009 8:05:10 AM
7440-23-5	Sodium	91000		27	1000	mg/L	1000	10/2/2009 11:42:22 AM
7440-24-6	Strontium	41		1.2	1.2	mg/L	200	10/1/2009 12:02:13 PM
7440-28-0	Thallium	ND		0.64	2.5	mg/L	50	10/1/2009 11:28:24 AM
7440-62-2	Vanadium	0.27	J	0.055	2.5	mg/L	50	10/1/2009 11:28:24 AM
7440-66-6	Zinc	0.14	J	0.018	2.5	mg/L	50	10/1/2009 1:21:21 PM

Qualifiers:				
	*	Value exceeds Maximum Contaminant Level	B	Analyte detected in the associated Method Blank
	E	Estimated value	H	Holding times for preparation or analysis exceeded
	J	Analyte detected below quantitation limits	MCL	Maximum Contaminant Level
	ND	Not Detected at the Reporting Limit	RL	Reporting Limit
	S	Spike recovery outside accepted recovery limits		

CLIENT:	Waste Isolation Pilot Plant		**Client Sample ID:**	SSWPZ13091709N1D
Lab Order:	0909384		**Tag Number:**	
Project:	SSW PZ-13		**Collection Date:**	9/17/2009 12:24:00 PM
Lab ID:	0909384-05A	**Date Received:** 9/18/2009	**Matrix:**	AQUEOUS

CAS #	**Analyses**	**Result**	**Qual**	**MDL**	**PQL**	**Units**	**DF**	**Date Analyzed**
	EPA METHOD 6010B: DISSOLVED METALS							Analyst: **RAGS**
7429-90-5	Aluminum	ND		0.065	1.0	mg/L	50	10/1/2009 11:32:50 AM
7440-36-0	Antimony	ND		0.44	2.5	mg/L	50	10/1/2009 1:24:04 PM
7440-38-2	Arsenic	ND		0.84	1.0	mg/L	50	10/1/2009 11:32:50 AM
7440-39-3	Barium	0.090	J	0.082	1.0	mg/L	50	10/1/2009 11:32:50 AM
7440-41-7	Beryllium	0.036	J	0.0061	0.15	mg/L	50	10/1/2009 11:32:50 AM
7440-42-8	Boron	0.26	J	0.14	2.0	mg/L	50	10/1/2009 11:32:50 AM
7440-43-9	Cadmium	ND		0.029	0.10	mg/L	50	10/1/2009 11:32:50 AM
7440-70-2	Calcium	2600		0.99	50	mg/L	50	10/1/2009 11:32:50 AM
7440-47-3	Chromium	ND		0.056	0.30	mg/L	50	10/1/2009 11:32:50 AM
7440-48-4	Cobalt	ND		0.056	0.30	mg/L	50	10/1/2009 2:51:20 PM
7440-50-8	Copper	ND		0.13	0.30	mg/L	50	10/1/2009 11:32:50 AM
7439-89-6	Iron	ND		0.23	1.0	mg/L	50	10/1/2009 11:32:50 AM
7439-92-1	Lead	0.39		0.11	0.25	mg/L	50	10/1/2009 11:32:50 AM
7439-95-4	Magnesium	1500		0.82	50	mg/L	50	10/1/2009 11:32:50 AM
7439-96-5	Manganese	0.25		0.021	0.10	mg/L	50	10/1/2009 11:32:50 AM
7439-98-7	Molybdenum	ND		0.067	0.40	mg/L	50	10/1/2009 11:32:50 AM
7440-02-0	Nickel	ND		0.034	0.50	mg/L	50	10/1/2009 11:32:50 AM
7440-09-7	Potassium	480		2.6	50	mg/L	50	10/1/2009 11:32:50 AM
7782-49-2	Selenium	ND		1.8	2.5	mg/L	50	10/1/2009 11:32:50 AM
7631-86-9	Silica	19		0	8.0	mg/L	50	10/1/2009 11:32:50 AM
7440-22-4	Silver	ND		0.030	0.25	mg/L	50	10/2/2009 8:10:19 AM
7440-23-5	Sodium	100000		140	5000	mg/L	5000	10/1/2009 10:32:07 AM
7440-24-6	Strontium	32		1.2	1.2	mg/L	200	10/2/2009 10:16:30 AM
7440-28-0	Thallium	ND		0.64	2.5	mg/L	50	10/1/2009 11:32:50 AM
7440-62-2	Vanadium	0.27	J	0.055	2.5	mg/L	50	10/1/2009 11:32:50 AM
7440-66-6	Zinc	0.094	J	0.018	2.5	mg/L	50	10/1/2009 1:24:04 PM

Qualifiers:				
	*	Value exceeds Maximum Contaminant Level	B	Analyte detected in the associated Method Blank
	E	Estimated value	H	Holding times for preparation or analysis exceeded
	J	Analyte detected below quantitation limits	MCL	Maximum Contaminant Level
	ND	Not Detected at the Reporting Limit	RL	Reporting Limit
	S	Spike recovery outside accepted recovery limits		

Hall Environmental Analysis Laboratory, Inc. **Date:** *12-Oct-09*

CLIENT:	Waste Isolation Pilot Plant	**Client Sample ID:**	SSWPZ13091709EB
Lab Order:	0909384	**Tag Number:**	
Project:	SSW PZ-13	**Collection Date:**	9/17/2009 1:33:00 PM
Lab ID:	0909384-06A **Date Received:** 9/18/2009	**Matrix:**	AQUEOUS

Analyses		Result	Qual	MDL	PQL	Units	DF	Date Analyzed
CAS #	**EPA METHOD 6010B: DISSOLVED METALS**							Analyst: **SNV**
7429-90-5	Aluminum	ND		0.0013	0.020	mg/L	1	9/30/2009 5:00:49 PM
7440-36-0	Antimony	0.0093	J	0.0088	0.050	mg/L	1	10/1/2009 1:26:49 PM
7440-38-2	Arsenic	ND		0.017	0.020	mg/L	1	9/30/2009 5:00:49 PM
7440-39-3	Barium	ND		0.0016	0.020	mg/L	1	9/30/2009 5:00:49 PM
7440-41-7	Beryllium	ND		0.00012	0.0030	mg/L	1	9/30/2009 5:00:49 PM
7440-42-8	Boron	ND		0.0028	0.040	mg/L	1	9/30/2009 5:00:49 PM
7440-43-9	Cadmium	ND		0.00058	0.0020	mg/L	1	9/30/2009 5:00:49 PM
7440-70-2	Calcium	0.079	J	0.020	1.0	mg/L	1	9/30/2009 5:00:49 PM
7440-47-3	Chromium	0.0018	J	0.0011	0.0060	mg/L	1	9/30/2009 5:00:49 PM
7440-48-4	Cobalt	0.0019	J	0.0011	0.0060	mg/L	1	9/30/2009 5:00:49 PM
7440-50-8	Copper	ND		0.0027	0.0060	mg/L	1	9/30/2009 5:00:49 PM
7439-89-6	Iron	0.0074	J	0.0045	0.020	mg/L	1	9/30/2009 5:00:49 PM
7439-92-1	Lead	ND		0.0022	0.0050	mg/L	1	9/30/2009 5:00:49 PM
7439-95-4	Magnesium	ND		0.016	1.0	mg/L	1	9/30/2009 5:00:49 PM
7439-96-5	Manganese	0.0020	J	0.00043	0.0020	mg/L	1	9/30/2009 5:00:49 PM
7439-98-7	Molybdenum	ND		0.0013	0.0080	mg/L	1	9/30/2009 5:00:49 PM
7440-02-0	Nickel	ND		0.00067	0.010	mg/L	1	9/30/2009 5:00:49 PM
7440-09-7	Potassium	0.075	J	0.052	1.0	mg/L	1	9/30/2009 5:00:49 PM
7782-49-2	Selenium	ND		0.037	0.050	mg/L	1	9/30/2009 5:00:49 PM
7631-86-9	Silica	ND		0	0.16	mg/L	1	9/30/2009 5:00:49 PM
7440-22-4	Silver	ND		0.00059	0.0050	mg/L	1	9/30/2009 5:00:49 PM
7440-23-5	Sodium	0.66	J	0.027	1.0	mg/L	1	10/1/2009 9:43:09 AM
7440-24-6	Strontium	ND		0.0060	0.0060	mg/L	1	9/30/2009 5:00:49 PM
7440-28-0	Thallium	ND		0.013	0.050	mg/L	1	9/30/2009 5:00:49 PM
7440-62-2	Vanadium	ND		0.0011	0.050	mg/L	1	9/30/2009 5:00:49 PM
7440-66-6	Zinc	0.011	J	0.00035	0.050	mg/L	1	10/1/2009 1:26:49 PM

Qualifiers:				
	*	Value exceeds Maximum Contaminant Level	B	Analyte detected in the associated Method Blank
	E	Estimated value	H	Holding times for preparation or analysis exceeded
	J	Analyte detected below quantitation limits	MCL	Maximum Contaminant Level
	ND	Not Detected at the Reporting Limit	RL	Reporting Limit
	S	Spike recovery outside accepted recovery limits		

Hall Environmental Analysis Laboratory, Inc.

Date: *12-Oct-09*

CLIENT:	Waste Isolation Pilot Plant		**Client Sample ID:**	SSWPZ13091709FB
Lab Order:	0909384		**Tag Number:**	
Project:	SSW PZ-13		**Collection Date:**	9/17/2009 1:27:00 PM
Lab ID:	0909384-07A	**Date Received:** 9/18/2009	**Matrix:**	AQUEOUS

Analyses		Result	Qual	MDL	PQL	Units	DF	Date Analyzed
CAS #	**EPA METHOD 6010B: DISSOLVED METALS**							Analyst: **RAGS**
7429-90-5	Aluminum	ND		0.0013	0.020	mg/L	1	10/1/2009 9:46:16 AM
7440-36-0	Antimony	0.014	J	0.0088	0.050	mg/L	1	10/1/2009 1:29:22 PM
7440-38-2	Arsenic	ND		0.017	0.020	mg/L	1	10/1/2009 9:46:16 AM
7440-39-3	Barium	ND		0.0016	0.020	mg/L	1	10/1/2009 9:46:16 AM
7440-41-7	Beryllium	0.00028	J	0.00012	0.0030	mg/L	1	10/1/2009 9:46:16 AM
7440-42-8	Boron	ND		0.0028	0.040	mg/L	1	10/1/2009 9:46:16 AM
7440-43-9	Cadmium	ND		0.00058	0.0020	mg/L	1	10/1/2009 9:46:16 AM
7440-70-2	Calcium	ND		0.020	1.0	mg/L	1	10/1/2009 9:46:16 AM
7440-47-3	Chromium	ND		0.0011	0.0060	mg/L	1	10/1/2009 9:46:16 AM
7440-48-4	Cobalt	0.0042	J	0.0011	0.0060	mg/L	1	10/1/2009 9:46:16 AM
7440-50-8	Copper	ND		0.0027	0.0060	mg/L	1	10/1/2009 9:46:16 AM
7439-89-6	Iron	0.050		0.0045	0.020	mg/L	1	10/1/2009 9:46:16 AM
7439-92-1	Lead	ND		0.0022	0.0050	mg/L	1	10/1/2009 9:46:16 AM
7439-95-4	Magnesium	0.024	J	0.016	1.0	mg/L	1	10/1/2009 9:46:16 AM
7439-96-5	Manganese	0.0035		0.00043	0.0020	mg/L	1	10/1/2009 9:46:16 AM
7439-98-7	Molybdenum	ND		0.0013	0.0080	mg/L	1	10/1/2009 9:46:16 AM
7440-02-0	Nickel	ND		0.00067	0.010	mg/L	1	10/1/2009 9:46:16 AM
7440-09-7	Potassium	ND		0.052	1.0	mg/L	1	10/1/2009 9:46:16 AM
7782-49-2	Selenium	ND		0.037	0.050	mg/L	1	10/1/2009 9:46:16 AM
7631-86-9	Silica	ND		0	0.16	mg/L	1	10/1/2009 9:46:16 AM
7440-22-4	Silver	0.00059	J	0.00059	0.0050	mg/L	1	10/1/2009 9:46:16 AM
7440-23-5	Sodium	0.096	J	0.027	1.0	mg/L	1	10/1/2009 9:46:16 AM
7440-24-6	Strontium	ND		0.0060	0.0060	mg/L	1	10/1/2009 9:46:16 AM
7440-28-0	Thallium	ND		0.013	0.050	mg/L	1	10/1/2009 9:46:16 AM
7440-62-2	Vanadium	0.0018	J	0.0011	0.050	mg/L	1	10/1/2009 9:46:16 AM
7440-66-6	Zinc	0.0073	J	0.00035	0.050	mg/L	1	10/1/2009 1:29:22 PM

Qualifiers:

*	Value exceeds Maximum Contaminant Level	B	Analyte detected in the associated Method Blank
E	Estimated value	H	Holding times for preparation or analysis exceeded
J	Analyte detected below quantitation limits	MCL	Maximum Contaminant Level
ND	Not Detected at the Reporting Limit	RL	Reporting Limit
S	Spike recovery outside accepted recovery limits		

CASE NARRATIVE October 12, 2009

Lab Name: Anatek Labs, Inc. 1282 Alturas Drive, Moscow, ID 83843 www.anateklabs.com *FL NELAP E87893, NV ID13-2004-31, WA DOE C126, OR ELAP ID200001, MT 0028, ID, CO, NM*

Project Tracking No.: 0909384
Anatek Batch: 090923079

Project Summary: Seven (7) water samples were received on 9/22/2009 for metals (EPA 6020A) analysis. All samples were received with the appropriate chain of custody. Samples were received at 2.0C.

Client Sample ID	Anatek Sample ID	Method/Prep Method
0909384-01B / SSWPZ13091409N1	090923079-001	EPA 6020A/3005A
0909384-02B / SSWPZ13091509N1	090923079-002	EPA 6020A/3005A
0909384-03B / SSWPZ13091609N1	090923079-003	EPA 6020A/3005A
0909384-04B / SSWPZ13091709N1	090923079-004	EPA 6020A/3005A
0909384-05B / SSWPZ13091709N1D	090923079-005	EPA 6020A/3005A
0909384-06B / SSWPZ13091709EB	090923079-006	EPA 6020A/3005A
0909384-07B / SSWPZ13091709FB	090923079-007	EPA 6020A/3005A

QA/QC Checks

Parameters	Yes / No	Exceptions / Deviations
Sample Holding Time Valid?	Y	NA
Surrogate Recoveries Valid?	Y	NA
QC Sample(s) Recoveries Valid?	Y	NA
Method Blank(s) Valid?	Y	NA
Tune(s) Valid?	Y	NA
Internal Standard Responses Valid?	Y	NA
Initial Calibration Curve(s) Valid?	Y	NA
Continuing Calibration(s) Valid?	Y	NA
Comments:	Y	See Note

1. **Holding Time Requirements**

   No problems encountered.

2. **GC/MS Tune Requirements**

   No problems encountered

3. **Calibration Requirements**

   No problems encountered.

4. **Surrogate Recovery Requirements**

   No problems encountered.

5. **QC Sample (LCS/MS/MSD) Recovery Requirements**

   No problems encountered.

6. Method Blank Requirements

No problems encountered.

7. Internal Standard(s) Response Requirements

No problems encountered.

8. Comments

Samples required dilution due to matrix.

I certify that this data package is in compliance with the terms and conditions of the contract. Release of the data contained in this data package has been authorized by the Laboratory Manager or his designee.

Approved by: John W. Cott

Anatek Labs, Inc.
1282 Alturas Drive • Moscow, ID 83843 • (208) 883-2839 • Fax (208) 882-9246 • email moscow@anateklabs.com
504 E Sprague Ste. D • Spokane WA 99202 • (509) 838-3999 • Fax (509) 838-4433 • email spokane@anateklabs.com

Client:	HALL ENVIRONMENTAL ANALYSIS LAB	**Batch #:**	090923079
Address:	4901 HAWKINS NE SUITE D ALBUQUERQUE, NM 87109	**Project Name:**	0909384
Attn:	ANDY FREEMAN		

Analytical Results Report

Sample Number	090923079-001	**Sampling Date**	9/14/2009	**Date/Time Received**	9/22/2009 10:25 AM
Client Sample ID	0909384-01B / SSWPZ13091409N1	**Sampling Time**	10:12 AM		
		Matrix	Water		

Comments

Parameter	Result	Units	PQL	Analysis Date	Analyst	Method	Qualifier
Dissolved Tin	ND	mg/L	0.5	10/9/2009	ETL	EPA 6020A	
Dissolved Titanium	ND	mg/L	0.05	10/9/2009	ETL	EPA 6020A	
Dissolved Uranium	ND	mg/L	0.05	10/9/2009	ETL	EPA 6020A	

Sample Number	090923079-002	**Sampling Date**	9/15/2009	**Date/Time Received**	9/22/2009 10:25 AM
Client Sample ID	0909384-02B / SSWPZ13091509N1	**Sampling Time**	10:53 AM		
		Matrix	Water		

Comments

Parameter	Result	Units	PQL	Analysis Date	Analyst	Method	Qualifier
Dissolved Tin	ND	mg/L	0.5	10/9/2009	ETL	EPA 6020A	
Dissolved Titanium	ND	mg/L	0.05	10/9/2009	ETL	EPA 6020A	
Dissolved Uranium	ND	mg/L	0.05	10/9/2009	ETL	EPA 6020A	

Sample Number	090923079-003	**Sampling Date**	9/16/2009	**Date/Time Received**	9/22/2009 10:25 AM
Client Sample ID	0909384-03B / SSWPZ13091609N1	**Sampling Time**	11:40 AM		
		Matrix	Water		

Comments

Parameter	Result	Units	PQL	Analysis Date	Analyst	Method	Qualifier
Dissolved Tin	ND	mg/L	0.5	10/9/2009	ETL	EPA 6020A	
Dissolved Titanium	ND	mg/L	0.05	10/9/2009	ETL	EPA 6020A	
Dissolved Uranium	ND	mg/L	0.05	10/9/2009	ETL	EPA 6020A	

Client:	HALL ENVIRONMENTAL ANALYSIS LAB	**Batch #:**	090923079
Address:	4901 HAWKINS NE SUITE D ALBUQUERQUE, NM 87109	**Project Name:**	0909384
Attn:	ANDY FREEMAN		

Analytical Results Report

Sample Number	090923079-004	**Sampling Date**	9/17/2009	**Date/Time Received**	9/22/2009 10:25 AM
Client Sample ID	0909384-04B / SSWPZ13091709N1	**Sampling Time**	12:20 PM		
		Matrix	Water		

Comments

Parameter	Result	Units	PQL	Analysis Date	Analyst	Method	Qualifier
Dissolved Tin	ND	mg/L	0.5	10/9/2009	ETL	EPA 6020A	
Dissolved Titanium	ND	mg/L	0.05	10/9/2009	ETL	EPA 6020A	
Dissolved Uranium	ND	mg/L	0.05	10/9/2009	ETL	EPA 6020A	

Sample Number	090923079-005	**Sampling Date**	9/17/2009	**Date/Time Received**	9/22/2009 10:25 AM
Client Sample ID	0909384-05B / SSWPZ13091709N1D	**Sampling Time**	12:24 PM		
		Matrix	Water		

Comments

Parameter	Result	Units	PQL	Analysis Date	Analyst	Method	Qualifier
Dissolved Tin	ND	mg/L	0.5	10/9/2009	ETL	EPA 6020A	
Dissolved Titanium	ND	mg/L	0.05	10/9/2009	ETL	EPA 6020A	
Dissolved Uranium	ND	mg/L	0.05	10/9/2009	ETL	EPA 6020A	

Sample Number	090923079-006	**Sampling Date**	9/17/2009	**Date/Time Received**	9/22/2009 10:25 AM
Client Sample ID	0909384-06B / SSWPZ13091709EB	**Sampling Time**	1:33 PM		
		Matrix	Water		

Comments

Parameter	Result	Units	PQL	Analysis Date	Analyst	Method	Qualifier
Dissolved Tin	ND	mg/L	0.5	10/9/2009	ETL	EPA 6020A	
Dissolved Titanium	ND	mg/L	0.05	10/9/2009	ETL	EPA 6020A	
Dissolved Uranium	ND	mg/L	0.05	10/9/2009	ETL	EPA 6020A	

Client:	HALL ENVIRONMENTAL ANALYSIS LAB	**Batch #:**	090923079
Address:	4901 HAWKINS NE SUITE D ALBUQUERQUE, NM 87109	**Project Name:**	0909384
Attn:	ANDY FREEMAN		

Analytical Results Report

Sample Number	090923079-007	**Sampling Date**	9/17/2009	**Date/Time Received**	9/22/2009 10:25 AM
Client Sample ID	0909384-07B / SSWPZ13091709FB	**Sampling Time**	1:27 PM		
		Matrix	Water		

Comments

Parameter	Result	Units	PQL	Analysis Date	Analyst	Method	Qualifier
Dissolved Tin	ND	mg/L	0.5	10/9/2009	ETL	EPA 6020A	
Dissolved Titanium	ND	mg/L	0.05	10/9/2009	ETL	EPA 6020A	
Dissolved Uranium	ND	mg/L	0.05	10/9/2009	ETL	EPA 6020A	

Authorized Signature John Coddington

MCL	EPA's Maximum Contaminant Level
ND	Not Detected
PQL	Practical Quantitation Limit

Anatek Labs, Inc.
1282 Alturas Drive • Moscow, ID 83843 • (208) 883-2839 • Fax (208) 882-9246 • email moscow@anateklabs.com
504 E Sprague Ste. D • Spokane WA 99202 • (509) 838-3999 • Fax (509) 838-4433 • email spokane@anateklabs.com

Client:	HALL ENVIRONMENTAL ANALYSIS LAB	**Batch #:**	090923079
Address:	4901 HAWKINS NE SUITE D ALBUQUERQUE, NM 87109	**Project Name:**	0909384
Attn:	ANDY FREEMAN		

Analytical Results Report

Quality Control Data

Lab Control Sample

Parameter	LCS Result	Units	LCS Spike	%Rec	AR %Rec	Prep Date	Analysis Date
Dissolved Uranium	0.0490	mg/L	0.05	98.0	80-120	10/9/2009	10/9/2009
Dissolved Titanium	0.0469	mg/L	0.05	93.8	80-120	10/9/2009	10/9/2009
Dissolved Tin	0.0480	mg/L	0.05	96.0	80-120	10/9/2009	10/9/2009

Matrix Spike

Sample Number	Parameter	Sample Result	MS Result	Units	MS Spike	%Rec	AR %Rec	Prep Date	Analysis Date
090923079-001	Dissolved Uranium	ND	9.81	mg/L	10	98.1	75-125	10/9/2009	10/9/2009
090923079-001	Dissolved Titanium	ND	9.61	mg/L	10	96.1	75-125	10/9/2009	10/9/2009
090923079-001	Dissolved Tin	ND	9.94	mg/L	10	99.4	75-125	10/9/2009	10/9/2009

Matrix Spike Duplicate

Parameter	MSD Result	Units	MSD Spike	%Rec	%RPD	AR %RPD	Prep Date	Analysis Date
Dissolved Uranium	9.91	mg/L	10	99.1	1.0	0-20	10/9/2009	10/9/2009
Dissolved Titanium	9.76	mg/L	10	97.6	1.5	0-20	10/9/2009	10/9/2009
Dissolved Tin	10.2	mg/L	10	102.0	2.6	0-20	10/9/2009	10/9/2009

Method Blank

Parameter	Result	Units	PQL	Prep Date	Analysis Date
Dissolved Tin	ND	mg/L	0.01	10/9/2009	10/9/2009
Dissolved Titanium	ND	mg/L	0.001	10/9/2009	10/9/2009
Dissolved Uranium	ND	mg/L	0.001	10/9/2009	10/9/2009

AR	Acceptable Range
ND	Not Detected
PQL	Practical Quantitation Limit
RPD	Relative Percentage Difference

Comments:

Certifications held by Anatek Labs ID: EPA:ID00013; AZ:0701; CO:ID00013; FL(NELAP):E87893; ID:ID00013; IN:C-ID-01; KY:90142; MT:CERT0028; NM: ID00013; OR:ID200001-002; WA:C1320
Certifications held by Anatek Labs WA: EPA:WA00169; CA:Cert2632; ID:WA00169; WA:C1287

Monday, October 12, 2009

QA/QC SUMMARY REPORT

Client: Waste Isolation Pilot Plant
Project: SSW PZ-13 **Work Order:** 0909384

Method: EPA Method 6010B: Dissolved Metals

Sample ID: 0909384-07AMSD *MSD* Batch ID: **R35537** Analysis Date: 10/1/2009 9:52:57 AM

Analyte	Result	Units	PQL	SPK Va	SPK ref	%Rec	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Aluminum	0.5172	mg/L	0.020	0.5	0	103	75	125	0.844	20	
Arsenic	0.5459	mg/L	0.020	0.5	0	109	75	125	0.319	20	
Barium	0.5046	mg/L	0.020	0.5	0	101	75	125	1.00	20	
Beryllium	0.5228	mg/L	0.0030	0.5	0.0003	105	75	125	1.37	20	
Boron	0.5265	mg/L	0.040	0.5	0	105	75	125	0.936	20	
Cadmium	0.5162	mg/L	0.0020	0.5	0	103	75	125	0.146	20	
Calcium	52.48	mg/L	1.0	50.5	0	104	75	125	0.975	20	
Chromium	0.5115	mg/L	0.0060	0.5	0	102	75	125	0.0958	20	
Cobalt	0.5234	mg/L	0.0060	0.5	0.0042	104	75	125	1.79	20	
Copper	0.4888	mg/L	0.0060	0.5	0	97.8	75	125	0.565	20	
Iron	0.5653	mg/L	0.020	0.5	0.0498	103	75	125	0.375	20	
Lead	0.5187	mg/L	0.0050	0.5	0	104	75	125	0.648	20	
Magnesium	51.73	mg/L	1.0	50.5	0.0237	102	75	125	0.687	20	
Manganese	0.5023	mg/L	0.0020	0.5	0.0035	99.8	75	125	0.658	20	
Molybdenum	0.5225	mg/L	0.0080	0.5	0	104	75	125	0.581	20	
Nickel	0.4951	mg/L	0.010	0.5	0	99.0	75	125	0.939	20	
Potassium	54.57	mg/L	1.0	55	0	99.2	75	125	0.739	20	
Selenium	0.5436	mg/L	0.050	0.5	0	109	75	125	1.62	20	
Silica	5.759	mg/L	0.16	5.885	0	97.9	75	125	2.30	20	
Silver	0.5035	mg/L	0.0050	0.5	0.0006	101	75	125	1.78	20	
Sodium	54.87	mg/L	1.0	50.5	0.0963	108	75	125	0.588	20	
Strontium	0.09588	mg/L	0.0060	0.1	0	95.9	75	125	2.65	20	
Thallium	0.5304	mg/L	0.050	0.5	0	106	75	125	0.196	20	
Vanadium	0.5107	mg/L	0.050	0.5	0.0018	102	75	125	1.45	20	

Sample ID: 0909384-07AMSD *MSD* Batch ID: **R35539** Analysis Date: 10/1/2009 1:43:32 PM

Analyte	Result	Units	PQL	SPK Va	SPK ref	%Rec	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Antimony	0.4851	mg/L	0.050	0.5	0.0141	94.2	75	125	0.124	20	
Silica	5.687	mg/L	0.16	5.885	0.0262	96.2	0	0	3.25	20	
Strontium	0.1015	mg/L	0.0060	0.1	0	101	75	125	1.04	20	
Zinc	0.5434	mg/L	0.050	0.5	0.0073	107	75	125	0.146	20	

Sample ID: MB *MBLK* Batch ID: **R35530** Analysis Date: 9/30/2009 3:49:18 PM

Analyte	Result	Units	PQL	SPK Va	SPK ref	%Rec	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Aluminum	ND	mg/L	0.020								
Arsenic	ND	mg/L	0.020								
Barium	ND	mg/L	0.020								
Beryllium	ND	mg/L	0.0030								
Boron	0.007577	mg/L	0.040								J
Cadmium	ND	mg/L	0.0020								
Chromium	ND	mg/L	0.0060								
Cobalt	ND	mg/L	0.0060								
Copper	ND	mg/L	0.0060								
Iron	ND	mg/L	0.020								
Lead	ND	mg/L	0.0050								
Manganese	ND	mg/L	0.0020								
Molybdenum	ND	mg/L	0.0080								
Nickel	ND	mg/L	0.010								

Qualifiers:

E	Estimated value	H	Holding times for preparation or analysis exceeded
J	Analyte detected below quantitation limits	ND	Not Detected at the Reporting Limit
R	RPD outside accepted recovery limits	S	Spike recovery outside accepted recovery limits

QA/QC SUMMARY REPORT

Client: Waste Isolation Pilot Plant
Project: SSW PZ-13
Work Order: 0909384

Method: EPA Method 6010B: Dissolved Metals

Sample ID: MB *MBLK* Batch ID: **R35530** Analysis Date: 9/30/2009 3:49:18 PM

Analyte	Result	Units	PQL	SPK Va	SPK ref	%Rec	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Potassium	ND	mg/L	1.0								
Selenium	ND	mg/L	0.050								
Silver	ND	mg/L	0.0050								
Thallium	ND	mg/L	0.050								
Vanadium	ND	mg/L	0.050								
Zinc	ND	mg/L	0.050								

Sample ID: MB *MBLK* Batch ID: **R35537** Analysis Date: 10/1/2009 9:56:26 AM

Analyte	Result	Units	PQL	SPK Va	SPK ref	%Rec	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Calcium	0.1116	mg/L	1.0								J
Magnesium	0.1942	mg/L	1.0								J
Silica	ND	mg/L	0.16								
Sodium	0.1709	mg/L	1.0								J
Strontium	ND	mg/L	0.0060								

Sample ID: MB *MBLK* Batch ID: **R35539** Analysis Date: 10/1/2009 1:02:41 PM

Analyte	Result	Units	PQL	SPK Va	SPK ref	%Rec	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Silica	ND	mg/L	0.16								
Strontium	ND	mg/L	0.0060								

Sample ID: MB *MBLK* Batch ID: **R35539** Analysis Date: 10/1/2009 2:31:49 PM

Analyte	Result	Units	PQL	SPK Va	SPK ref	%Rec	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Cobalt	ND	mg/L	0.0060								

Sample ID: LCS *LCS* Batch ID: **R35530** Analysis Date: 9/30/2009 3:52:32 PM

Analyte	Result	Units	PQL	SPK Va	SPK ref	%Rec	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Aluminum	0.5075	mg/L	0.020	0.5	0	101	80	120			
Arsenic	0.5053	mg/L	0.020	0.5	0	101	80	120			
Barium	0.4745	mg/L	0.020	0.5	0	94.9	80	120			
Beryllium	0.4938	mg/L	0.0030	0.5	0	98.8	80	120			
Boron	0.4978	mg/L	0.040	0.5	0.0076	98.1	80	120			
Cadmium	0.4913	mg/L	0.0020	0.5	0	98.3	80	120			
Chromium	0.4826	mg/L	0.0060	0.5	0	96.5	80	120			
Cobalt	0.4438	mg/L	0.0060	0.5	0	88.8	80	120			
Copper	0.4830	mg/L	0.0060	0.5	0	96.6	80	120			
Iron	0.5037	mg/L	0.020	0.5	0	101	80	120			
Lead	0.4803	mg/L	0.0050	0.5	0	96.1	80	120			
Manganese	0.4748	mg/L	0.0020	0.5	0	95.0	80	120			
Molybdenum	0.4941	mg/L	0.0080	0.5	0	98.8	80	120			
Nickel	0.4693	mg/L	0.010	0.5	0	93.9	80	120			
Potassium	63.12	mg/L	1.0	55	0	115	80	120			
Selenium	0.4857	mg/L	0.050	0.5	0	97.1	80	120			
Silver	0.4988	mg/L	0.0050	0.5	0	99.8	80	120			
Thallium	0.4919	mg/L	0.050	0.5	0	98.4	80	120			
Vanadium	0.4991	mg/L	0.050	0.5	0	99.8	80	120			
Zinc	0.4825	mg/L	0.050	0.5	0	96.5	80	120			

Sample ID: LCSD *LCS* Batch ID: **R35530** Analysis Date: 9/30/2009 3:55:58 PM

Analyte	Result	Units	PQL	SPK Va	SPK ref	%Rec	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Aluminum	0.4746	mg/L	0.020	0.5	0	94.9	80	120			
Arsenic	0.4764	mg/L	0.020	0.5	0	95.3	80	120			
Barium	0.4572	mg/L	0.020	0.5	0	91.4	80	120			
Beryllium	0.4668	mg/L	0.0030	0.5	0	93.4	80	120			

Qualifiers:

E	Estimated value	H	Holding times for preparation or analysis exceeded
J	Analyte detected below quantitation limits	ND	Not Detected at the Reporting Limit
R	RPD outside accepted recovery limits	S	Spike recovery outside accepted recovery limits

QA/QC SUMMARY REPORT

Client: Waste Isolation Pilot Plant
Project: SSW PZ-13 **Work Order:** 0909384

Analyte	Result	Units	PQL	SPK Val	SPK ref	%Rec	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Method: EPA Method 6010B: Dissolved Metals											
Sample ID: LCSD		*LCS*				Batch ID:	**R35530**	Analysis Date:		9/30/2009 3:55:58 PM	
Boron	0.4647	mg/L	0.040	0.5	0.0076	91.4	80	120			
Cadmium	0.4738	mg/L	0.0020	0.5	0	94.8	80	120			
Chromium	0.4654	mg/L	0.0060	0.5	0	93.1	80	120			
Cobalt	0.4289	mg/L	0.0060	0.5	0	85.8	80	120			
Copper	0.4623	mg/L	0.0060	0.5	0	92.5	80	120			
Iron	0.4659	mg/L	0.020	0.5	0	93.2	80	120			
Lead	0.4638	mg/L	0.0050	0.5	0	92.8	80	120			
Manganese	0.4571	mg/L	0.0020	0.5	0	91.4	80	120			
Molybdenum	0.4737	mg/L	0.0080	0.5	0	94.7	80	120			
Nickel	0.4528	mg/L	0.010	0.5	0	90.6	80	120			
Potassium	57.16	mg/L	1.0	55	0	104	80	120			
Selenium	0.4641	mg/L	0.050	0.5	0	92.8	80	120			
Silver	0.4781	mg/L	0.0050	0.5	0	95.6	80	120			
Thallium	0.4630	mg/L	0.050	0.5	0	92.6	80	120			
Vanadium	0.4808	mg/L	0.050	0.5	0	96.2	80	120			
Zinc	0.4643	mg/L	0.050	0.5	0	92.9	80	120			
Sample ID: LCS		*LCS*				Batch ID:	**R35537**	Analysis Date:		10/1/2009 9:59:39 AM	
Calcium	51.48	mg/L	1.0	50.5	0.1116	102	80	120			
Magnesium	50.53	mg/L	1.0	50.5	0.1942	99.7	80	120			
Sodium	49.69	mg/L	1.0	50.5	0.1709	98.1	80	120			
Sample ID: LCSD		*LCS*				Batch ID:	**R35537**	Analysis Date:		10/1/2009 10:02:55 AM	
Calcium	51.56	mg/L	1.0	50.5	0.1116	102	80	120			
Magnesium	50.53	mg/L	1.0	50.5	0.1942	99.7	80	120			
Sodium	49.58	mg/L	1.0	50.5	0.1709	97.8	80	120			
Sample ID: LCS		*LCS*				Batch ID:	**R35539**	Analysis Date:		10/1/2009 1:05:11 PM	
Silica	5.497	mg/L	0.16	5.885	0	93.4	80	120			
Strontium	0.09976	mg/L	0.0060	0.1	0	99.8	80	120			
Sample ID: LCSD		*LCS*				Batch ID:	**R35539**	Analysis Date:		10/1/2009 1:07:47 PM	
Silica	5.620	mg/L	0.16	5.885	0	95.5	80	120			
Strontium	0.1024	mg/L	0.0060	0.1	0	102	80	120			
Sample ID: LCS		*LCS*				Batch ID:	**R35539**	Analysis Date:		10/1/2009 2:34:23 PM	
Cobalt	0.5302	mg/L	0.0060	0.5	0	106	80	120			
Sample ID: LCSD		*LCS*				Batch ID:	**R35539**	Analysis Date:		10/1/2009 2:36:46 PM	
Cobalt	0.5190	mg/L	0.0060	0.5	0	104	80	120			
Sample ID: 0909384-07AMS		*MS*				Batch ID:	**R35537**	Analysis Date:		10/1/2009 9:49:30 AM	
Aluminum	0.5216	mg/L	0.020	0.5	0	104	75	125			
Arsenic	0.5441	mg/L	0.020	0.5	0	109	75	125			
Barium	0.5097	mg/L	0.020	0.5	0	102	75	125			
Beryllium	0.5157	mg/L	0.0030	0.5	0.0003	103	75	125			
Boron	0.5314	mg/L	0.040	0.5	0	106	75	125			
Cadmium	0.5155	mg/L	0.0020	0.5	0	103	75	125			
Calcium	51.97	mg/L	1.0	50.5	0	103	75	125			
Chromium	0.5120	mg/L	0.0060	0.5	0	102	75	125			

Qualifiers:

E	Estimated value	H	Holding times for preparation or analysis exceeded
J	Analyte detected below quantitation limits	ND	Not Detected at the Reporting Limit
R	RPD outside accepted recovery limits	S	Spike recovery outside accepted recovery limits

QA/QC SUMMARY REPORT

Client: Waste Isolation Pilot Plant
Project: SSW PZ-13
Work Order: 0909384

Analyte	Result	Units	PQL	SPK Va	SPK ref	%Rec	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Method: EPA Method 6010B: Dissolved Metals											
Sample ID: 0909384-07AMS		*MS*				Batch ID:	**R35537**	Analysis Date:		10/1/2009 9:49:30 AM	
Cobalt	0.5141	mg/L	0.0060	0.5	0.0042	102	75	125			
Copper	0.4915	mg/L	0.0060	0.5	0	98.3	75	125			
Iron	0.5631	mg/L	0.020	0.5	0.0498	103	75	125			
Lead	0.5154	mg/L	0.0050	0.5	0	103	75	125			
Magnesium	51.38	mg/L	1.0	50.5	0.0237	102	75	125			
Manganese	0.5056	mg/L	0.0020	0.5	0.0035	100	75	125			
Molybdenum	0.5195	mg/L	0.0080	0.5	0	104	75	125			
Nickel	0.4998	mg/L	0.010	0.5	0	100	75	125			
Potassium	54.16	mg/L	1.0	55	0	98.5	75	125			
Selenium	0.5348	mg/L	0.050	0.5	0	107	75	125			
Silica	5.628	mg/L	0.16	5.885	0	95.6	75	125			
Silver	0.5126	mg/L	0.0050	0.5	0.0006	102	75	125			
Sodium	54.55	mg/L	1.0	50.5	0.0963	108	75	125			
Strontium	0.09338	mg/L	0.0060	0.1	0	93.4	75	125			
Thallium	0.5314	mg/L	0.050	0.5	0	106	75	125			
Vanadium	0.5181	mg/L	0.050	0.5	0.0018	103	75	125			
Sample ID: 0909384-07AMS		*MS*				Batch ID:	**R35539**	Analysis Date:		10/1/2009 1:40:54 PM	
Antimony	0.4845	mg/L	0.050	0.5	0.0141	94.1	75	125			
Zinc	0.5426	mg/L	0.050	0.5	0.0073	107	75	125			

Qualifiers:

E	Estimated value	H	Holding times for preparation or analysis exceeded
J	Analyte detected below quantitation limits	ND	Not Detected at the Reporting Limit
R	RPD outside accepted recovery limits	S	Spike recovery outside accepted recovery limits

Hall Environmental Analysis Laboratory, Inc.

Sample Receipt Checklist

Client Name WIPP

Date Received: 9/18/2009

Work Order Number 0909384

Received by: AT

Sample ID labels checked by: ____ Initials

Checklist completed by: ____ Signature 09/18/09 Date

Matrix:

Carrier name FedEx

Shipping container/cooler in good condition?	Yes ☑	No ☐	Not Present ☐	
Custody seals intact on shipping container/cooler?	Yes ☑	No ☐	Not Present ☐	Not Shipped ☐
Custody seals intact on sample bottles?	Yes ☑	No ☐	N/A ☐	
Chain of custody present?	Yes ☑	No ☐		
Chain of custody signed when relinquished and received?	Yes ☑	No ☐		
Chain of custody agrees with sample labels?	Yes ☑	No ☐		
Samples in proper container/bottle?	Yes ☑	No ☐		
Sample containers intact?	Yes ☑	No ☐		
Sufficient sample volume for indicated test?	Yes ☑	No ☐		
All samples received within holding time?	Yes ☑	No ☐		Number of preserved bottles checked for pH:
Water - VOA vials have zero headspace?	No VOA vials submitted ☑	Yes ☐	No ☐	
Water - Preservation labels on bottle and cap match?	Yes ☑	No ☐	N/A ☐	7
Water - pH acceptable upon receipt?	Yes ☐	No ☑	N/A ☐	[✓ <2] >12 unless noted below.
Container/Temp Blank temperature?	4.8°	<6° C *Acceptable* If given sufficient time to cool.		

COMMENTS:

Client contacted ____ Date contacted: ____ Person contacted ____

Contacted by: ____ Regarding: ____

Comments: Samples filtered & preserved in lab / AT 09/18/09

Corrective Action ____

REQUEST FOR ANALYSIS

WASTE ISOLATION PILOT PLANT
P.O. BOX 2078
CARLSBAD, NM 88221-2078

DATE SAMPLES SHIPPED 9/17/09

RFA Control № 9126

LAB DESTINATION Hall Env. Anal. Labs

LABORATORY CONTACT Andy Freeman/Kacey Gutierrez

SEND LAB REPORT TO Rick Salness
PO Box 2078
Carlsbad, NM 88221

C of C Control № 9126

4.8° AT 09/18/09

DATE REPORT REQUIRED 30 days upon rept.

PROJECT CONTACT Rick Salness

PROJECT CONTACT PHONE NO. 575-234-8966

SAMPLING PROGRAM SSW PZ-13

PURCHASE ORDER NO. TO 409304-2

Sample Number	Sample Type	Sample Quantity	Preservative	Req't. Testing Program	Special Instructions
SSWPZ13091409NI	water	500mL	none	EPA Method	
SSWPZ13091509NI				6010B except	• samples filtered
SSWPZ13091609NI				Uranium	at lab
SSWPZ13091709NI					
SSWPZ13091709NID				EPA Method	
SSWPZ13091709EB				6020 for	
SSWPZ13091709FB				Uranium	
		DW			
		9/17/09			

TURNAROUND TIME REQUIRED: (Rush must be approved by appropriate Manager) NORMAL X RUSH ______ (Subject in rush surcharge)

POSSIBLE HAZARD IDENTIFICATION: (Please indicate if sample(s) are hazardous materials and/or suspected to contain high levels of hazardous substances.)

NONHAZARD X FLAMMABLE ______ SKIN IRRITANT ______ HIGHLY TOXIC ______ BIOLOGICAL ______ OTHER ______ (Specify)

SAMPLE DISPOSAL: (Please indicate disposition of sample following analysis.) RETURN TO CLIENT ______ DISPOSAL BY LAB X

FOR LAB USE ONLY

RECEIVED BY

DATE/TIME 09/18/09 0930

WP 02-EM3001

WHITE - Original to accompany samples

YELLOW - Field copy

PINK - Other

NICHOLS PRINTING INC.

CHAIN-OF-CUSTODY RECORD

WASTE ISOLATION PILOT PLANT
P.O. BOX 2078
CARLSBAD, NM 88221-2078

4.5

C of C Control № 9126

RFA Control № 9126

SAMPLING PROGRAM SSW PZ-13

LAB DESTINATION Hall Env. Anal. Labs

SAMPLE TEAM MEMBERS D. Waterson, R. Salness

CARRIER/WAYBILL NO. FedEx 8681 3702 8663

Sample Number	Sample Location and Description	Date and Time Collected	Sample Type	Container Type	Condition on Receipt (Name and Date)	Disposal Record No.
SSWPZ13091409N1	PZ13, water	9/14/09, 1012	water	500mL plastic	0909384 -	1
SSWPZ13091509N1		9/15/09, 1053			-	2
SSWPZ13091609N1		9/16/09, 1140			-	3
SSWPZ13091709N1		9/17/09, 1220			-	4
SSWPZ13091709N1D		9/17/09, 1224			-	5
SSWPZ13091709EB		9/17/09, 1333			-	6
SSWPZ13091709FB		9/17/09, 1327			-	7
		DW 9/17/09				

Special Instructions: filter samples at lab

Possible Sample Hazards: High TDS → above 240,000 mg/L

SIGNATURES: (Name, Company, Date and Time)

1. Relinquished By: WRES, 9/17/09, 1530

Received By: 09/18/09 0930

2. Relinquished By:

Received By:

3. Relinquished By:

Received By:

4. Relinquished By:

Received By:

WP 02-EM3001

WHITE - Original to accompany samples

YELLOW - Field copy

PINK - Other

NICHOLS PRINTING INC.

Appendix G

Geochemical Modeling and Analysis

Appendix G. Geochemical Modeling and Analysis

Geochemical modeling was used to evaluate the water quality in PZ-13 in relation to the mineralogy of the geologic formations that may influence the SSW. Because of the high chloride concentration of the saline SSW in PZ-13, the solubility of lead is elevated and the mobility, fate, and transport depart from behavior reported in the literature for typical low-ionic strength aqueous systems. Water in PZ-13 has the highest TDS concentration detected in any of the SSW wells and is almost saturated with respect to halite and other evaporite minerals. These conditions complicate predictions of the potential for attenuation of the lead; however, it is also necessary to consider the hydrogeologic context of the SSW at PZ-13, which could sharply limit the potential for migration. This section presents general principles framing the analysis of lead geochemistry, explains the selection of the model approach and thermodynamic database, and discusses results of geochemical modeling analyses.

G.1 Geochemistry Background

Mobilization and transport of lead are controlled by both hydrologic and geochemical processes. Lead is considered to be relatively immobile to highly mobile depending on ambient physicochemical conditions (Smith and Huyck, 1999). The geochemical processes involved in lead mobilization and transport include mineral dissolution, metal solubility, sorption, and diffusion. Diffusion is relatively slow under low concentration gradients but can be significant when concentration gradients are high. Given the relatively low concentrations of lead detected in the SSW with respect to other constituents, diffusion can be considered a minor factor. The following discussion will briefly outline the more significant geochemical processes with respect to lead occurrences in PZ-13.

Metal dissolution and solubility are governed by the chemical composition and atomic structure of the host mineral and the physicochemical conditions to which it is exposed. In the presence of aqueous media, minerals may be at or close to equilibrium if they were deposited at ambient conditions, or far from equilibrium if crystallized at conditions that existed in the past and if dissolution reactions are kinetically inhibited. For a given mineral/solid source, the primary differences in aqueous mobility at near-surface low-temperature conditions arise as a result of pH, TDS (ionic strength), and oxidation/reduction (redox) conditions. pH and redox are considered “master variables” with respect to solid-phase stability and aqueous-phase composition. pH is governed by mineral reactions and is usually buffered at circumneutral conditions by reactions with soil and rock minerals in most natural waters unless oxidation of sulfides, organics, and transition metals is occurring or there is a discharge of acid from some source. Redox conditions are primarily governed by the organic, sulfide, gas, and water content of the media, whether it is a waste pile, soil, sediment, or other geologic media. Unsaturated conditions are usually oxidizing relative to saturated conditions. For saturated conditions, oxygen is usually limited (unless the rate of flow is very rapid) and reducing conditions may occur.

Common lead salts such as anglesite ($PbSO_4$) and cerussite ($PbCO_3$) dissolve relatively rapidly in aqueous media until saturation concentrations are reached. Lead sulfides (e.g., galena [PbS]) dissolve more slowly because oxidation is the rate-limiting step. Galena oxidizes at a rate that is about twice as high as pyrite under similar physicochemical conditions (Rimstidt et al., 1994). Therefore, under conditions conducive to the formation of acidic leaching (relatively oxidizing conditions), galena can be expected to contribute lead. However, lead concentrations in acidic rock leaching conditions are often limited by anglesite solubility due to the high concentration of sulfate. In fresh water, lead concentrations are more often limited by cerussite or hydrocerussite solubility and adsorption due to higher pH conditions and alkalinity (Langmuir, 1997).

Metal solubility is dependent on the aqueous chemical composition, temperature, and pressure. Chloride generally does not complex with metals under surficial conditions in fresh water, but higher concentrations can increase solubility due to complexation. This is true for lead and other cations. Other common anions such as sulfate, carbonate, phosphate, nitrate, and organic compounds form metal complexes and may increase or decrease solubility.

Solubility controls some metal concentrations in soils and rock; however, trace metal mobility in soils and rocks is highly influenced by presence of iron hydroxides, clays, and organic matter, which have high surface areas that promote binding with metals through adsorption and ion exchange reactions. Adsorption and ion exchange depend on many factors, including solution pH, temperature, the composition and structure of the solid surface, and the composition of the solution (which may precipitate surface functional groups that promote adsorption).

Metal mobility in soils and rock is very difficult to predict due to the highly variable chemical and physical properties and the effects of climate. A qualitative prediction of metal and other constituent mobility in surficial environments is provided by Railsback (2008) and Smith and Huyck (1999). Lead is most mobile under reducing conditions in the absence of hydrogen sulfide. Lead is moderately concentrated in soils due to its tendency to adsorb to silicates and oxides. Concentrations of metals in soil pore water and in groundwater depend upon infiltration rates, permeability, and moisture content, as well as the physical and chemical properties of soil media and aquifers. Concentrations of most metals in soil water and groundwater located in undisturbed areas are usually low because of initially low concentrations in the geologic media, acid-base buffering reactions, chemical precipitation, and sorption by soil particles.

G.2 Model Theory and Selection

The numerical geochemical model PHREEQC (Parkhurst and Appelo, 1999) was used to calculate saturation indices for minerals of lead and major ions. Aqueous speciation calculation, saturation indices, and other geochemical equilibrium reaction simulations require the determination of activity coefficients for each major ion in solution. The analysis relied primarily on data for the first water sample collected from PZ-13 on October 10, 2007 because it was the only sample for which lead and all the major ions were measured simultaneously (subsequent samples had similar concentrations of the individual analytes measured at any given time). The density of the brine was estimated from the measured TDS concentration using the site-specific regression developed for the SSW by DBS&A (2008). Due to the high ionic strength of the brine in PZ-13 (molarity greater than 4), it was necessary to employ a Pitzer (1991) model approach using the Harvie-Moller-Weare (1984) database with additional parameters for lead and other analytes, as explained below. According to a recent analysis plan intended for use with deep brines at WIPP (Ismail, 2008), Sandia National Laboratories is developing its own thermodynamic database including Pitzer model parameters for lead. The database was not available as of this assessment; however, future analysis should consider whether the database is appropriate for the SSW in order to employ consistent methods for different analyses at WIPP.

Thermodynamic equilibrium theory is used to describe the chemical state of phases such as water, aqueous solutions, and solids (minerals and amorphous materials) and their interactions. The equilibrium reaction between phases or components of a phase is described by a mass balance relationship such as the simple dissociation reaction of salt in water:

$$NaCl \leftrightarrow Na^{+} + Cl^{-}$$

where the presence of water on both sides of the reaction is implied.

The degree to which the dissociation reaction occurs is described by the equilibrium mass action constant (K), for example:

$$K = \frac{\left[Na^{+}\right]\left[Cl^{-}\right]}{\left[NaCl\right]}$$

where the square bracket notation indicates the activity of the species and all species are measured at equilibrium. If the activities are measured at existing conditions rather than equilibrium, the same ratio is denoted as Q. Saturation with respect to a particular mineral species is quantified as a saturation index (SI), as follows:

$$SI = \log_{10}\left(\frac{Q}{K}\right)$$

Positive values of the saturation index indicate that the solution is supersaturated with respect to the mineral (i.e., at equilibrium the mineral should precipitate). Negative values indicate that the solution is undersaturated (i.e., more of the mineral can dissolve before reaching equilibrium). Values that are close to or equal to zero reflect saturation with respect to the mineral, such that no net dissolution or precipitation is predicted to occur. Non-equilibrium conditions may persist if the relevant reactions are kinetically slow.

The concept of activity accounts for the fact that the effective concentration, in terms of the solute's availability to participate in the equilibrium reaction, is not always the same as the mass concentration due to electrostatic and covalent interactions of ions in solution. It should be noted that the degree of dissociation and complexation of ions is a mathematical construct that facilitates chemical equilibrium calculations. In reality, the degrees of formation and dissociation of molecular complexes in solution are somewhat arbitrary (Nordstrom and Munoz, 1985). Alternative activity models often define different degrees of dissociation and complexation.

The activity (α) is related to concentration by the following relationship:

$$\alpha = \frac{\gamma \cdot c}{M}$$

where c = the mass concentration
M = the molecular mass of the substance
γ = the activity coefficient, which is equal to unity for pure solids and ions in very dilute solutions at standard state condition

The activity coefficient is a function of the composition of the aqueous solution and pressure and temperature of the water.

To determine aqueous speciation and other equilibrium properties, such as mineral solubility and the distribution of components between solid and aqueous phases, it is necessary to calculate the osmotic coefficient (water activity) and activity coefficients of the dissolved components. Historically, there have been two classes of models used to estimate activity coefficients in natural waters: ion association and ion interaction. Most applications of geochemical models that compute the distribution of aqueous species in relatively dilute natural waters employ various versions of the ion interaction model known as the Debye-Hückel equation (Debye and Hückel, 1923) because the databases developed for this approach are more comprehensive and are widely applicable over the range of concentrations found in most natural waters. The Debye-Hückel equation assumes that strong electrolytes such as NaCl are completely dissociated in solution and that only electrostatic long-range interactions are occurring in a solution. These models therefore only consider interactions between pairs of individual ions of opposite sign, as these attractive forces are the strongest. These models are based on specific ion interaction theory and only require parameters for the solvent (e.g., density and dielectric constant of water), the total concentration of solutes (i.e., ionic strength), and specific ion fitting parameters. Modifications of the Davies equation such as the Truesdell-Jones (1974) equation account for shorter-range ion interactions that become more important at higher solution concentrations (i.e., higher ionic strengths); however, even these equations become inaccurate at very high concentrations (molarities up to 2) and when species other than chloride are present at significant concentrations.

Ion association reactions have been successfully incorporated into the ion interaction model using a virial activity coefficient model developed by Pitzer (1991). The Pitzer equations are more comprehensive, and treat interactions between pairs of ions of like sign and among triplets of ions, as well as Coulomb interactions of species of opposite charge. The Pitzer model has been used successfully for calculations of solubility in NaCl brines to ionic strengths of 10 to 15 moles per kilogram (mol/kg) (Pitzer, 1991). However, the Pitzer model may not be as accurate for the calculation of trace metal activity coefficients because the activity coefficient parameters for some species of importance are not available. In addition, the high concentrations of major ions like Na^+, K^+, Ca^{2+}, Mg^{2+}, Cl^-, and SO_4^{2-} in the SSW are not known to as high a degree of accuracy and precision as the trace elements due to the necessity to dilute the samples for chemical analysis, the need to avoid precipitation of solids from matrix spike samples, and the potential for matrix interferences (IT, 1997; TraceAnalysis, 2007). Therefore, small relative variations and errors can cause large differences in the calculation of ionic strength and activity coefficients. However, the electrical charge balance of the PZ-13 sample from October 10, 2007 is within typical acceptability criteria of ±10 percent for aqueous speciation modeling (Alpers and Nordstrom, 1999).

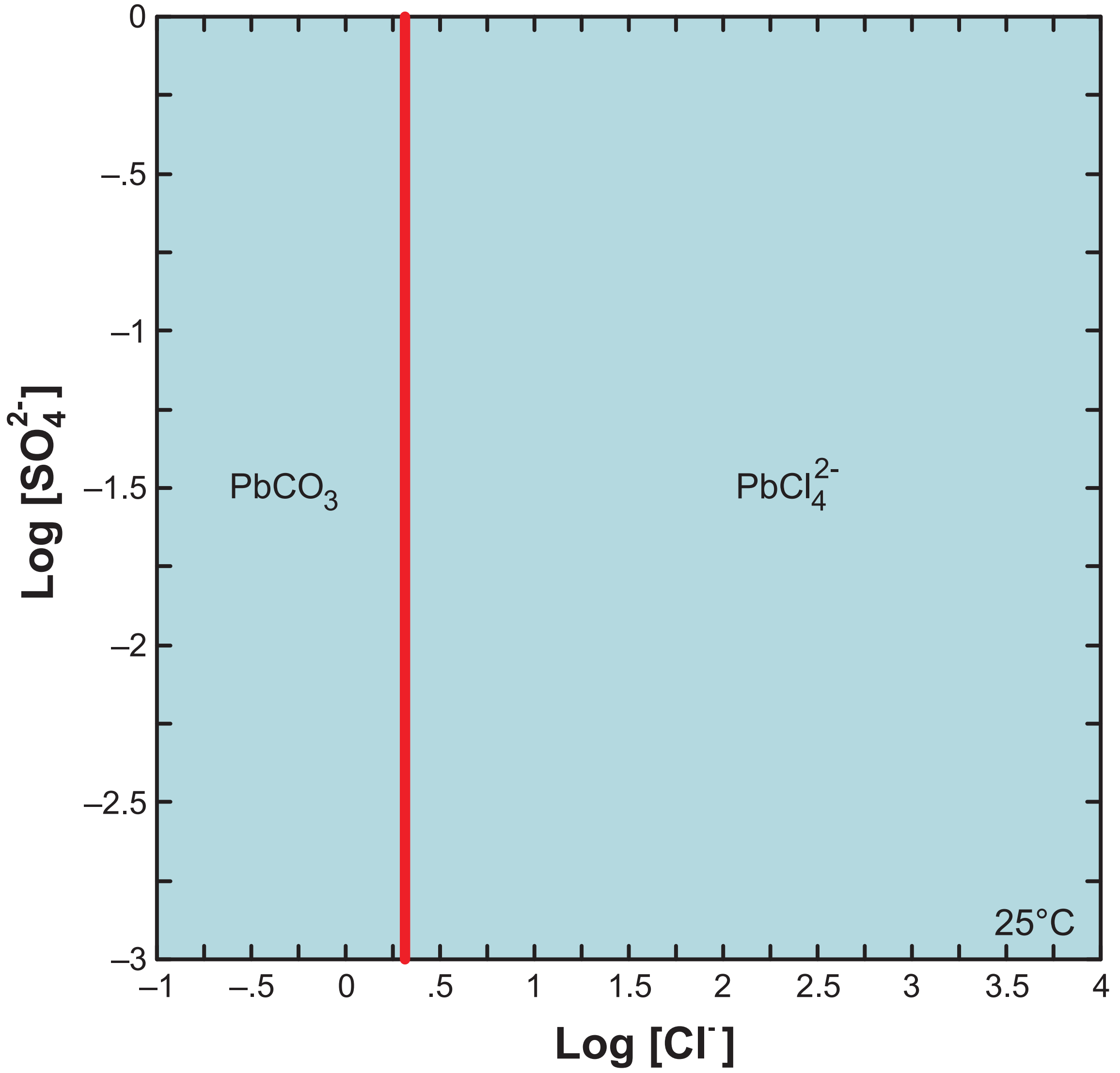
Aqueous speciation modeling of trace elements will be most successful if the ion interaction parameters for the most abundant species are available. Chloride is the most abundant anion in the PZ-13 and other SSW samples. The ion interaction and mineral thermodynamic database developed by Harvie et al. (1984) has been used successfully in the determination of major ion activity coefficients in seawater and evaporites and WIPP SSW samples (DBS&A, 2008) using the Pitzer (1991) model. The Pitzer database for PHREEQC (Parkhurst and

Appelo, 1999) is an extension of the highly successful Harvie et al. (1984) database for the purposes of aqueous speciation and solubility index modeling for solutions of high ionic strength. Pitzer (1991) determined the ion interaction parameters for lead-chloride and lead nitrate systems; these interaction parameters were added to the Pitzer database without evoking explicit metal complex formation according the approach taken by Downes and Pitzer (1976) for the NaCl, $NaSO_4$, $CuCl_2$, and $CuSO_4$ system at 25°C. In addition, other interaction parameters for lead-sulfate were estimated from copper-sulfate interaction parameters determined experimentally (Downes and Pitzer, 1976). Many speciation models of seawater predict that $PbCO_3$ will be the predominant lead species in solution (Pitzer, 1991); therefore, it was added as an explicit complex in the database. However, it should be cautioned that lead concentrations in seawater are very low and speciation calculations at these levels are subject to many sources of error. $PbCO_3$ was not determined to be a significant species in the PZ-13 sample by speciation modeling.

G.3 Lead Speciation Modeling

The activity diagram shown in Figure G-1 shows that $PbCl_4^{2-}$ is predominant at high chloride activities, whereas the uncharged, aqueous $PbCO_3$ species is predominant in fresh water regardless of sulfate activity. The Pitzer model used for these simulations does not explicitly incorporate the formation of lead-chloride complexes. However, the model results are reasonable with respect to the predicted activity of trace concentrations of lead. Langmuir (1997) surmises that trace metal activity coefficients can be compared to major element activity coefficients to determine the relative accuracy of a speciation model. Figure G-2 shows that the activity coefficient for Pb^{2+} is within an order of magnitude of the activity coefficient of Ca^{2+} over a range of ionic strengths.

The concentrations of phosphate have not been determined for SSW samples and the saturation state of lead phosphates is unknown. Lead phosphates are relatively insoluble except when low total phosphate concentrations combine with very high chloride concentrations like those detected in PZ-13 (Figure G-3). The tan shading in Figure G-3 indicates that in the regime where chloropyromorphite predominates, it tends to precipitate out of solution. Although



Explanation

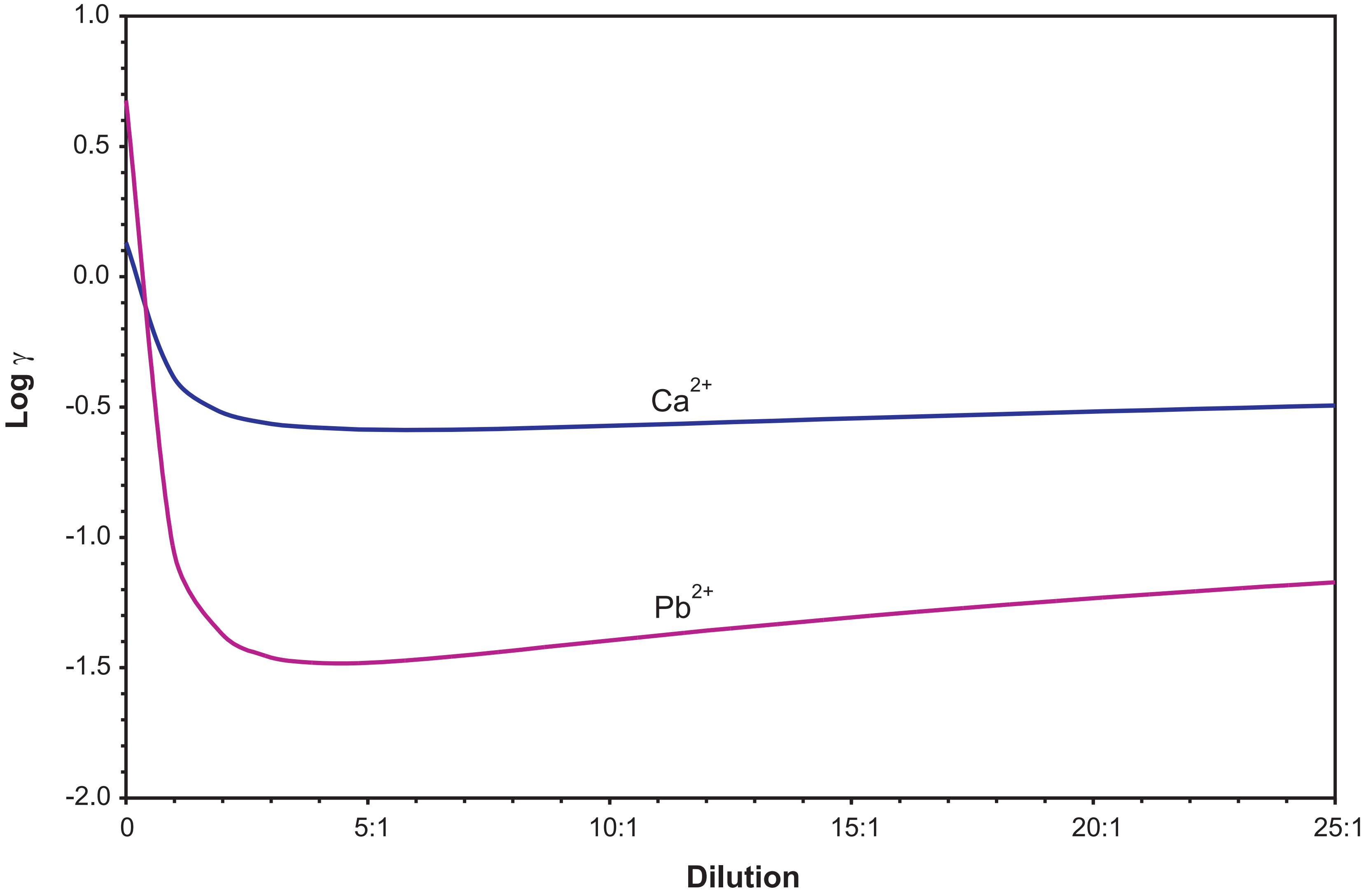
🟦 Dissolved phase

WIPP LEAD ASSESSMENT

Lead Stability Fields for Approximate PZ-13 Composition with Variable Sulfate and Chloride Activities

Daniel B. Stephens & Associates, Inc.
6-12-09
JN ES08.0072

Figure G-1



WIPP LEAD ASSESSMENT

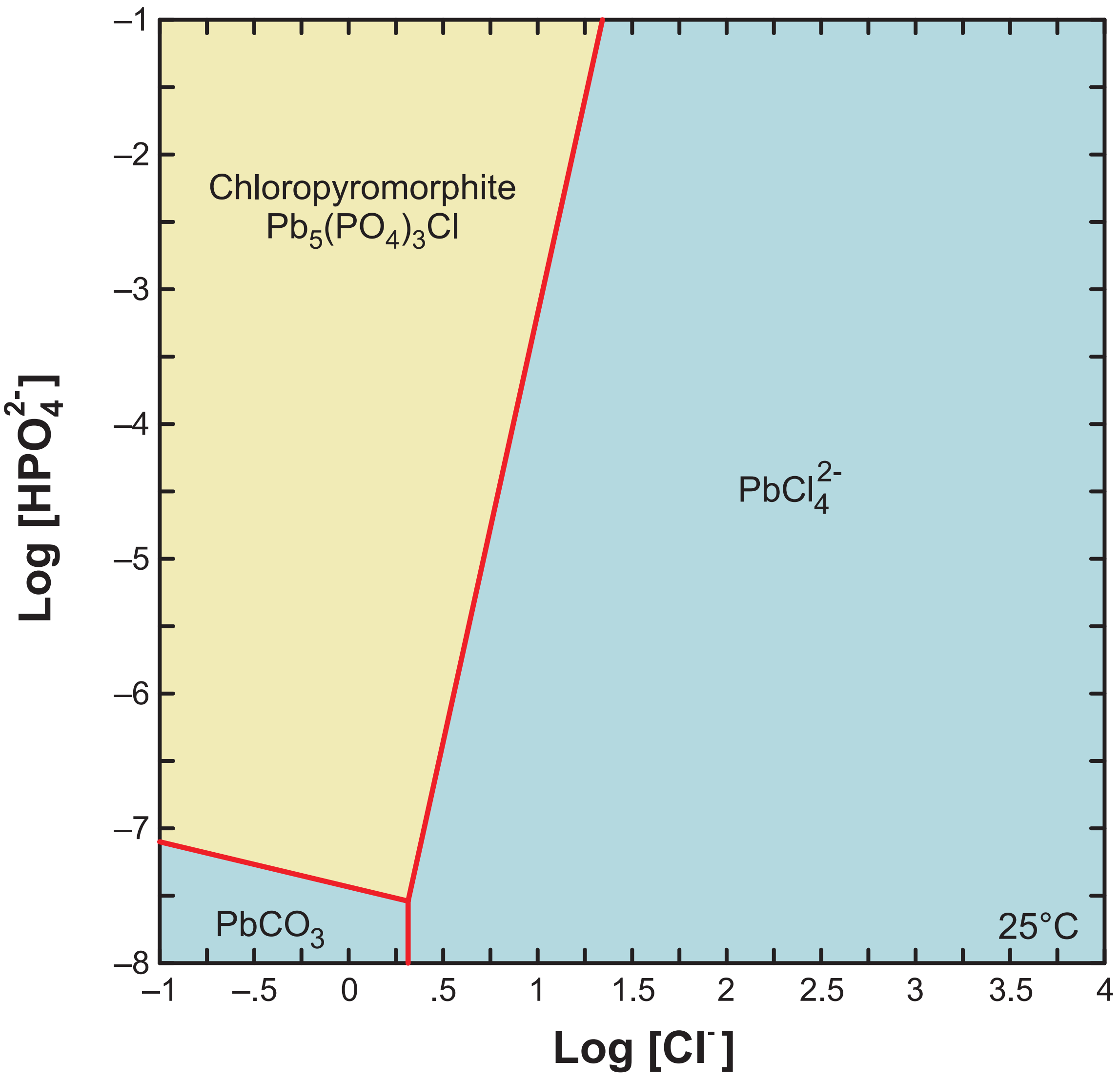
Modeled Activity Coefficients Over Dilution to 10,000 mg/L TDS

Figure G-2

Daniel B. Stephens & Associates, Inc.

6-12-09

JN ES08.0072



Explanation

🟨 Solid phase

🟦 Dissolved phase

WIPP LEAD ASSESSMENT

Lead Stability Fields for Approximate PZ-13 Composition with Variable Phosphate and Chloride Activities

Daniel B. Stephens & Associates, Inc.

6-12-09

JN ES08.0072

Figure G-3

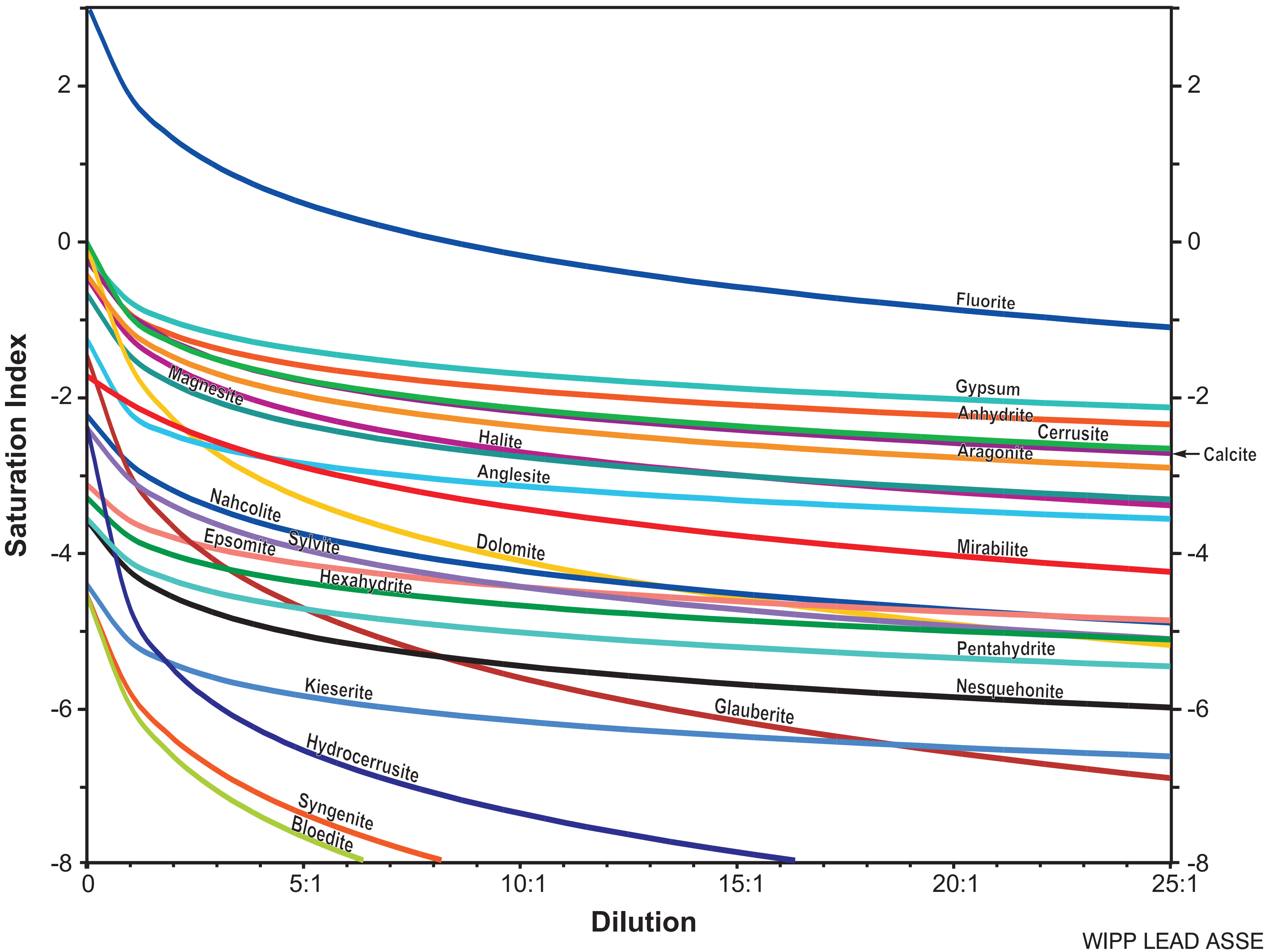
the nature of the construction debris and the mineralogy of the rocks in the SPDV pile suggest that only very minor amounts of phosphate are present, the effect of the addition of small amounts of phosphate to the aqueous phase could still be significant. Perchlorate, if present, could also have significant control over lead speciation, and concentrations of perchlorate in SSW samples have likewise not been determined. There is no specific mention of perchlorate in the materials disposed in the SPDV pile, but perchlorate has been documented to occur in potash from the region (Orris et al., 2003), and in numerous anthropogenic sources.

G.4 Calculation of Solubility

The PHREEQC model was used to calculate saturation indices for PZ-13 water quality and water with lower salinity levels, which is characteristic of the SSW. Based on the water quality input, the model selects the important minerals that are potentially associated with the ionic species in solution. Each of the minerals involved is defined in Table B-1. The model simultaneously solves for the saturation indices of all minerals with sufficient data from measured analytes and from the thermodynamic database (Figure G-4).

Figure G-4 shows the saturation indices calculated for lead-bearing minerals and other primary minerals associated with the PZ-13 water quality. The PZ-13 water quality is represented by the zero-dilution line on Figure G-4, whereas more dilute solutions are represented by the dilution ratios up to 25:1, which represents a TDS concentration of approximately 10,000 mg/L. Figure G-4 indicates that the PZ-13 water sample is saturated (SI = 0.0) with respect to lead carbonate (cerussite), but undersaturated with respect to lead sulfates and other lead minerals in this system.

In addition to cerussite, the following minerals are near saturation at the observed composition of PZ-13 water: halite, anhydrite, gypsum, calcite, magnesite, and dolomite. Fluorite is supersaturated before dilution and is the only mineral that remains saturated in the PZ-13 solution during dilution. High chloride concentrations suppress fluoride solubility because the chloride-fluoride interactions increase the activity of fluoride, which is similar to the common ion effect. Because no other minerals are near saturation except at the starting concentrations, and assuming lead concentrations do not increase by orders of magnitude above concentrations



WIPP LEAD ASSESSMENT

Saturation State of Minerals in PZ-13 Water Over Dilution to 10,000 mg/L TDS

Figure G-4

Daniel B. Stephens & Associates, Inc.
6-12-08
JN ES08.0072

observed to date, precipitation and co-precipitation are not expected to be significant sinks for lead. This conclusion bears the caveat that the model's implicit lack of phosphate or perchlorate in the system has not been confirmed with analytical data.

Dilution of the observed PZ-13 water composition was simulated to determine if the reduction in chloride levels and ionic strength would result in saturation with respect to lead phases (e.g., if the dominant lead species shifted from $PbCl_4^{2-}$ to $PbCO_3$). Cerussite is currently at saturation and quickly becomes undersaturated as dilution proceeds. No saturation limit for any lead mineral is reached during progressive dilution to a final TDS concentration below 10,000 mg/L. Lead concentrations followed a conservative mixing curve. The degree of mixing required to dilute the TDS concentration of PZ-13 water to less than 10,000 mg/L would simultaneously dilute the lead concentration to below the federal drinking water action level of 0.015 mg/L, provided that the lead concentration at PZ-13 does not rise beyond its current level.

The upper solubility of primary lead minerals was investigated by simulating saturation with anglesite ($PbSO_4$) and cerussite ($PbCO_3$) in PZ-13 quality water followed by progressive dilution to a TDS concentration of approximately 10,000 mg/L with fresh water. The simulated dilution represents the hypothetical migration of the brine into distant groundwater (ignoring, for the sake of argument, hydrogeologic limits to such scenarios). Anglesite and cerussite were selected for the simulated initial saturation because sulfate and bicarbonate are the second and third most abundant anions after chloride in the water sample. The predicted solubility of lead in the presence of excess anglesite and cerussite is about 10^{-4} and 10^{-5} molal, respectively given the inferred accuracy of the model. Therefore, the lead solubility after dilution of the brine with fresh water is 1 to 2 orders of magnitude higher than the observed concentration, and lead would remain in solution if it were mixed with water that is more dilute than observed PZ-13 water.

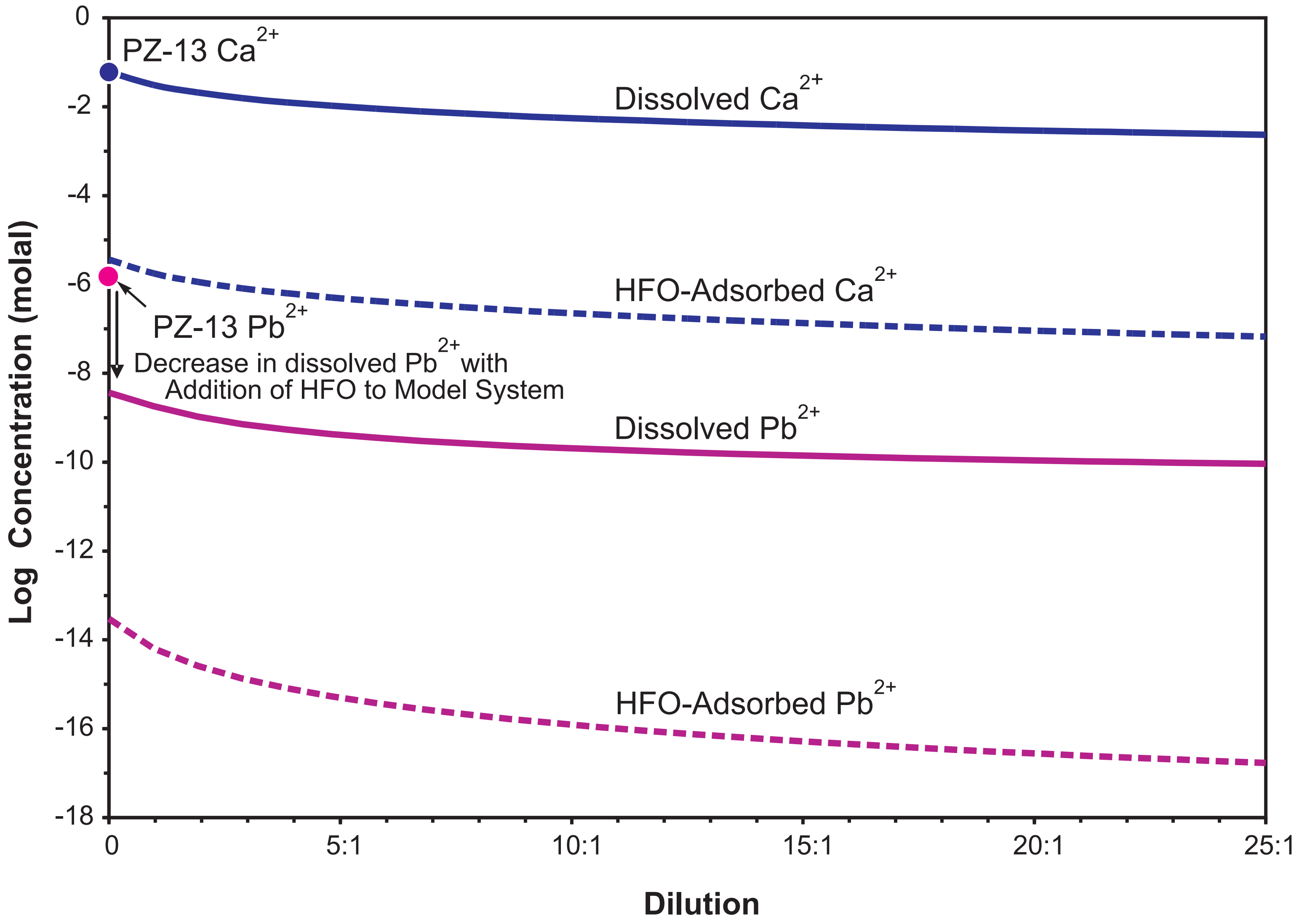
G.5 Assessment of Lead Adsorption

Lead is susceptible to adsorption, as indicated by the compilations of partition coefficients provided in Appendix H. Partition coefficients are only valid under the conditions in which they are measured and range from 20 to 400,000 depending on pH condition, TDS concentration, and the nature of the substrate. The sorption edge for lead is between pH 3 and pH 5 (Smith, 1999); therefore, lead is readily sorbed at circumneutral conditions found in most groundwater and in SSW at the WIPP site.

Briny solutions like PZ-13 water suppress adsorption because the major ions compete with lead for surface sites. Sorption simulations (Figure G-5) using a conservative adsorption model for hydrous ferric oxides (HFO) (Dzombak and Morel, 1990) show that the mass of lead adsorbed at the high chloride concentration of the PZ-13 water is about two orders of magnitude higher than the mass adsorbed from SSW that is diluted to a TDS concentration of 10,000 mg/L. Adsorption of lead by HFO reduces the aqueous concentration by over two orders of magnitude at the observed composition of PZ-13 water. The mass of lead adsorbed declines with dilution as total lead concentration decreases; the amount of decline depends on changing activity coefficients and effects of competing ions such as Ca^{2+}.

Because most sorption experiments are conducted at low ionic strength and theoretical isotherms are based on these experiments, a determination of the sorption capacity of the subsurface formations with respect to lead is difficult. Partition coefficients are also highly dependent upon the nature of the substrate (see compilations in Appendix H), which is highly heterogeneous.

The theoretical calculations of lead adsorption to HFO presented are preliminary because the iron contents of the water and formations near PZ-13 are unknown and had to be estimated. Batch adsorption experiments using PZ-13 water and formation core samples would be necessary to quantify the maximum sorption capacity with any degree of confidence. However, it is reasonable to expect the abundant iron mineral surfaces in the Santa Rosa and Dewey Lake to provide substantial sorption capacity. In addition, the HFO model parameters determined for the generalized two-layer sorption model by Dzomback and Morel (1990) are largely restricted to relatively low ionic strength solutions. Notwithstanding these limitations, one can expect adsorption to provide a significant barrier to migration of lead away from its source and a mechanism of attenuation near the source; however, precise modeling of these processes should not be ventured without additional site-specific data. Figure G-5 shows that



WIPP LEAD ASSESSMENT

Hydrous Ferric Oxides (HFO) Double Layer Surface Complexation

Daniel B. Stephens & Associates, Inc.
6-10-08
JN ES08.0072

Figure G-5

HFO adsorption is expected to decrease dissolved lead concentrations by about two orders of magnitude and that dissolved lead would continue to decrease with dilution.

References

Alpers, C.N. and D.K. Nordstrom. 1999. Geochemical modeling of water rock interactions in mining environments. *Chapter 14 in* Plumlee, G.S. and M.J. Logsdon (eds.), The environmental geochemistry of mineral deposits, Part A: Processes, techniques, and health issues. *Reviews in Economic Geology* (6A):289-323.

DBS&A. 2008. *Hydrologic assessment of shallow subsurface water, Waste Isolation Pilot Plant, Carlsbad, New Mexico.* Prepared for Washington TRU Solutions LLC. December 18, 2008.

Debye, P. and E. Hückel. 1923. On the theory of electrolytes. *Physikalische Zeitschrift* 24(9):185-208, 305-325.

Downes, C.J., and K.S. Pitzer. 1976, Thermodynamics of electrolytes. binary mixtures formed from aqueous NaCl, Na_2S0_4, $CuCl_2$, and $CuSO_4$ at 25 Degrees C. *Journal of Solution Chemistry* 5(6):389-398.

Dzombak, D.A. and F.M.M. Morel. 1990. *Surface complexation modeling, Hydrous ferric oxide.* John Wiley and Sons, New York. 393p.

Harvie, C.E., N. Moller, and J.H. Weare. 1984. The prediction of mineral solubilities in natural waters: The Na-K-Mg-Ca-H-Cl-SO_4-OH-HCO_3-CO_3-CO_2-H_2O system to high ionic strengths at 25°C. *Geochimica Cosmochimica Acta* 48(4):723-751.

Ismail, A.E. 2008. *Calculation of new Pitzer parameters for the WIPP FMT and EQ3/6 thermodynamic databases, Analysis plan AP-136.* Sandia National Laboratories, Carlsbad, New Mexico. Effective April 17, 2008.

IT. 1997. *Composition and origin of nonindigenous brine and water in the vicinity of the exhaust shaft, Waste Isolation Pilot Plant, New Mexico.* Prepared for Westinghouse Electric Corporation, Carlsbad, New Mexico. DOE/WIPP 97-2226. February 1997.

Langmuir, D. 1997. *Aqueous environmental geochemistry*. New Jersey, Prentice-Hall, 600 p.

Nordstrom, D.K. and J.L. Munoz. *Geochemical thermodynamics*. Palo Alto, Blackwell Scientific Publications. 477 p.

Orris, G., G. Harvey, D. Tsui, and J. Eldridge. 2003. *Preliminary analyses for perchlorate in selected natural materials and their derivative products*. U.S. Geological Survey Open-File Report 03-314.

Parkhurst, D.L. and A.A.J. Appelo. 1999. *User's guide to PHREEQC (version 2) A computer program for speciation, batch-reaction, one dimensional transport, and inverse geochemical modeling*. USGS Water resources investigation 99-4259.

Pitzer, K.S. 1991. Ion interaction approach: Theory and data correlation. Chapter 3 in Pitzer, K.S. (ed.), *Activity coefficients in electrolyte solutions, 2nd edition*. CRC Press, Boca Raton, Florida.

Railsback, L.B. 2008. *An earth scientist's periodic table of the elements and their ions.* Version 4.8d. Department of Geology, University of Georgia, Athens, Georgia. August 2008. Available at <http://www.gly.uga.edu/railsback/PT.html>.

Rimstidt, J.D., J.A. Chermak, and P.M. Gagen. 1994. Rates of reactions of galena, sphalerite, chalcopyrite, and arsenopyrite with Fe(III) in acidic solutions. *In* Alpers, C.N. and D.W. Blowes (eds.), *Environmental geochemistry of sulfide oxidation*. ACS Symposium Series 550.

Smith, K.S. 1999. Metal sorption on mineral surfaces: An overview with examples relating to mineral deposits. *Chapter 7 in* Plumlee, G.S. and M.J. Logsdon (eds.), The environmental geochemistry of mineral deposits, Part A: Processes, techniques, and health issues. *Reviews in Economic Geology* (6A):161-182.

Smith, K.S. and H.L.O. Huyck. 1999. An overview of the abundance, relative mobility, bioavailability, and human toxicity of metals. *Chapter 2 in* Plumlee, G.S. and M.J. Logsdon (eds.), The environmental geochemistry of mineral deposits, Part A: Processes, techniques, and health issues. *Reviews in Economic Geology* (6A):29-70.

TraceAnalysis, Inc. (TraceAnalysis). 2007. Analytical and quality control report for WIPP/SSWMP samples collected October 11, 2007. Work order 7101117. October 26, 2007.

Truesdell, A.H. and B.F. Jones. 1974. WATEQ, a computer program for calculating chemical equilibria of natural waters. *U.S. Geological Survey Journal of Research* 2:233-248.

U.S. DOE. 2008. *Basic data report for piezometers PZ-13, PZ-14, and PZ-15 and shallow subsurface water.* DOE/WIPP-08-3375, Revision 3. October 2008.

Appendix H

Experimental Lead Adsorption Parameters

Compiled Pb Distribution/Partition Coefficients Source: http://www.epa.gov/athens/publications/reports/Ambrose600R05074PartitionCoefficients.pdf

logKd (L/Kg)	**Soil/Water**	**Suspended**	**Sediment**	**DOC**
Pb	4.2	5.6	5.1	5
Range	0.7-5.0	3.4-6.5	2.0-7.0	3.8-5.6
Kd (L/Kg)	L/Kg			
Pb	15848.9319	398107.1706	125892.5412	100000
1/Kd (Kg/L)				
Pb	6.3096E-05	2.51189E-06	7.94328E-06	0.00001

Pb Distribution/Partition Coefficients **Source:** **Kd.dat in GWB**

Kd.dat	**Kd**	**Units**	**Kd.dat in GWB**
Pb	0.025	mol/g	
	0.1	L/Kg	

Compiled Kd values **Source:** **Table 4 in** http://www.epa.gov/rpdweb00/docs/kdreport/vol2/402-r-99-004b_appf.pdf

Soil Description	**Experimental Parameters**	**CEC (meq/100g)**	**pH**	**Kd (ml/g)**
Sediment, Split Rock Formation, Wyoming			2	20
			4.5	100
			5.75	1500
			7	4000
Wyoming Sand (Soil C)	Batch Experiment	22	4.5	280
Sand (Soil C)	Batch Experiment	22	5	1295
Sandy Loam (Soil D)	Batch Experiment	16	7.5	3000
Sandy Loam (Soil D)	Batch Experiment	16	8	4000
Loam (Soil 2)	Batch Experiment	17	7.3	21000
Medium Sand (Soil 3)	Batch Experiment	5.8	4.9	19
Organic soil (Soil 4)	Batch Experiment	120	5.5	30000
Fine Sandy Loam (Soil 6)	Batch Experiment	8.7	7.4	59000
Sand (Hanford)	Batch tracer studies	5.27	8.35	13000 - 79000

Appendix I

Laboratory Reports for Dewey Lake and Drill Bit Leach Tests

HALL ENVIRONMENTAL ANALYSIS LABORATORY

COVER LETTER

Friday, July 24, 2009

Mark Miller
Daniel B. Stephens & Assoc.
6020 Academy NE Suite 100
Albuquerque, NM 87109

TEL: (505) 822-9400
FAX (505) 822-8877

RE: WIPP Pb Assessment

Order No.: 0907223

Dear Mark Miller:

Hall Environmental Analysis Laboratory, Inc. received 12 sample(s) on 7/10/2009 for the analyses presented in the following report.

These were analyzed according to EPA procedures or equivalent. Below is a list of our accreditations. To access our accredited tests please go to www.hallenvironmental.com or the state specific web sites.

Reporting limits are determined by EPA methodology. No determination of compounds below these (denoted by the ND or < sign) has been made.

Please don't hesitate to contact HEAL for any additional information or clarifications.

Sincerely,

Andy Freeman, Business Manager
Nancy McDuffie, Laboratory Manager

NM Lab # NM9425
AZ license # AZ0682
ORELAP Lab # NM100001
Texas Lab# T104704424-08-TX

ACCREDITED IN ACCORDANCE WITH nelac

4901 Hawkins NE ■ Suite D ■ Albuquerque, NM 87109
505.345.3975 ■ Fax 505.345.4107
www.hallenvironmental.com

Hall Environmental Analysis Laboratory, Inc.

Date: *24-Jul-09*

CLIENT: Daniel B. Stephens & Assoc.
Project: WIPP Pb Assessment
Lab Order: 0907223

Lab ID: 0907223-01 **Collection Date:** 7/7/2009 9:50:00 AM
Client Sample ID: PZ-13 46'-47' **Matrix:** SOLID

Analyses	Result	PQL	Qual	Units	DF	Date Analyzed
EPA METHOD 6010B: SOIL METALS						Analyst: **TES**
Lead	4.0	0.25		mg/Kg	1	7/24/2009 12:32:54 PM

Lab ID: 0907223-02 **Collection Date:** 7/7/2009 10:03:00 AM
Client Sample ID: PZ-13 65'-67.5' **Matrix:** SOLID

Analyses	Result	PQL	Qual	Units	DF	Date Analyzed
EPA METHOD 6010B: SOIL METALS						Analyst: **TES**
Lead	1.4	0.25		mg/Kg	1	7/24/2009 12:35:29 PM

Lab ID: 0907223-03 **Collection Date:** 7/7/2009 10:21:00 AM
Client Sample ID: PZ-13 74'-75' **Matrix:** SOLID

Analyses	Result	PQL	Qual	Units	DF	Date Analyzed
EPA METHOD 6010B: SOIL METALS						Analyst: **TES**
Lead	12	0.25		mg/Kg	1	7/24/2009 12:44:58 PM

Lab ID: 0907223-04 **Collection Date:** 7/7/2009 10:34:00 AM
Client Sample ID: PZ-13 76'-77' Red **Matrix:** SOLID

Analyses	Result	PQL	Qual	Units	DF	Date Analyzed
EPA METHOD 6010B: SOIL METALS						Analyst: **TES**
Lead	16	1.3		mg/Kg	5	7/24/2009 1:39:37 PM

Lab ID: 0907223-05 **Collection Date:** 7/7/2009 10:38:00 AM
Client Sample ID: PZ-13 76'-77' Green **Matrix:** SOLID

Analyses	Result	PQL	Qual	Units	DF	Date Analyzed
EPA METHOD 6010B: SOIL METALS						Analyst: **TES**
Lead	ND	1.3		mg/Kg	5	7/24/2009 1:42:19 PM

Lab ID: 0907223-06 **Collection Date:** 7/7/2009 11:11:00 AM
Client Sample ID: PZ-14 71'-72 **Matrix:** SOLID

Analyses	Result	PQL	Qual	Units	DF	Date Analyzed
EPA METHOD 6010B: SOIL METALS						Analyst: **TES**
Lead	12	0.25		mg/Kg	1	7/24/2009 1:01:13 PM

Qualifiers:

*	Value exceeds Maximum Contaminant Level	B	Analyte detected in the associated Method Blank
E	Estimated value	H	Holding times for preparation or analysis exceeded
J	Analyte detected below quantitation limits	MCL	Maximum Contaminant Level
ND	Not Detected at the Reporting Limit	RL	Reporting Limit
S	Spike recovery outside accepted recovery limits		

CLIENT: Daniel B. Stephens & Assoc. **Lab Order:** 0907223
Project: WIPP Pb Assessment

Lab ID: 0907223-07 **Collection Date:** 7/7/2009 11:20:00 AM
Client Sample ID: PZ-14 72.5'-73' **Matrix:** SOLID

Analyses	Result	PQL	Qual	Units	DF	Date Analyzed
EPA METHOD 6010B: SOIL METALS						Analyst: **TES**
Lead	8.8	0.25		mg/Kg	1	7/24/2009 1:03:36 PM

Lab ID: 0907223-08 **Collection Date:** 7/7/2009 11:38:00 AM
Client Sample ID: PZ-14 73'-73.5' Green **Matrix:** SOLID

Analyses	Result	PQL	Qual	Units	DF	Date Analyzed
EPA METHOD 6010B: SOIL METALS						Analyst: **TES**
Lead	ND	0.25		mg/Kg	1	7/24/2009 1:06:11 PM

Lab ID: 0907223-09 **Collection Date:** 7/7/2009 11:30:00 AM
Client Sample ID: PZ-14 73'-73.5' Red **Matrix:** SOLID

Analyses	Result	PQL	Qual	Units	DF	Date Analyzed
EPA METHOD 6010B: SOIL METALS						Analyst: **TES**
Lead	12	0.25		mg/Kg	1	7/24/2009 1:08:46 PM

Lab ID: 0907223-10 **Collection Date:** 7/7/2009 11:57:00 AM
Client Sample ID: PZ-15 45'-45.3' **Matrix:** SOLID

Analyses	Result	PQL	Qual	Units	DF	Date Analyzed
EPA METHOD 6010B: SOIL METALS						Analyst: **TES**
Lead	2.4	0.25		mg/Kg	1	7/24/2009 1:11:09 PM

Lab ID: 0907223-11 **Collection Date:** 7/7/2009 12:09:00 PM
Client Sample ID: PZ-15 50.5'-52' Red **Matrix:** SOLID

Analyses	Result	PQL	Qual	Units	DF	Date Analyzed
EPA METHOD 6010B: SOIL METALS						Analyst: **TES**
Lead	3.3	0.25		mg/Kg	1	7/24/2009 1:13:48 PM

Lab ID: 0907223-12 **Collection Date:** 7/7/2009 12:04:00 PM
Client Sample ID: PZ-15 50.5'-52' Green **Matrix:** SOLID

Analyses	Result	PQL	Qual	Units	DF	Date Analyzed
EPA METHOD 6010B: SOIL METALS						Analyst: **TES**
Lead	ND	0.25		mg/Kg	1	7/24/2009 1:18:09 PM

Qualifiers:

*	Value exceeds Maximum Contaminant Level	B	Analyte detected in the associated Method Blank
E	Estimated value	H	Holding times for preparation or analysis exceeded
J	Analyte detected below quantitation limits	MCL	Maximum Contaminant Level
ND	Not Detected at the Reporting Limit	RL	Reporting Limit
S	Spike recovery outside accepted recovery limits		

QA/QC SUMMARY REPORT

Client: Daniel B. Stephens & Assoc.
Project: WIPP Pb Assessment
Work Order: 0907223

Analyte	Result	Units	PQL	%Rec	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Method: EPA Method 6010B: Soil Metals									
Sample ID: 0907223-02AMSD		*MSD*			Batch ID: **19669**		Analysis Date: 7/24/2009 12:40:40 PM		
Lead	22.24	mg/Kg	0.25	83.4	75	125	0.629	30	
Sample ID: MB-19669		*MBLK*			Batch ID: **19669**		Analysis Date: 7/24/2009 12:25:08 PM		
Lead	ND	mg/Kg	0.25						
Sample ID: LCS-19669		*LCS*			Batch ID: **19669**		Analysis Date: 7/24/2009 12:27:41 PM		
Lead	25.39	mg/Kg	0.25	102	80	120			
Sample ID: LCS-19669		*LCS*			Batch ID: **19669**		Analysis Date: 7/24/2009 12:30:17 PM		
Lead	24.43	mg/Kg	0.25	97.7	80	120	3.83	0	
Sample ID: 0907223-02AMS		*MS*			Batch ID: **19669**		Analysis Date: 7/24/2009 12:38:04 PM		
Lead	22.10	mg/Kg	0.25	82.9	75	125			

Qualifiers:

E	Estimated value	H	Holding times for preparation or analysis exceeded
J	Analyte detected below quantitation limits	ND	Not Detected at the Reporting Limit
R	RPD outside accepted recovery limits	S	Spike recovery outside accepted recovery limits

Hall Environmental Analysis Laboratory, Inc.

Sample Receipt Checklist

Client Name DBS

Date Received: 7/10/2009

Work Order Number 0907223

Received by: AT

Sample ID labels checked by: Initials

Checklist completed by: Signature Date 7/10/09

Matrix:

Carrier name Client drop-off

Shipping container/cooler in good condition?	Yes ☑	No ☐	Not Present ☐	
Custody seals intact on shipping container/cooler?	Yes ☐	No ☐	Not Present ☐	Not Shipped ☑
Custody seals intact on sample bottles?	Yes ☐	No ☐	N/A ☑	
Chain of custody present?	Yes ☑	No ☐		
Chain of custody signed when relinquished and received?	Yes ☑	No ☐		
Chain of custody agrees with sample labels?	Yes ☑	No ☐		
Samples in proper container/bottle?	Yes ☑	No ☐		
Sample containers intact?	Yes ☑	No ☐		
Sufficient sample volume for indicated test?	Yes ☑	No ☐		
All samples received within holding time?	Yes ☑	No ☐		
Water - VOA vials have zero headspace?	No VOA vials submitted ☑	Yes ☐	No ☐	
Water - Preservation labels on bottle and cap match?	Yes ☐	No ☐	N/A ☑	
Water - pH acceptable upon receipt?	Yes ☐	No ☐	N/A ☑	
Container/Temp Blank temperature?	**27.2°**	*<6° C Acceptable* If given sufficient time to cool.		

Number of preserved bottles checked for pH: ______

<2 >12 unless noted below.

COMMENTS:

Client contacted ______ Date contacted: ______ Person contacted ______

Contacted by: ______ Regarding: ______

Comments: ______

Corrective Action ______

CHAIN-OF-CUSTODY RECORD

HALL ENVIRONMENTAL ANALYSIS LABORATORY
4901 Hawkins NE, Suite A
Albuquerque, New Mexico 87109
Tel. 505.345.3975 Fax 505.345.4107
www.hallenvironmental.com

Client: DBS&A

Address: 6020 Academy NE,
Suite 100
ABQ, NM 87109

Phone #: 822-9400

Fax #: 822-8877

Project Name: WIPP Pb Assessment

Project #: ES08.0072.09

Project Manager: Mark Miller

Sampler: Chris Wolf

Samples Cold?: ☐ Yes ☒ No 27.2

Date	Time	Matrix	Sample I.D. No.	Number/Volume	Preservative HgCl2	Preservative HCl	Preservative	HEAL No. 0907223
7/7/09	0950	Rock	PZ-13 46'-47'	1				-1
7/7/09	1003		PZ-13 65'-67.5'	1				-2
7/7/09	1021		PZ-13 74'-75'	1				-3
7/9/09	1034		PZ-13 76'-77' Red	1				-4
7/7/09	1038		PZ-13 76'-77' Green	1				-5
7/7/09	1111		PZ-14 71'-72'	1				-6
7/7/09	1120		PZ-14 72.5'-73'	1				-7
7/7/09	1138		PZ-14 73'-73.5' Green	1				-8
7/7/09	1130		PZ-14 73'-73.5 Red	1				-9
7/7/09	1157		PZ-15 45'-45.3'	1				-10
7/7/09	1209		PZ-15 50.5'-52' Red	1				-11
7/7/09	1204		PZ-15 50.5'-52' Green	1				-12

ANALYSIS REQUEST

HEAL No.	BTEX + MTBE + TMB's (8021)	BTEX + MTBE + TPH (Gasoline Only)	TPH Method 8015B MOD (Gas/Diesel)	TPH (Method 418.1)	Volatiles Full List (8021)	EDB (Method 504.1)	EDC (Method 8021)	8310 (PNA or PAH)	RCRA 8 Metals	Cations (Na, K, Ca, Mg)	Anions (F, Cl, NO_3, NO_2, PO_4, SO_4)	8081 Pesticides / PCB's (8082)	8260 (VOA)	8270 (Semi-VOA)	Lead (Pb)		Air Bubbles or Headspace (Y or N)
-1															✓		
-2															✓		
-3															✓		
-4															✓		
-5															✓		
-6															✓		
-7															✓		
-8															✓		
-9															✓		
-10															✓		
-11															✓		
-12															✓		

Date:	Time:	Relinquished By: (Signature)	Received By: (Signature)
7/10/09	1636		7/10/09 1636
Date:	Time:	Relinquished By: (Signature)	Received By: (Signature)

Remarks: Please email report to Mark Miller and Chris Wolf

**HALL
ENVIRONMENTAL
ANALYSIS
LABORATORY**

COVER LETTER

Thursday, December 03, 2009

Mark Miller
Daniel B. Stephens & Assoc.
6020 Academy NE Suite 100
Albuquerque, NM 87109

TEL: (505) 822-9400
FAX (505) 822-8877

RE: PZ-13

Order No.: 0911388

Dear Mark Miller:

Hall Environmental Analysis Laboratory, Inc. received 1 sample(s) on 11/19/2009 for the analyses presented in the following report.

These were analyzed according to EPA procedures or equivalent. Below is a list of our accreditations. To access our accredited tests please go to www.hallenvironmental.com or the state specific web sites.

Reporting limits are determined by EPA methodology. No determination of compounds below these (denoted by the ND or < sign) has been made.

Please don't hesitate to contact HEAL for any additional information or clarifications.

Sincerely,

For/Andy Freeman, Laboratory Manager

NM Lab # NM9425 NM0901
AZ license # AZ0682
ORELAP Lab # NM100001
Texas Lab# T104704424-08-TX

ACCREDITED IN ACCORDANCE WITH nelac

4901 Hawkins NE ■ Suite D ■ Albuquerque, NM 87109
505.345.3975 ■ Fax 505.345.4107
www.hallenvironmental.com

Hall Environmental Analysis Laboratory, Inc.

Date: *03-Dec-09*

CLIENT:	Daniel B. Stephens & Assoc.	**Client Sample ID:**	Salado Fm
Lab Order:	0911388	**Collection Date:**	11/16/2009
Project:	PZ-13	**Date Received:**	11/19/2009
Lab ID:	0911388-01	**Matrix:**	SOLID

Analyses	Result	PQL	Qual	Units	DF	Date Analyzed
EPA METHOD 6010B: SOIL METALS						Analyst: **RAGS**
Lead	ND	1.3		mg/Kg	5	12/2/2009 11:54:19 AM

Qualifiers:

*	Value exceeds Maximum Contaminant Level	B	Analyte detected in the associated Method Blank
E	Estimated value	H	Holding times for preparation or analysis exceeded
J	Analyte detected below quantitation limits	MCL	Maximum Contaminant Level
ND	Not Detected at the Reporting Limit	RL	Reporting Limit
S	Spike recovery outside accepted recovery limits		

QA/QC SUMMARY REPORT

Client: Daniel B. Stephens & Assoc.
Project: PZ-13
Work Order: 0911388

Analyte	Result	Units	PQL	SPK Va	SPK ref	%Rec	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Method: EPA Method 6010B: Soil Metals											
Sample ID: MB-20740		*MBLK*				Batch ID: **20740**		Analysis Date:	12/2/2009 11:05:39 AM		
Lead	ND	mg/Kg	0.25								
Sample ID: LCS-20740		*LCS*				Batch ID: **20740**		Analysis Date:	12/2/2009 11:08:03 AM		
Lead	24.10	mg/Kg	0.25	25	0	96.4	80	120			

Qualifiers:

E	Estimated value	H	Holding times for preparation or analysis exceeded
J	Analyte detected below quantitation limits	ND	Not Detected at the Reporting Limit
R	RPD outside accepted recovery limits	S	Spike recovery outside accepted recovery limits

Hall Environmental Analysis Laboratory, Inc.

Sample Receipt Checklist

Client Name DBS

Date Received: 11/19/2009

Work Order Number 0911388

Received by: AT

Sample ID labels checked by: AT
Initials

Checklist completed by: Signature 11/19/09 Date

Matrix:

Carrier name Client drop-off

Shipping container/cooler in good condition?	Yes ☑	No ☐	Not Present ☐	
Custody seals intact on shipping container/cooler?	Yes ☐	No ☐	Not Present ☐	Not Shipped ☑
Custody seals intact on sample bottles?	Yes ☐	No ☐	N/A ☑	
Chain of custody present?	Yes ☑	No ☐		
Chain of custody signed when relinquished and received?	Yes ☑	No ☐		
Chain of custody agrees with sample labels?	Yes ☑	No ☐		
Samples in proper container/bottle?	Yes ☑	No ☐		
Sample containers intact?	Yes ☑	No ☐		
Sufficient sample volume for indicated test?	Yes ☑	No ☐		
All samples received within holding time?	Yes ☑	No ☐		Number of preserved bottles checked for pH:
Water - VOA vials have zero headspace?	No VOA vials submitted ☑	Yes ☐	No ☐	
Water - Preservation labels on bottle and cap match?	Yes ☐	No ☐	N/A ☑	
Water - pH acceptable upon receipt?	Yes ☐	No ☐	N/A ☑	*<2 >12 unless noted below.*
Container/Temp Blank temperature?	**20.4°**	*<6° C Acceptable* If given sufficient time to cool.		

COMMENTS:

Client contacted

Date contacted:

Person contacted

Contacted by:

Regarding:

Comments:

Corrective Action

CHAIN-OF-CUSTODY RECORD

QA / QC Package:
Std ☐ Level 4 ☐
Other:

HALL ENVIRONMENTAL
ANALYSIS LABORATORY
4901 Hawkins NE, Suite D
Albuquerque, New Mexico 87109
Tel. 505.345.3975 Fax 505.345.4107
www.hallenvironmental.com

Client: DBS&A

Address: 6020 Academy
ABQ NM 87109

Phone #: 822-9400

Fax #:

Project Name: PZ-13

Project #: ES08.0072.10

Project Manager: M. Miller

Sampler:

Sample Temperature: 20.4°

ANALYSIS REQUEST

Date	Time	Matrix	Sample I.D. No.	Number/Volume	Preservative			HEAL No.	BTEX + MTBE + TMB's (8021)	BTEX + MTBE + TPH (Gasoline Only)	TPH Method 8015B (Gas/Diesel)	TPH (Method 418.1)	EDB (Method 504.1)	EDC (Method 8021)	8310 (PNA or PAH)	RCRA 8 Metals	Anions (F, Cl, NO_3, NO_2, PO_4, SO_4)	8081 Pesticides / PCB's (8082)	8260B (VOA)	8270 (Semi-VOA)		Pb			Air Bubbles or Headspace (Y or N)
					$HgCl_2$	HNO_3																			
11/16/09	-	salt	Salado Fm.	1				0911388-1														✓			

Date: 11/19/09	Time: 0815	Relinquished By: (Signature)	Received By: (Signature) 11/19/09 0815
Date:	Time:	Relinquished By: (Signature)	Received By: (Signature)

Remarks:

**HALL
ENVIRONMENTAL
ANALYSIS
LABORATORY**

COVER LETTER

Wednesday, December 09, 2009

Mark Miller
Daniel B. Stephens & Assoc.
6020 Academy NE Suite 100
Albuquerque, NM 87109
TEL: (505) 822-9400
FAX (505) 822-8877

RE: PZ-13

Order No.: 0911393

Dear Mark Miller:

Hall Environmental Analysis Laboratory, Inc. received 1 sample(s) on 11/19/2009 for the analyses presented in the following report.

These were analyzed according to EPA procedures or equivalent. Below is a list of our accreditations. To access our accredited tests please go to www.hallenvironmental.com or the state specific web sites.

Reporting limits are determined by EPA methodology. No determination of compounds below these (denoted by the ND or < sign) has been made.

Please don't hesitate to contact HEAL for any additional information or clarifications.

Sincerely,

Andy Freeman, Laboratory Manager

NM Lab # NM9425 NM0901
AZ license # AZ0682
ORELAP Lab # NM100001
Texas Lab# T104704424-08-TX

ACCREDITED IN ACCORDANCE WITH nelac

4901 Hawkins NE ■ Suite D ■ Albuquerque, NM 87109
505.345.3975 ■ Fax 505.345.4107
www.hallenvironmental.com

Hall Environmental Analysis Laboratory, Inc.

Date: *09-Dec-09*

CLIENT:	Daniel B. Stephens & Assoc.
Project:	PZ-13
Lab Order:	0911393

CASE NARRATIVE

The CCV for cobalt was high. Cobalt was not detected, thus the results are reported.

Hall Environmental Analysis Laboratory, Inc.

Date: *09-Dec-09*

CLIENT:	Daniel B. Stephens & Assoc.	**Client Sample ID:**	Evap Pond
Lab Order:	0911393	**Collection Date:**	11/16/2009
Project:	PZ-13	**Date Received:**	11/19/2009
Lab ID:	0911393-01	**Matrix:**	AQUEOUS

Analyses	Result	PQL	Qual	Units	DF	Date Analyzed
EPA METHOD 300.0: ANIONS						Analyst: **TAF**
Fluoride	ND	10		mg/L	100	11/24/2009 8:36:19 PM
Chloride	240000	2000		mg/L	20000	11/25/2009 6:03:23 PM
Bromide	330	10		mg/L	100	11/24/2009 8:36:19 PM
Nitrate (As N)+Nitrite (As N)	ND	1000		mg/L	5000	12/3/2009 8:29:20 PM
Phosphorus, Orthophosphate (As P)	ND	50	H	mg/L	100	11/24/2009 8:36:19 PM
Sulfate	27000	500		mg/L	1000	11/24/2009 8:53:44 PM
EPA METHOD 6010B: DISSOLVED METALS						Analyst: **RAGS**
Calcium	350	20		mg/L	20	11/23/2009 3:00:52 PM
Iron	ND	0.40		mg/L	20	11/23/2009 3:00:52 PM
Magnesium	6600	100		mg/L	100	11/23/2009 3:09:05 PM
Potassium	13000	500		mg/L	500	11/23/2009 3:13:02 PM
Sodium	120000	2000		mg/L	2000	11/30/2009 10:26:16 AM
EPA 6010B: TOTAL RECOVERABLE METALS						Analyst: **RAGS**
Barium	ND	0.50		mg/L	10	12/4/2009 12:39:02 PM
Cadmium	ND	0.10		mg/L	10	12/4/2009 12:39:02 PM
Chromium	ND	0.30		mg/L	10	12/4/2009 12:39:02 PM
Cobalt	ND	0.30		mg/L	10	12/6/2009 1:49:38 PM
Iron	ND	2.5		mg/L	10	12/4/2009 12:39:02 PM
Lead	ND	0.25		mg/L	10	12/4/2009 1:32:22 PM
Magnesium	6600	250		mg/L	100	12/4/2009 12:34:57 PM
Manganese	1.9	0.10		mg/L	10	12/4/2009 12:39:02 PM
Nickel	ND	0.50		mg/L	10	12/4/2009 12:39:02 PM
Strontium	25	5.0		mg/L	100	12/4/2009 12:34:57 PM
Vanadium	ND	2.5		mg/L	10	12/4/2009 12:39:02 PM
Zinc	4.6	1.0		mg/L	10	12/4/2009 12:39:02 PM
SM 2320B: ALKALINITY						Analyst: **MMS**
Alkalinity, Total (As CaCO3)	240	20		mg/L CaCO3	1	11/21/2009 5:15:01 AM
Carbonate	ND	2.0		mg/L CaCO3	1	11/21/2009 5:15:01 AM
Bicarbonate	240	20		mg/L CaCO3	1	11/21/2009 5:15:01 AM
EPA 120.1: SPECIFIC CONDUCTANCE						Analyst: **MMS**
Specific Conductance	630000	2.5		µmhos/cm	250	12/1/2009 1:19:48 PM
SM2540C MOD: TOTAL DISSOLVED SOLIDS						Analyst: **MMS**
Total Dissolved Solids	348000	2000		mg/L	1	11/25/2009 2:23:00 PM

Qualifiers:

*	Value exceeds Maximum Contaminant Level	B	Analyte detected in the associated Method Blank
E	Estimated value	H	Holding times for preparation or analysis exceeded
J	Analyte detected below quantitation limits	MCL	Maximum Contaminant Level
ND	Not Detected at the Reporting Limit	RL	Reporting Limit
S	Spike recovery outside accepted recovery limits		

Anatek Labs, Inc.

1282 Alturas Drive • Moscow, ID 83843 • (208) 883-2839 • Fax (208) 882-9246 • email moscow@anateklabs.com
504 E Sprague Ste. D • Spokane WA 99202 • (509) 838-3999 • Fax (509) 838-4433 • email spokane@anateklabs.com

Client: HALL ENVIRONMENTAL ANALYSIS LAB
Address: 4901 HAWKINS NE SUITE D
ALBUQUERQUE, NM 87109
Attn: ANDY FREEMAN

Batch #: 091123010
Project Name: 0911393

Analytical Results Report

Sample Number 091123010-001
Sampling Date 11/16/2009
Date/Time Received 11/20/2009 11:11 AM
Client Sample ID 0911393-01D / EVAP POND
Matrix Water
Comments

Parameter	Result	Units	PQL	Analysis Date	Analyst	Method	Qualifier
Arsenic	ND	mg/L	0.1	12/3/2009	ETL	EPA 6020A	
Lead	ND	mg/L	0.1	12/3/2009	ETL	EPA 6020A	
Titanium	ND	mg/L	0.1	12/8/2009	JTT	EPA 6020A	
Tungsten	ND	mg/L	0.5	12/7/2009	ETL	EPA 6020A	
Uranium	ND	mg/L	0.1	12/3/2009	ETL	EPA 6020A	

Authorized Signature John W. Codd

John Coddington, Lab Manager

MCL EPA's Maximum Contaminant Level
ND Not Detected
PQL Practical Quantitation Limit

QA/QC SUMMARY REPORT

Client: Daniel B. Stephens & Assoc.
Project: PZ-13
Work Order: 0911393

Analyte	Result	Units	PQL	SPK Va	SPK ref	%Rec	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Method: EPA Method 300.0: Anions											
Sample ID: MB		*MBLK*				Batch ID: **R36293**			Analysis Date: 11/20/2009 10:59:26 AM		
Fluoride	ND	mg/L	0.10								
Chloride	ND	mg/L	0.10								
Bromide	ND	mg/L	0.10								
Nitrate (As N)+Nitrite (As N)	ND	mg/L	0.20								
Phosphorus, Orthophosphate (As P)	ND	mg/L	0.50								
Sulfate	ND	mg/L	0.50								
Sample ID: MB		*MBLK*				Batch ID: **R36293**			Analysis Date: 11/21/2009 1:47:19 AM		
Fluoride	ND	mg/L	0.10								
Chloride	ND	mg/L	0.10								
Bromide	ND	mg/L	0.10								
Nitrate (As N)+Nitrite (As N)	ND	mg/L	0.20								
Phosphorus, Orthophosphate (As P)	ND	mg/L	0.50								
Sulfate	ND	mg/L	0.50								
Sample ID: MB		*MBLK*				Batch ID: **R36323**			Analysis Date: 11/24/2009 9:17:21 AM		
Fluoride	ND	mg/L	0.10								
Chloride	ND	mg/L	0.10								
Bromide	ND	mg/L	0.10								
Nitrate (As N)+Nitrite (As N)	ND	mg/L	0.20								
Phosphorus, Orthophosphate (As P)	ND	mg/L	0.50								
Sulfate	ND	mg/L	0.50								
Sample ID: MB		*MBLK*				Batch ID: **R36339**			Analysis Date: 11/25/2009 7:26:33 AM		
Fluoride	ND	mg/L	0.10								
Chloride	ND	mg/L	0.10								
Bromide	ND	mg/L	0.10								
Nitrate (As N)+Nitrite (As N)	ND	mg/L	0.20								
Phosphorus, Orthophosphate (As P)	ND	mg/L	0.50								
Sulfate	ND	mg/L	0.50								
Sample ID: MB		*MBLK*				Batch ID: **R36359**			Analysis Date: 11/30/2009 6:07:13 PM		
Fluoride	ND	mg/L	0.10								
Chloride	ND	mg/L	0.10								
Bromide	ND	mg/L	0.10								
Nitrate (As N)+Nitrite (As N)	ND	mg/L	0.20								
Phosphorus, Orthophosphate (As P)	ND	mg/L	0.50								
Sulfate	ND	mg/L	0.50								
Sample ID: MB		*MBLK*				Batch ID: **R36419**			Analysis Date: 12/3/2009 10:54:54 AM		
Fluoride	ND	mg/L	0.10								
Chloride	ND	mg/L	0.10								
Bromide	ND	mg/L	0.10								
Nitrate (As N)+Nitrite (As N)	ND	mg/L	0.20								
Phosphorus, Orthophosphate (As P)	ND	mg/L	0.50								
Sulfate	ND	mg/L	0.50								
Sample ID: LCS		*LCS*				Batch ID: **R36293**			Analysis Date: 11/20/2009 11:16:50 AM		
Fluoride	0.5204	mg/L	0.10	0.5	0	104	90	110			

Qualifiers:

E	Estimated value	H	Holding times for preparation or analysis exceeded
J	Analyte detected below quantitation limits	ND	Not Detected at the Reporting Limit
R	RPD outside accepted recovery limits	S	Spike recovery outside accepted recovery limits

QA/QC SUMMARY REPORT

Client: Daniel B. Stephens & Assoc.
Project: PZ-13
Work Order: 0911393

Analyte	Result	Units	PQL	SPK Va	SPK ref	%Rec	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Method: EPA Method 300.0: Anions											
Sample ID: LCS		*LCS*				Batch ID:	**R36293**	Analysis Date:	11/20/2009 11:16:50 AM		
Chloride	5.024	mg/L	0.10	5	0	100	90	110			
Bromide	2.539	mg/L	0.10	2.5	0	102	90	110			
Nitrate (As N)+Nitrite (As N)	3.501	mg/L	0.20	3.5	0	100	90	110			
Phosphorus, Orthophosphate (As P)	4.920	mg/L	0.50	5	0	98.4	90	110			
Sulfate	10.09	mg/L	0.50	10	0	101	90	110			
Sample ID: LCS		*LCS*				Batch ID:	**R36293**	Analysis Date:	11/21/2009 2:04:44 AM		
Fluoride	0.5367	mg/L	0.10	0.5	0	107	90	110			
Chloride	5.018	mg/L	0.10	5	0	100	90	110			
Bromide	2.539	mg/L	0.10	2.5	0	102	90	110			
Nitrate (As N)+Nitrite (As N)	3.530	mg/L	0.20	3.5	0	101	90	110			
Phosphorus, Orthophosphate (As P)	4.989	mg/L	0.50	5	0	99.8	90	110			
Sulfate	10.06	mg/L	0.50	10	0	101	90	110			
Sample ID: LCS		*LCS*				Batch ID:	**R36323**	Analysis Date:	11/24/2009 9:34:46 AM		
Fluoride	0.5130	mg/L	0.10	0.5	0	103	90	110			
Chloride	4.976	mg/L	0.10	5	0	99.5	90	110			
Bromide	2.590	mg/L	0.10	2.5	0	104	90	110			
Nitrate (As N)+Nitrite (As N)	3.461	mg/L	0.20	3.5	0	98.9	90	110			
Phosphorus, Orthophosphate (As P)	5.044	mg/L	0.50	5	0	101	90	110			
Sulfate	9.990	mg/L	0.50	10	0	99.9	90	110			
Sample ID: LCS		*LCS*				Batch ID:	**R36339**	Analysis Date:	11/25/2009 7:43:58 AM		
Fluoride	0.5294	mg/L	0.10	0.5	0	106	90	110			
Chloride	5.034	mg/L	0.10	5	0	101	90	110			
Bromide	2.634	mg/L	0.10	2.5	0	105	90	110			
Nitrate (As N)+Nitrite (As N)	3.502	mg/L	0.20	3.5	0	100	90	110			
Phosphorus, Orthophosphate (As P)	5.072	mg/L	0.50	5	0	101	90	110			
Sulfate	9.972	mg/L	0.50	10	0	99.7	90	110			
Sample ID: LCS		*LCS*				Batch ID:	**R36359**	Analysis Date:	11/30/2009 6:24:37 PM		
Fluoride	0.5254	mg/L	0.10	0.5	0	105	90	110			
Chloride	4.981	mg/L	0.10	5	0	99.6	90	110			
Bromide	2.572	mg/L	0.10	2.5	0	103	90	110			
Nitrate (As N)+Nitrite (As N)	3.473	mg/L	0.20	3.5	0	99.2	90	110			
Phosphorus, Orthophosphate (As P)	4.992	mg/L	0.50	5	0	99.8	90	110			
Sulfate	9.908	mg/L	0.50	10	0	99.1	90	110			
Sample ID: LCS-b		*LCS*				Batch ID:	**R36419**	Analysis Date:	12/3/2009 5:52:42 PM		
Fluoride	0.5196	mg/L	0.10	0.5	0	104	90	110			
Chloride	4.990	mg/L	0.10	5	0	99.8	90	110			
Bromide	2.509	mg/L	0.10	2.5	0	100	90	110			
Nitrate (As N)+Nitrite (As N)	3.494	mg/L	0.20	3.5	0	99.8	90	110			
Phosphorus, Orthophosphate (As P)	4.934	mg/L	0.50	5	0	98.7	90	110			
Sulfate	10.19	mg/L	0.50	10	0	102	90	110			

Qualifiers:

E	Estimated value	H	Holding times for preparation or analysis exceeded
J	Analyte detected below quantitation limits	ND	Not Detected at the Reporting Limit
R	RPD outside accepted recovery limits	S	Spike recovery outside accepted recovery limits

QA/QC SUMMARY REPORT

Client: Daniel B. Stephens & Assoc.
Project: PZ-13 **Work Order:** 0911393

Analyte	Result	Units	PQL	SPK Va	SPK ref	%Rec	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Method: SM 2320B: Alkalinity											
Sample ID: MB		*MBLK*				Batch ID:	**R36290**	Analysis Date:		11/20/2009 4:42:25 PM	
Alkalinity, Total (As CaCO3)	ND	mg/L Ca	20								
Carbonate	ND	mg/L Ca	2.0								
Bicarbonate	ND	mg/L Ca	20								
Sample ID: MB		*MBLK*				Batch ID:	**R36324**	Analysis Date:		11/24/2009 1:08:58 PM	
Alkalinity, Total (As CaCO3)	ND	mg/L Ca	20								
Carbonate	ND	mg/L Ca	2.0								
Bicarbonate	ND	mg/L Ca	20								
Sample ID: MB		*MBLK*				Batch ID:	**R36354**	Analysis Date:		11/25/2009 12:51:27 PM	
Alkalinity, Total (As CaCO3)	ND	mg/L Ca	20								
Carbonate	ND	mg/L Ca	2.0								
Bicarbonate	ND	mg/L Ca	20								
Sample ID: MB		*MBLK*				Batch ID:	**R36372**	Analysis Date:		12/1/2009 11:25:23 AM	
Alkalinity, Total (As CaCO3)	ND	mg/L Ca	20								
Carbonate	ND	mg/L Ca	2.0								
Bicarbonate	ND	mg/L Ca	20								
Sample ID: LCS		*LCS*				Batch ID:	**R36290**	Analysis Date:		11/20/2009 4:48:16 PM	
Alkalinity, Total (As CaCO3)	79.12	mg/L Ca	20	80	0	98.9	80	120			
Sample ID: 80PPM LCS		*LCS*				Batch ID:	**R36324**	Analysis Date:		11/24/2009 1:15:03 PM	
Alkalinity, Total (As CaCO3)	81.04	mg/L Ca	20	80	0	101	80	120			
Sample ID: LCS		*LCS*				Batch ID:	**R36354**	Analysis Date:		11/25/2009 12:56:54 PM	
Alkalinity, Total (As CaCO3)	80.76	mg/L Ca	20	80	0	101	80	120			
Sample ID: LCS		*LCS*				Batch ID:	**R36372**	Analysis Date:		12/1/2009 11:31:20 AM	
Alkalinity, Total (As CaCO3)	80.12	mg/L Ca	20	80	0	100	80	120			
Method: EPA Method 6010B: Dissolved Metals											
Sample ID: MB		*MBLK*				Batch ID:	**R36295**	Analysis Date:		11/23/2009 12:50:27 PM	
Calcium	ND	mg/L	1.0								
Iron	ND	mg/L	0.020								
Magnesium	ND	mg/L	1.0								
Potassium	ND	mg/L	1.0								
Sodium	ND	mg/L	1.0								
Sample ID: LCS		*LCS*				Batch ID:	**R36295**	Analysis Date:		11/23/2009 12:53:21 PM	
Calcium	50.40	mg/L	1.0	50.5	0	99.8	80	120			
Iron	0.4981	mg/L	0.020	0.5	0	99.6	80	120			
Magnesium	50.62	mg/L	1.0	50.5	0	100	80	120			
Potassium	53.37	mg/L	1.0	55	0	97.0	80	120			
Sodium	49.88	mg/L	1.0	50.5	0	98.8	80	120			

Qualifiers:

E	Estimated value	H	Holding times for preparation or analysis exceeded
J	Analyte detected below quantitation limits	ND	Not Detected at the Reporting Limit
R	RPD outside accepted recovery limits	S	Spike recovery outside accepted recovery limits

QA/QC SUMMARY REPORT

Client: Daniel B. Stephens & Assoc.
Project: PZ-13
Work Order: 0911393

Analyte	Result	Units	PQL	SPK Va	SPK ref	%Rec	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Method: EPA 6010B: Total Recoverable Metals											
Sample ID: MB-20722		*MBLK*				Batch ID:	**20722**	Analysis Date:		12/2/2009 4:21:16 PM	
Chromium	ND	mg/L	0.0060								
Iron	ND	mg/L	0.050								
Magnesium	ND	mg/L	0.50								
Manganese	ND	mg/L	0.0020								
Sample ID: MB-20722		*MBLK*				Batch ID:	**20722**	Analysis Date:		12/4/2009 12:06:11 PM	
Barium	ND	mg/L	0.010								
Cadmium	ND	mg/L	0.0020								
Chromium	ND	mg/L	0.0060								
Iron	ND	mg/L	0.050								
Lead	ND	mg/L	0.0050								
Magnesium	ND	mg/L	0.50								
Manganese	ND	mg/L	0.0020								
Nickel	ND	mg/L	0.010								
Strontium	ND	mg/L	0.010								
Vanadium	ND	mg/L	0.050								
Zinc	ND	mg/L	0.020								
Sample ID: MB-20722		*MBLK*				Batch ID:	**20722**	Analysis Date:		12/6/2009 1:43:18 PM	
Cobalt	ND	mg/L	0.0060								
Sample ID: LCS-20722		*LCS*				Batch ID:	**20722**	Analysis Date:		12/2/2009 4:24:13 PM	
Chromium	0.4921	mg/L	0.0060	0.5	0	98.4	80	120			
Iron	0.5119	mg/L	0.050	0.5	0	102	80	120			
Magnesium	49.82	mg/L	0.50	50	0	99.6	80	120			
Manganese	0.4950	mg/L	0.0020	0.5	0	99.0	80	120			
Sample ID: LCS-20722		*LCS*				Batch ID:	**20722**	Analysis Date:		12/4/2009 12:09:10 PM	
Barium	0.4852	mg/L	0.010	0.5	0	97.0	80	120			
Cadmium	0.4846	mg/L	0.0020	0.5	0	96.9	80	120			
Chromium	0.4802	mg/L	0.0060	0.5	0	96.0	80	120			
Iron	0.4960	mg/L	0.050	0.5	0	99.2	80	120			
Lead	0.4765	mg/L	0.0050	0.5	0	95.3	80	120			
Magnesium	52.29	mg/L	0.50	50	0	105	80	120			
Manganese	0.4863	mg/L	0.0020	0.5	0	97.3	80	120			
Nickel	0.4701	mg/L	0.010	0.5	0	94.0	80	120			
Strontium	0.1006	mg/L	0.010	0.1	0	101	80	120			
Vanadium	0.4995	mg/L	0.050	0.5	0	99.9	80	120			
Zinc	0.4742	mg/L	0.020	0.5	0	94.8	80	120			
Sample ID: LCS-20722		*LCS*				Batch ID:	**20722**	Analysis Date:		12/6/2009 1:45:44 PM	
Cobalt	0.5385	mg/L	0.0060	0.5	0	108	80	120			
Method: SM2540C MOD: Total Dissolved Solids											
Sample ID: MB-20700		*MBLK*				Batch ID:	**20700**	Analysis Date:		11/25/2009 2:23:00 PM	
Total Dissolved Solids	ND	mg/L	20.0								
Sample ID: LCS-20700		*LCS*				Batch ID:	**20700**	Analysis Date:		11/25/2009 2:23:00 PM	
Total Dissolved Solids	1017	mg/L	20.0	1000	0	102	80	120			

Qualifiers:

E	Estimated value	H	Holding times for preparation or analysis exceeded
J	Analyte detected below quantitation limits	ND	Not Detected at the Reporting Limit
R	RPD outside accepted recovery limits	S	Spike recovery outside accepted recovery limits

Hall Environmental Analysis Laboratory, Inc.

Sample Receipt Checklist

Client Name DBS

Date Received: 11/19/2009

Work Order Number 0911393

Received by: AT

Sample ID labels checked by: AT
Initials

Checklist completed by:
Signature
11/19/09
Date

Matrix:

Carrier name Client drop-off

Shipping container/cooler in good condition?	Yes	☑	No	☐	Not Present	☐		
Custody seals intact on shipping container/cooler?	Yes	☐	No	☐	Not Present	☐	Not Shipped	☑
Custody seals intact on sample bottles?	Yes	☐	No	☐	N/A	☑		
Chain of custody present?	Yes	☑	No	☐				
Chain of custody signed when relinquished and received?	Yes	☑	No	☐				
Chain of custody agrees with sample labels?	Yes	☑	No	☐				
Samples in proper container/bottle?	Yes	☑	No	☐				
Sample containers intact?	Yes	☑	No	☐				
Sufficient sample volume for indicated test?	Yes	☑	No	☐				
All samples received within holding time?	Yes	☑	No	☐				
Water - VOA vials have zero headspace?	No VOA vials submitted	☑	Yes	☐	No	☐		
Water - Preservation labels on bottle and cap match?	Yes	☐	No	☑	N/A	☐		
Water - pH acceptable upon receipt?	Yes	☐	No	☑	N/A	☐		
Container/Temp Blank temperature?	6.0°		*<6° C Acceptable* If given sufficient time to cool.					

Number of preserved bottles checked for pH: 3

[✓ <2] >12 *unless noted below.*

COMMENTS:

Client contacted

Date contacted:

Person contacted

Contacted by:

Regarding:

Comments: Sample poured off, filtered & preserved in lab/ for acceptable pH AT 11/19/09

Corrective Action

CHAIN-OF-CUSTODY RECORD

QA / QC Package:
Std ☐ Level 4 ☐
Other:

HALL ENVIRONMENTAL
ANALYSIS LABORATORY
4901 Hawkins NE, Suite D
Albuquerque, New Mexico 87109
Tel. 505.345.3975 Fax 505.345.4107
www.hallenvironmental.com

Client: DBS&A
Address: 6020 Academy
ABQ, NM 87109
Phone #: 822-9400
Fax #:

Project Name: PZ-13
Project #: ES08.0072.10
Project Manager: M.Miller
Sampler:
Sample Temperature: 4.0

Date	Time	Matrix	Sample I.D. No.	Number/Volume	Preservative HgCl$_2$	Preservative HNO$_3$	Preservative	HEAL No. 0911393
11/16/09	–	Aq	Evap Pond	5/1Gal				-1

ANALYSIS REQUEST

Sample I.D. No.	BTEX + MTBE + TMB's (8021)	BTEX + MTBE + TPH (Gasoline Only)	TPH Method 8015B (Gas/Diesel)	TPH (Method 418.1)	EDB (Method 504.1)	EDC (Method 8021)	8310 (PNA or PAH)	RCRA 8 Metals	Anions (F, Cl, NO$_3$, NO$_2$, PO$_4$, SO$_4$)	8081 Pesticides / PCB's (8082)	8260B (VOA)	8270 (Semi-VOA)	CAB, TDS, pH	Pb, As, Ba, Cd, Co,	Cr, Fe, Mg, Mn, Ni, Se,	Ti, U, V, W, Zn	Air Bubbles or Headspace (Y or N)
Evap Pond													✓	✓	✓	✓	

Date:	Time:	Relinquished By: (Signature)	Received By: (Signature)
11/19/09	0815		11/19/09 0815
Date:	Time:	Relinquished By: (Signature)	Received By: (Signature)

Remarks:
- Low detection limit
- Test Pb and call w/results before other analyses

**HALL
ENVIRONMENTAL
ANALYSIS
LABORATORY**

COVER LETTER

Wednesday, December 09, 2009

Mark Miller
Daniel B. Stephens & Assoc.
6020 Academy NE Suite 100
Albuquerque, NM 87109

TEL: (505) 822-9400
FAX (505) 822-8877

RE: PZ-13 Pb

Order No.: 0912017

Dear Mark Miller:

Hall Environmental Analysis Laboratory, Inc. received 1 sample(s) on 11/25/2009 for the analyses presented in the following report.

These were analyzed according to EPA procedures or equivalent. Below is a list of our accreditations. To access our accredited tests please go to www.hallenvironmental.com or the state specific web sites.

Reporting limits are determined by EPA methodology. No determination of compounds below these (denoted by the ND or < sign) has been made.

Please don't hesitate to contact HEAL for any additional information or clarifications.

Sincerely,

Andy Freeman, Laboratory Manager

NM Lab # NM9425 NM0901
AZ license # AZ0682
ORELAP Lab # NM100001
Texas Lab# T104704424-08-TX

4901 Hawkins NE ■ Suite D ■ Albuquerque, NM 87109
505.345.3975 ■ Fax 505.345.4107
www.hallenvironmental.com

Hall Environmental Analysis Laboratory, Inc.

Date: *09-Dec-09*

CLIENT:	Daniel B. Stephens & Assoc.	**Client Sample ID:**	Salado Fm
Lab Order:	0912017	**Collection Date:**	12/1/2009
Project:	PZ-13 Pb	**Date Received:**	11/25/2009
Lab ID:	0912017-01	**Matrix:**	AQUEOUS

Analyses	Result	PQL	Qual	Units	DF	Date Analyzed
EPA METHOD 300.0: ANIONS						Analyst: **TAF**
Fluoride	ND	5.0		mg/L	50	12/1/2009 5:16:16 PM
Chloride	110000	1000		mg/L	10000	12/2/2009 3:16:09 PM
Nitrogen, Nitrite (As N)	ND	200		mg/L	2000	12/2/2009 2:58:44 PM
Bromide	110	50		mg/L	500	12/1/2009 5:33:40 PM
Nitrogen, Nitrate (As N)	ND	5.0		mg/L	50	12/1/2009 5:16:16 PM
Phosphorus, Orthophosphate (As P)	ND	25		mg/L	50	12/1/2009 5:16:16 PM
Sulfate	730	25		mg/L	50	12/1/2009 5:16:16 PM
EPA 6010B: TOTAL RECOVERABLE METALS						Analyst: **RAGS**
Barium	ND	0.20		mg/L	20	12/4/2009 1:10:07 PM
Cadmium	ND	0.040		mg/L	20	12/4/2009 1:10:07 PM
Calcium	240	10		mg/L	20	12/4/2009 1:10:07 PM
Chromium	ND	0.12		mg/L	20	12/4/2009 1:10:07 PM
Cobalt	ND	0.12		mg/L	20	12/4/2009 1:10:07 PM
Iron	5.3	1.0		mg/L	20	12/4/2009 1:10:07 PM
Lead	ND	0.10		mg/L	20	12/4/2009 1:35:46 PM
Magnesium	100	10		mg/L	20	12/4/2009 1:10:07 PM
Manganese	0.082	0.040		mg/L	20	12/4/2009 1:10:07 PM
Nickel	ND	0.20		mg/L	20	12/4/2009 1:10:07 PM
Potassium	160	20		mg/L	20	12/4/2009 1:10:07 PM
Sodium	59000	500		mg/L	1000	12/6/2009 4:31:11 PM
Strontium	3.5	0.20		mg/L	20	12/4/2009 1:10:07 PM
Vanadium	ND	1.0		mg/L	20	12/4/2009 1:10:07 PM
Zinc	ND	0.40		mg/L	20	12/4/2009 1:10:07 PM
EPA 120.1: SPECIFIC CONDUCTANCE						Analyst: **DAM**
Specific Conductance	270000	0.50		µmhos/cm	50	12/4/2009 3:26:00 PM
SM2540C MOD: TOTAL DISSOLVED SOLIDS						Analyst: **MMS**
Total Dissolved Solids	153000	2000		mg/L	1	12/8/2009 3:08:00 PM

Qualifiers:

*	Value exceeds Maximum Contaminant Level	B	Analyte detected in the associated Method Blank
E	Estimated value	H	Holding times for preparation or analysis exceeded
J	Analyte detected below quantitation limits	MCL	Maximum Contaminant Level
ND	Not Detected at the Reporting Limit	RL	Reporting Limit
S	Spike recovery outside accepted recovery limits		

Anatek Labs, Inc.

1282 Alturas Drive • Moscow, ID 83843 • (208) 883-2839 • Fax (208) 882-9246 • email moscow@anateklabs.com
504 E Sprague Ste. D • Spokane WA 99202 • (509) 838-3999 • Fax (509) 838-4433 • email spokane@anateklabs.com

Client:	HALL ENVIRONMENTAL ANALYSIS LAB	**Batch #:**	091202020
Address:	4901 HAWKINS NE SUITE D ALBUQUERQUE, NM 87109	**Project Name:**	0912017
Attn:	ANDY FREEMAN		

Analytical Results Report

Sample Number	091202020-001	**Sampling Date**	12/1/2009	**Date/Time Received**	12/2/2009 11:20 AM
Client Sample ID	0912017-01C / SALADO FM				
Matrix	Water				
Comments					

Parameter	Result	Units	PQL	Analysis Date	Analyst	Method	Qualifier
Arsenic	ND	mg/L	0.05	12/9/2009	ETL	EPA 6020A	
Titanium	0.102	mg/L	0.05	12/9/2009	ETL	EPA 6020A	
Tungsten	ND	mg/L	0.05	12/9/2009	ETL	EPA 6020A	
Uranium	ND	mg/L	0.05	12/9/2009	ETL	EPA 6020A	

Authorized Signature John W. Codd

John Coddington, Lab Manager

MCL	EPA's Maximum Contaminant Level
ND	Not Detected
PQL	Practical Quantitation Limit

This report shall not be reproduced except in full, without the written approval of the laboratory.
The results reported relate only to the samples indicated.
Soil/solid results are reported on a dry-weight basis unless otherwise noted.

QA/QC SUMMARY REPORT

Client: Daniel B. Stephens & Assoc.
Project: PZ-13 Pb **Work Order:** 0912017

Analyte	Result	Units	PQL	SPK Va	SPK ref	%Rec	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Method: EPA Method 300.0: Anions											
Sample ID: MB		*MBLK*				Batch ID: **R36381**		Analysis Date: 12/1/2009 10:18:27 AM			
Fluoride	ND	mg/L	0.10								
Chloride	ND	mg/L	0.10								
Nitrogen, Nitrite (As N)	ND	mg/L	0.10								
Bromide	ND	mg/L	0.10								
Nitrogen, Nitrate (As N)	ND	mg/L	0.10								
Phosphorus, Orthophosphate (As P)	ND	mg/L	0.50								
Sulfate	ND	mg/L	0.50								
Sample ID: MB		*MBLK*				Batch ID: **R36404**		Analysis Date: 12/2/2009 11:12:25 AM			
Fluoride	ND	mg/L	0.10								
Chloride	ND	mg/L	0.10								
Nitrogen, Nitrite (As N)	ND	mg/L	0.10								
Bromide	ND	mg/L	0.10								
Nitrogen, Nitrate (As N)	ND	mg/L	0.10								
Phosphorus, Orthophosphate (As P)	ND	mg/L	0.50								
Sulfate	ND	mg/L	0.50								
Sample ID: LCS		*LCS*				Batch ID: **R36381**		Analysis Date: 12/1/2009 10:35:51 AM			
Fluoride	0.5248	mg/L	0.10	0.5	0	105	90	110			
Chloride	5.065	mg/L	0.10	5	0	101	90	110			
Nitrogen, Nitrite (As N)	0.9709	mg/L	0.10	1	0	97.1	90	110			
Bromide	2.651	mg/L	0.10	2.5	0	106	90	110			
Nitrogen, Nitrate (As N)	2.539	mg/L	0.10	2.5	0	102	90	110			
Phosphorus, Orthophosphate (As P)	5.065	mg/L	0.50	5	0	101	90	110			
Sulfate	10.06	mg/L	0.50	10	0	101	90	110			
Sample ID: LCS		*LCS*				Batch ID: **R36404**		Analysis Date: 12/2/2009 11:29:50 AM			
Fluoride	0.5215	mg/L	0.10	0.5	0	104	90	110			
Chloride	5.037	mg/L	0.10	5	0	101	90	110			
Nitrogen, Nitrite (As N)	0.9654	mg/L	0.10	1	0	96.5	90	110			
Bromide	2.615	mg/L	0.10	2.5	0	105	90	110			
Nitrogen, Nitrate (As N)	2.546	mg/L	0.10	2.5	0	102	90	110			
Phosphorus, Orthophosphate (As P)	5.063	mg/L	0.50	5	0	101	90	110			
Sulfate	9.982	mg/L	0.50	10	0	99.8	90	110			

Qualifiers:

E	Estimated value	H	Holding times for preparation or analysis exceeded
J	Analyte detected below quantitation limits	ND	Not Detected at the Reporting Limit
R	RPD outside accepted recovery limits	S	Spike recovery outside accepted recovery limits

QA/QC SUMMARY REPORT

Client: Daniel B. Stephens & Assoc.
Project: PZ-13 Pb **Work Order:** 0912017

Analyte	Result	Units	PQL	SPK Va	SPK ref	%Rec	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Method: EPA 6010B: Total Recoverable Metals											
Sample ID: MB-20777		*MBLK*				Batch ID:	**20777**	Analysis Date:		12/4/2009 12:12:24 PM	
Barium	ND	mg/L	0.010								
Cadmium	ND	mg/L	0.0020								
Calcium	ND	mg/L	0.50								
Chromium	ND	mg/L	0.0060								
Iron	ND	mg/L	0.050								
Lead	ND	mg/L	0.0050								
Magnesium	ND	mg/L	0.50								
Manganese	ND	mg/L	0.0020								
Nickel	ND	mg/L	0.010								
Potassium	ND	mg/L	1.0								
Sodium	ND	mg/L	0.50								
Strontium	ND	mg/L	0.010								
Vanadium	ND	mg/L	0.050								
Zinc	ND	mg/L	0.020								
Sample ID: LCS-20777		*LCS*				Batch ID:	**20777**	Analysis Date:		12/4/2009 12:15:22 PM	
Barium	0.4767	mg/L	0.010	0.5	0	95.3	80	120			
Cadmium	0.4820	mg/L	0.0020	0.5	0	96.4	80	120			
Calcium	51.16	mg/L	0.50	50	0	102	80	120			
Chromium	0.4783	mg/L	0.0060	0.5	0	95.7	80	120			
Iron	0.4984	mg/L	0.050	0.5	0	99.7	80	120			
Lead	0.4727	mg/L	0.0050	0.5	0	94.5	80	120			
Magnesium	51.72	mg/L	0.50	50	0	103	80	120			
Manganese	0.4775	mg/L	0.0020	0.5	0	95.5	80	120			
Nickel	0.4673	mg/L	0.010	0.5	0	93.5	80	120			
Potassium	54.21	mg/L	1.0	50	0	108	80	120			
Sodium	54.78	mg/L	0.50	50	0	110	80	120			
Strontium	0.1018	mg/L	0.010	0.1	0	102	80	120			
Vanadium	0.4888	mg/L	0.050	0.5	0	97.8	80	120			
Zinc	0.4637	mg/L	0.020	0.5	0	92.7	80	120			
Method: SM2540C MOD: Total Dissolved Solids											
Sample ID: MB-20792		*MBLK*				Batch ID:	**20792**	Analysis Date:		12/8/2009 3:08:00 PM	
Total Dissolved Solids	ND	mg/L	20.0								
Sample ID: LCS-20792		*LCS*				Batch ID:	**20792**	Analysis Date:		12/8/2009 3:08:00 PM	
Total Dissolved Solids	1009	mg/L	20.0	1000	0	101	80	120			

Qualifiers:

E	Estimated value	H	Holding times for preparation or analysis exceeded
J	Analyte detected below quantitation limits	ND	Not Detected at the Reporting Limit
R	RPD outside accepted recovery limits	S	Spike recovery outside accepted recovery limits

Hall Environmental Analysis Laboratory, Inc.

Sample Receipt Checklist

Client Name DBS		Date Received:	11/25/2009
Work Order Number 0912017		Received by:	AMF
		Sample ID labels checked by:	Initials
Checklist completed by: Signature	11/25/09 Date		

Matrix:

Carrier name Client drop-off

Shipping container/cooler in good condition?	Yes ☑	No ☐	Not Present ☐	
Custody seals intact on shipping container/cooler?	Yes ☐	No ☐	Not Present ☐	Not Shipped ☑
Custody seals intact on sample bottles?	Yes ☐	No ☐	N/A ☑	
Chain of custody present?	Yes ☑	No ☐		
Chain of custody signed when relinquished and received?	Yes ☑	No ☐		
Chain of custody agrees with sample labels?	Yes ☑	No ☐		
Samples in proper container/bottle?	Yes ☑	No ☐		
Sample containers intact?	Yes ☑	No ☐		
Sufficient sample volume for indicated test?	Yes ☑	No ☐		
All samples received within holding time?	Yes ☑	No ☐		Number of preserved bottles checked for pH:
Water - VOA vials have zero headspace?	No VOA vials submitted ☑	Yes ☐	No ☐	
Water - Preservation labels on bottle and cap match?	Yes ☐	No ☐	N/A ☑	2
Water - pH acceptable upon receipt?	Yes ☐	No ☐	N/A ☑	[✓ <2] >12 unless noted below.
Container/Temp Blank temperature?	**19.3°**	*<6° C Acceptable* If given sufficient time to cool.		

COMMENTS:

Client contacted ______ Date contacted: ______ Person contacted ______

Contacted by: ______ Regarding: ______

Comments: Sample preserved in lab / AT 12/01/09

Corrective Action

Chain-of-Custody Record

Client: Daniel B Stephens & Assoc

Mailing Address: 6020 Academy NE
ABQ NM 87109

Phone #: 822-9400

email or Fax#: cwolf@dbstephens.com

QA/QC Package:
☒ Standard ☐ Level 4 (Full Validation)

Accreditation
☐ NELAP ☐ Other ____

☒ EDD (Type) xls

Turn-Around Time:
☐ Standard ☒ Rush ____

Project Name: PZ-13 Pb

Project #: ES08.0072.10

Project Manager: M. Miller

Sampler: Wolf

On Ice: ☐ Yes ☒ No

Sample Temperature: 19.3°

HALL ENVIRONMENTAL ANALYSIS LABORATORY

www.hallenvironmental.com

4901 Hawkins NE - Albuquerque, NM 87109

Tel. 505-345-3975 Fax 505-345-4107

Analysis Request

Date	Time	Matrix	Sample Request ID	Container Type and #	Preservative Type	HEAL No.	BTEX + MTBE + TMB's (8021)	BTEX + MTBE + TPH (Gas only)	TPH Method 8015B (Gas/Diesel)	TPH (Method 418.1)	EDB (Method 504.1)	8310 (PNA or PAH)	RCRA 8 Metals	Anions (F,Cl,NO_3,NO_2,PO_4,SO_4)	8081 Pesticides / 8082 PCB's	8260B (VOA)	8270 (Semi-VOA)	CAB	Mix brine soln	Metals - low level		Air Bubbles (Y or N)
11/16/09	—	solid	Salado Fm.	1 bucket	—	0912017-1												✓	✓	✓		

Date:	Time:	Relinquished by:	Received by:	Date	Time
11/25/09	9:25	Ch Wolf		11/25/09	9:25
Date:	Time:	Relinquished by:	Received by:	Date	Time

Remarks:
Mix brine solution & analyze Pb, As, Ba, Cd, Co, Cr, Fe, Mn, Ni, Sr, Ti, U, V, W, Zn alkalinity, Br, Ca, Cl, F, K, Na, Mg, NO_2, NO_3, PO_4 SO_4, TDS, EC, pH, Temp.

**HALL
ENVIRONMENTAL
ANALYSIS
LABORATORY**

COVER LETTER

Thursday, December 10, 2009

Mark Miller
Daniel B. Stephens & Assoc.
6020 Academy NE Suite 100
Albuquerque, NM 87109

TEL: (505) 822-9400
FAX (505) 822-8877

RE: PZ-13 Lead

Order No.: 0911475

Dear Mark Miller:

Hall Environmental Analysis Laboratory, Inc. received 3 sample(s) on 11/23/2009 for the analyses presented in the following report.

These were analyzed according to EPA procedures or equivalent. Below is a list of our accreditations. To access our accredited tests please go to www.hallenvironmental.com or the state specific web sites.

Reporting limits are determined by EPA methodology. No determination of compounds below these (denoted by the ND or < sign) has been made.

Please don't hesitate to contact HEAL for any additional information or clarifications.

Sincerely,

Andy Freeman, Laboratory Manager

NM Lab # NM9425 NM0901
AZ license # AZ0682
ORELAP Lab # NM100001
Texas Lab# T104704424-08-TX

ACCREDITED IN ACCORDANCE WITH nelac

4901 Hawkins NE ■ Suite D ■ Albuquerque, NM 87109
505.345.3975 ■ Fax 505.345.4107
www.hallenvironmental.com

Hall Environmental Analysis Laboratory, Inc. **Date:** *11-Dec-09*

CLIENT:	Daniel B. Stephens & Assoc.
Project:	PZ-13 Lead
Lab Order:	0911475

CASE NARRATIVE

The following samples were leached overnight in 5% nitric acid solution
0911475-01A and 01B
0911475-02A and 02B
0911475-03A and 03B

The sample ID's with the "C" fraction were sonicated in DI water for 10 minutes and the DI water was then analyzed.

CLIENT:	Daniel B. Stephens & Assoc.	**Client Sample ID:**	HSA Flat #4
Lab Order:	0911475	**Tag Number:**	
Project:	PZ-13 Lead	**Collection Date:**	11/23/2009
Lab ID:	0911475-01A **Date Received:** 11/23/2009	**Matrix:**	AQUEOUS

Analyses	Result	PQL	Qual	Units	DF	Date Analyzed
EPA 6010B: TOTAL RECOVERABLE METALS						Analyst: **RAGS**
Barium	ND	0.25		mg/L	5	12/2/2009 5:14:07 PM
Cadmium	ND	0.010		mg/L	1	12/2/2009 4:43:57 PM
Chromium	150	1.5		mg/L	50	12/2/2009 4:35:08 PM
Cobalt	730	6.0		mg/L	200	12/2/2009 5:33:51 PM
Iron	19000	1300		mg/L	5000	12/2/2009 5:56:27 PM
Lead	ND	1.3		mg/L	50	12/2/2009 4:35:08 PM
Manganese	130	0.50		mg/L	50	12/2/2009 4:35:08 PM
Nickel	13	0.25		mg/L	5	12/2/2009 5:14:07 PM
Strontium	ND	0.050		mg/L	1	12/2/2009 4:43:57 PM
Vanadium	ND	0.25		mg/L	1	12/2/2009 4:43:57 PM
Zinc	15	0.50		mg/L	5	12/2/2009 5:14:07 PM

Qualifiers:

*	Value exceeds Maximum Contaminant Level	B	Analyte detected in the associated Method Blank
E	Estimated value	H	Holding times for preparation or analysis exceeded
J	Analyte detected below quantitation limits	MCL	Maximum Contaminant Level
ND	Not Detected at the Reporting Limit	RL	Reporting Limit
S	Spike recovery outside accepted recovery limits		

Hall Environmental Analysis Laboratory, Inc.

Date: *11-Dec-09*

CLIENT:	Daniel B. Stephens & Assoc.	**Client Sample ID:**	HAS Flat #4 Sonication
Lab Order:	0911475	**Tag Number:**	
Project:	PZ-13 Lead	**Collection Date:**	11/23/2009
Lab ID:	0911475-01C **Date Received:** 11/23/2009	**Matrix:**	AQUEOUS

Analyses	Result	PQL	Qual	Units	DF	Date Analyzed
EPA METHOD 6010B: DISSOLVED METALS						Analyst: **RAGS**
Barium	ND	0.020		mg/L	1	12/3/2009 6:27:06 PM
Cadmium	ND	0.0020		mg/L	1	12/3/2009 6:27:06 PM
Chromium	0.53	0.0060		mg/L	1	12/3/2009 6:27:06 PM
Cobalt	0.095	0.0060		mg/L	1	12/6/2009 3:20:34 PM
Iron	16	0.40		mg/L	20	12/6/2009 5:03:41 PM
Lead	ND	0.0050		mg/L	1	12/3/2009 6:27:06 PM
Manganese	0.10	0.0020		mg/L	1	12/3/2009 6:27:06 PM
Nickel	0.054	0.010		mg/L	1	12/3/2009 6:27:06 PM
Strontium	ND	0.0060		mg/L	1	12/3/2009 6:27:06 PM
Vanadium	ND	0.050		mg/L	1	12/3/2009 6:27:06 PM
Zinc	1.4	0.25		mg/L	5	12/6/2009 4:58:01 PM

Qualifiers:				
	*	Value exceeds Maximum Contaminant Level	B	Analyte detected in the associated Method Blank
	E	Estimated value	H	Holding times for preparation or analysis exceeded
	J	Analyte detected below quantitation limits	MCL	Maximum Contaminant Level
	ND	Not Detected at the Reporting Limit	RL	Reporting Limit
	S	Spike recovery outside accepted recovery limits		

CLIENT: Daniel B. Stephens & Assoc. **Client Sample ID:** HSA Round #3
Lab Order: 0911475 **Tag Number:**
Project: PZ-13 Lead **Collection Date:** 11/23/2009
Lab ID: 0911475-02A **Date Received:** 11/23/2009 **Matrix:** AQUEOUS

Analyses	Result	PQL	Qual	Units	DF	Date Analyzed
EPA 6010B: TOTAL RECOVERABLE METALS						Analyst: **RAGS**
Barium	ND	0.25		mg/L	5	12/2/2009 5:17:57 PM
Cadmium	ND	0.010		mg/L	1	12/2/2009 5:05:52 PM
Chromium	6.1	0.15		mg/L	5	12/2/2009 5:17:57 PM
Cobalt	360	3.0		mg/L	100	12/2/2009 5:53:23 PM
Iron	15000	1300		mg/L	5000	12/2/2009 5:59:30 PM
Lead	ND	1.3		mg/L	50	12/2/2009 4:38:01 PM
Manganese	270	1.0		mg/L	100	12/2/2009 5:53:23 PM
Nickel	36	0.50		mg/L	10	12/2/2009 5:25:49 PM
Strontium	ND	0.050		mg/L	1	12/2/2009 5:05:52 PM
Vanadium	ND	1.3		mg/L	5	12/2/2009 5:17:57 PM
Zinc	4.1	0.10		mg/L	1	12/2/2009 5:05:52 PM

Qualifiers:

*	Value exceeds Maximum Contaminant Level	B	Analyte detected in the associated Method Blank
E	Estimated value	H	Holding times for preparation or analysis exceeded
J	Analyte detected below quantitation limits	MCL	Maximum Contaminant Level
ND	Not Detected at the Reporting Limit	RL	Reporting Limit
S	Spike recovery outside accepted recovery limits		

Hall Environmental Analysis Laboratory, Inc.

Date: *11-Dec-09*

CLIENT:	Daniel B. Stephens & Assoc.	**Client Sample ID:**	HSA Round #3 Sonication
Lab Order:	0911475	**Tag Number:**	
Project:	PZ-13 Lead	**Collection Date:**	11/23/2009
Lab ID:	0911475-02C **Date Received:** 11/23/2009	**Matrix:**	AQUEOUS

Analyses	Result	PQL	Qual	Units	DF	Date Analyzed
EPA METHOD 6010B: DISSOLVED METALS						Analyst: **RAGS**
Barium	ND	0.020		mg/L	1	12/3/2009 6:30:10 PM
Cadmium	ND	0.0020		mg/L	1	12/3/2009 6:30:10 PM
Chromium	ND	0.0060		mg/L	1	12/3/2009 6:30:10 PM
Cobalt	0.090	0.0060		mg/L	1	12/6/2009 3:22:48 PM
Iron	1.9	0.10		mg/L	5	12/6/2009 5:14:44 PM
Lead	ND	0.0050		mg/L	1	12/3/2009 6:30:10 PM
Manganese	0.055	0.0020		mg/L	1	12/3/2009 6:30:10 PM
Nickel	0.026	0.010		mg/L	1	12/3/2009 6:30:10 PM
Strontium	ND	0.0060		mg/L	1	12/3/2009 6:30:10 PM
Vanadium	ND	0.050		mg/L	1	12/3/2009 6:30:10 PM
Zinc	0.60	0.050		mg/L	1	12/3/2009 6:30:10 PM

Qualifiers:

*	Value exceeds Maximum Contaminant Level	B	Analyte detected in the associated Method Blank
E	Estimated value	H	Holding times for preparation or analysis exceeded
J	Analyte detected below quantitation limits	MCL	Maximum Contaminant Level
ND	Not Detected at the Reporting Limit	RL	Reporting Limit
S	Spike recovery outside accepted recovery limits		

CLIENT:	Daniel B. Stephens & Assoc.	**Client Sample ID:**	Tri Cone #2
Lab Order:	0911475	**Tag Number:**	
Project:	PZ-13 Lead	**Collection Date:**	11/23/2009
Lab ID:	0911475-03A **Date Received:** 11/23/2009	**Matrix:**	AQUEOUS

Analyses	Result	PQL	Qual	Units	DF	Date Analyzed
EPA 6010B: TOTAL RECOVERABLE METALS						Analyst: **RAGS**
Barium	ND	0.050		mg/L	1	12/2/2009 5:10:00 PM
Cadmium	ND	0.010		mg/L	1	12/2/2009 5:10:00 PM
Chromium	0.18	0.030		mg/L	1	12/2/2009 5:10:00 PM
Cobalt	340	3.0		mg/L	100	12/2/2009 5:30:49 PM
Iron	78	13		mg/L	50	12/2/2009 4:40:56 PM
Lead	ND	0.025		mg/L	1	12/2/2009 5:10:00 PM
Manganese	0.090	0.010		mg/L	1	12/2/2009 5:10:00 PM
Nickel	13	0.25		mg/L	5	12/2/2009 5:21:48 PM
Strontium	ND	0.050		mg/L	1	12/2/2009 5:10:00 PM
Vanadium	ND	0.25		mg/L	1	12/2/2009 5:10:00 PM
Zinc	ND	0.10		mg/L	1	12/2/2009 5:10:00 PM

Qualifiers:

*	Value exceeds Maximum Contaminant Level	B	Analyte detected in the associated Method Blank
E	Estimated value	H	Holding times for preparation or analysis exceeded
J	Analyte detected below quantitation limits	MCL	Maximum Contaminant Level
ND	Not Detected at the Reporting Limit	RL	Reporting Limit
S	Spike recovery outside accepted recovery limits		

Hall Environmental Analysis Laboratory, Inc.

Date: *11-Dec-09*

CLIENT:	Daniel B. Stephens & Assoc.	**Client Sample ID:**	Tri Cone #2 Sonication
Lab Order:	0911475	**Tag Number:**	
Project:	PZ-13 Lead	**Collection Date:**	11/23/2009
Lab ID:	0911475-03C **Date Received:** 11/23/2009	**Matrix:**	AQUEOUS

Analyses	Result	PQL	Qual	Units	DF	Date Analyzed
EPA METHOD 6010B: DISSOLVED METALS						Analyst: **RAGS**
Barium	ND	0.020		mg/L	1	12/3/2009 6:46:06 PM
Cadmium	ND	0.0020		mg/L	1	12/3/2009 6:46:06 PM
Chromium	ND	0.0060		mg/L	1	12/3/2009 6:46:06 PM
Cobalt	0.21	0.0060		mg/L	1	12/6/2009 3:25:06 PM
Iron	0.37	0.020		mg/L	1	12/3/2009 6:46:06 PM
Lead	ND	0.0050		mg/L	1	12/3/2009 6:46:06 PM
Manganese	0.0048	0.0020		mg/L	1	12/3/2009 6:46:06 PM
Nickel	0.060	0.010		mg/L	1	12/3/2009 6:46:06 PM
Strontium	ND	0.0060		mg/L	1	12/3/2009 6:46:06 PM
Vanadium	ND	0.050		mg/L	1	12/3/2009 6:46:06 PM
Zinc	0.14	0.050		mg/L	1	12/3/2009 6:46:06 PM

Qualifiers:

*	Value exceeds Maximum Contaminant Level	B	Analyte detected in the associated Method Blank
E	Estimated value	H	Holding times for preparation or analysis exceeded
J	Analyte detected below quantitation limits	MCL	Maximum Contaminant Level
ND	Not Detected at the Reporting Limit	RL	Reporting Limit
S	Spike recovery outside accepted recovery limits		

Anatek Labs, Inc.

1282 Alturas Drive • Moscow, ID 83843 • (208) 883-2839 • Fax (208) 882-9246 • email moscow@anateklabs.com
504 E Sprague Ste. D • Spokane WA 99202 • (509) 838-3999 • Fax (509) 838-4433 • email spokane@anateklabs.com

Client:	HALL ENVIRONMENTAL ANALYSIS LAB	**Batch #:**	091201028
Address:	4901 HAWKINS NE SUITE D ALBUQUERQUE, NM 87109	**Project Name:**	0911475
Attn:	ANDY FREEMAN		

Analytical Results Report

Sample Number	091201028-001	**Sampling Date**	11/23/2009	**Date/Time Received**	12/1/2009	11:20 AM
Client Sample ID	0911475-01B / HAS FLAT #4					
Matrix	Water					
Comments						

Parameter	Result	Units	PQL	Analysis Date	Analyst	Method	Qualifier
Arsenic	0.579	mg/L	0.05	12/9/2009	ETL	EPA 6020A	
Lead	0.0940	mg/L	0.05	12/9/2009	ETL	EPA 6020A	
Titanium	0.266	mg/L	0.05	12/9/2009	ETL	EPA 6020A	
Tungsten	4.88	mg/L	0.5	12/9/2009	ETL	EPA 6020A	
Uranium	ND	mg/L	0.05	12/9/2009	ETL	EPA 6020A	

Sample Number	091201028-002	**Sampling Date**	11/23/2009	**Date/Time Received**	12/1/2009	11:20 AM
Client Sample ID	0911475-02B / HSA ROUND #3					
Matrix	Water					
Comments						

Parameter	Result	Units	PQL	Analysis Date	Analyst	Method	Qualifier
Arsenic	0.0829	mg/L	0.05	12/9/2009	ETL	EPA 6020A	
Lead	ND	mg/L	0.05	12/9/2009	ETL	EPA 6020A	
Titanium	ND	mg/L	0.05	12/9/2009	ETL	EPA 6020A	
Tungsten	3.03	mg/L	0.5	12/9/2009	ETL	EPA 6020A	
Uranium	ND	mg/L	0.05	12/9/2009	ETL	EPA 6020A	

Client:	HALL ENVIRONMENTAL ANALYSIS LAB	**Batch #:**	091201028
Address:	4901 HAWKINS NE SUITE D ALBUQUERQUE, NM 87109	**Project Name:**	0911475
Attn:	ANDY FREEMAN		

Analytical Results Report

Sample Number	091201028-003	**Sampling Date**	11/23/2009	**Date/Time Received**	12/1/2009 11:20 AM
Client Sample ID	0911475-03B / TRI CONE #2				
Matrix	Water				
Comments					

Parameter	Result	Units	PQL	Analysis Date	Analyst	Method	Qualifier
Arsenic	0.366	mg/L	0.05	12/9/2009	ETL	EPA 6020A	
Lead	ND	mg/L	0.05	12/9/2009	ETL	EPA 6020A	
Titanium	2.02	mg/L	0.05	12/9/2009	ETL	EPA 6020A	
Tungsten	7.24	mg/L	0.5	12/9/2009	ETL	EPA 6020A	
Uranium	ND	mg/L	0.05	12/9/2009	ETL	EPA 6020A	

Authorized Signature

John Coddington, Lab Manager

MCL	EPA's Maximum Contaminant Level
ND	Not Detected
PQL	Practical Quantitation Limit

This report shall not be reproduced except in full, without the written approval of the laboratory.
The results reported relate only to the samples indicated.
Soil/solid results are reported on a dry-weight basis unless otherwise noted.

QA/QC SUMMARY REPORT

Client: Daniel B. Stephens & Assoc.
Project: PZ-13 Lead
Work Order: 0911475

Analyte	Result	Units	PQL	SPK Val	SPK ref	%Rec	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Method: EPA Method 6010B: Dissolved Metals											
Sample ID: MB		*MBLK*				Batch ID:	**R36425**	Analysis Date:		12/3/2009 5:55:13 PM	
Barium	ND	mg/L	0.020								
Cadmium	ND	mg/L	0.0020								
Chromium	ND	mg/L	0.0060								
Iron	ND	mg/L	0.020								
Lead	ND	mg/L	0.0050								
Manganese	ND	mg/L	0.0020								
Nickel	ND	mg/L	0.010								
Strontium	ND	mg/L	0.0060								
Vanadium	ND	mg/L	0.050								
Zinc	ND	mg/L	0.050								
Sample ID: MB		*MBLK*				Batch ID:	**R36435**	Analysis Date:		12/6/2009 1:52:04 PM	
Cobalt	ND	mg/L	0.0060								
Sample ID: LCS		*LCS*				Batch ID:	**R36425**	Analysis Date:		12/3/2009 5:58:12 PM	
Barium	0.4988	mg/L	0.020	0.5	0	99.8	80	120			
Cadmium	0.5192	mg/L	0.0020	0.5	0	104	80	120			
Chromium	0.5011	mg/L	0.0060	0.5	0	100	80	120			
Iron	0.5053	mg/L	0.020	0.5	0	101	80	120			
Lead	0.5163	mg/L	0.0050	0.5	0	103	80	120			
Manganese	0.4982	mg/L	0.0020	0.5	0	99.6	80	120			
Nickel	0.5100	mg/L	0.010	0.5	0	102	80	120			
Strontium	0.1053	mg/L	0.0060	0.1	0	105	80	120			
Vanadium	0.5194	mg/L	0.050	0.5	0	104	80	120			
Zinc	0.5723	mg/L	0.050	0.5	0	114	80	120			
Sample ID: LCSRR		*LCS*				Batch ID:	**R36425**	Analysis Date:		12/3/2009 6:03:02 PM	
Barium	0.4952	mg/L	0.020	0.5	0	99.0	80	120			
Cadmium	0.5183	mg/L	0.0020	0.5	0	104	80	120			
Chromium	0.4997	mg/L	0.0060	0.5	0	99.9	80	120			
Iron	0.4999	mg/L	0.020	0.5	0	100	80	120			
Lead	0.5170	mg/L	0.0050	0.5	0	103	80	120			
Manganese	0.4944	mg/L	0.0020	0.5	0	98.9	80	120			
Nickel	0.5107	mg/L	0.010	0.5	0	102	80	120			
Strontium	0.1046	mg/L	0.0060	0.1	0	105	80	120			
Vanadium	0.5196	mg/L	0.050	0.5	0	104	80	120			
Zinc	0.5679	mg/L	0.050	0.5	0	114	80	120			
Sample ID: LCS		*LCS*				Batch ID:	**R36435**	Analysis Date:		12/6/2009 1:54:30 PM	
Cobalt	0.5598	mg/L	0.0060	0.5	0	112	80	120			

Qualifiers:

E	Estimated value	H	Holding times for preparation or analysis exceeded
J	Analyte detected below quantitation limits	ND	Not Detected at the Reporting Limit
R	RPD outside accepted recovery limits	S	Spike recovery outside accepted recovery limits

QA/QC SUMMARY REPORT

Client: Daniel B. Stephens & Assoc.
Project: PZ-13 Lead **Work Order:** 0911475

Analyte	Result	Units	PQL	SPK Va	SPK ref	%Rec	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Method: EPA 6010B: Total Recoverable Metals											
Sample ID: MB-20747		*MBLK*				Batch ID:	**20747**	Analysis Date:		12/1/2009 1:49:50 PM	
Cadmium	ND	mg/L	0.0020								
Chromium	ND	mg/L	0.0060								
Cobalt	ND	mg/L	0.0060								
Iron	ND	mg/L	0.050								
Lead	ND	mg/L	0.0050								
Manganese	ND	mg/L	0.0020								
Nickel	ND	mg/L	0.010								
Strontium	ND	mg/L	0.010								
Vanadium	ND	mg/L	0.050								
Zinc	ND	mg/L	0.020								
Sample ID: MB-SPLP #2		*MBLK*				Batch ID:	**20747**	Analysis Date:		12/1/2009 1:55:59 PM	
Cadmium	ND	mg/L	0.0020								
Chromium	ND	mg/L	0.0060								
Cobalt	ND	mg/L	0.0060								
Iron	ND	mg/L	0.050								
Lead	ND	mg/L	0.0050								
Manganese	ND	mg/L	0.0020								
Nickel	ND	mg/L	0.010								
Strontium	ND	mg/L	0.010								
Vanadium	ND	mg/L	0.050								
Zinc	ND	mg/L	0.020								
Sample ID: MB-20747		*MBLK*				Batch ID:	**20747**	Analysis Date:		12/2/2009 4:28:58 PM	
Barium	ND	mg/L	0.010								
Cadmium	ND	mg/L	0.0020								
Chromium	ND	mg/L	0.0060								
Cobalt	ND	mg/L	0.0060								
Iron	ND	mg/L	0.050								
Lead	ND	mg/L	0.0050								
Manganese	ND	mg/L	0.0020								
Nickel	ND	mg/L	0.010								
Strontium	ND	mg/L	0.010								
Vanadium	ND	mg/L	0.050								
Zinc	ND	mg/L	0.020								
Sample ID: MB-20747		*MBLK*				Batch ID:	**20747**	Analysis Date:		12/7/2009 5:40:29 PM	
Barium	ND	mg/L	0.010								
Cadmium	ND	mg/L	0.0020								
Chromium	ND	mg/L	0.0060								
Cobalt	ND	mg/L	0.0060								
Iron	ND	mg/L	0.050								
Lead	ND	mg/L	0.0050								
Manganese	ND	mg/L	0.0020								
Sample ID: LCS-20747		*LCS*				Batch ID:	**20747**	Analysis Date:		12/1/2009 1:52:48 PM	
Cadmium	0.4860	mg/L	0.0020	0.5	0	97.2	80	120			

Qualifiers:

E	Estimated value	H	Holding times for preparation or analysis exceeded
J	Analyte detected below quantitation limits	ND	Not Detected at the Reporting Limit
R	RPD outside accepted recovery limits	S	Spike recovery outside accepted recovery limits

QA/QC SUMMARY REPORT

Client: Daniel B. Stephens & Assoc.
Project: PZ-13 Lead
Work Order: 0911475

Method: **EPA 6010B: Total Recoverable Metals**

Sample ID: LCS-20747 *LCS* Batch ID: **20747** Analysis Date: 12/1/2009 1:52:48 PM

Analyte	Result	Units	PQL	SPK Val	SPK ref	%Rec	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Chromium	0.4872	mg/L	0.0060	0.5	0	97.4	80	120			
Cobalt	0.4667	mg/L	0.0060	0.5	0	93.3	80	120			
Iron	0.4722	mg/L	0.050	0.5	0	94.4	80	120			
Lead	0.4802	mg/L	0.0050	0.5	0	96.0	80	120			
Manganese	0.4822	mg/L	0.0020	0.5	0	96.4	80	120			
Nickel	0.4765	mg/L	0.010	0.5	0	95.3	80	120			
Strontium	0.1028	mg/L	0.010	0.1	0	103	80	120			
Vanadium	0.5044	mg/L	0.050	0.5	0	101	80	120			
Zinc	0.4756	mg/L	0.020	0.5	0	95.1	80	120			

Sample ID: LCS-20747 *LCS* Batch ID: **20747** Analysis Date: 12/2/2009 4:31:54 PM

Analyte	Result	Units	PQL	SPK Val	SPK ref	%Rec	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Barium	0.4757	mg/L	0.010	0.5	0	95.1	80	120			
Cadmium	0.4823	mg/L	0.0020	0.5	0	96.5	80	120			
Chromium	0.4811	mg/L	0.0060	0.5	0	96.2	80	120			
Cobalt	0.4547	mg/L	0.0060	0.5	0	90.9	80	120			
Iron	0.4917	mg/L	0.050	0.5	0	98.3	80	120			
Lead	0.4773	mg/L	0.0050	0.5	0	95.5	80	120			
Manganese	0.4764	mg/L	0.0020	0.5	0	95.3	80	120			
Nickel	0.4730	mg/L	0.010	0.5	0	94.6	80	120			
Strontium	0.1029	mg/L	0.010	0.1	0	103	80	120			
Vanadium	0.4953	mg/L	0.050	0.5	0	99.1	80	120			
Zinc	0.4681	mg/L	0.020	0.5	0	93.6	80	120			

Sample ID: LCS-20747 *LCS* Batch ID: **20747** Analysis Date: 12/7/2009 5:43:26 PM

Analyte	Result	Units	PQL	SPK Val	SPK ref	%Rec	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Barium	0.4784	mg/L	0.010	0.5	0	95.7	80	120			
Cadmium	0.4862	mg/L	0.0020	0.5	0	97.2	80	120			
Chromium	0.4828	mg/L	0.0060	0.5	0	96.6	80	120			
Cobalt	0.4504	mg/L	0.0060	0.5	0	90.1	80	120			
Iron	0.4927	mg/L	0.050	0.5	0	98.5	80	120			
Lead	0.4792	mg/L	0.0050	0.5	0	95.8	80	120			
Manganese	0.4778	mg/L	0.0020	0.5	0	95.6	80	120			

Qualifiers:

E	Estimated value	H	Holding times for preparation or analysis exceeded
J	Analyte detected below quantitation limits	ND	Not Detected at the Reporting Limit
R	RPD outside accepted recovery limits	S	Spike recovery outside accepted recovery limits

Hall Environmental Analysis Laboratory, Inc.

Sample Receipt Checklist

Client Name DBS

Date Received: 11/23/2009

Work Order Number 0911475

Received by: AMF

Sample ID labels checked by: Initials

Checklist completed by: Signature 11/23/09 Date

Matrix:

Carrier name Client drop-off

Shipping container/cooler in good condition?	Yes ☑	No ☐	Not Present ☐	
Custody seals intact on shipping container/cooler?	Yes ☐	No ☐	Not Present ☐	Not Shipped ☑
Custody seals intact on sample bottles?	Yes ☐	No ☐	N/A ☑	
Chain of custody present?	Yes ☑	No ☐		
Chain of custody signed when relinquished and received?	Yes ☑	No ☐		
Chain of custody agrees with sample labels?	Yes ☑	No ☐		
Samples in proper container/bottle?	Yes ☑	No ☐		
Sample containers intact?	Yes ☑	No ☐		
Sufficient sample volume for indicated test?	Yes ☑	No ☐		
All samples received within holding time?	Yes ☑	No ☐		Number of preserved bottles checked for pH:
Water - VOA vials have zero headspace?	No VOA vials submitted ☑	Yes ☐	No ☐	
Water - Preservation labels on bottle and cap match?	Yes ☐	No ☐	N/A ☑	
Water - pH acceptable upon receipt?	Yes ☐	No ☑	N/A ☐	*<2 >12 unless noted below.*
Container/Temp Blank temperature?	**21.4°**	*<6° C Acceptable* If given sufficient time to cool.		

COMMENTS:

Client contacted ________ Date contacted: ________ Person contacted ________

Contacted by: ________ Regarding: ________

Comments:

Corrective Action

Chain-of-Custody Record

Client: DBS & A

Mailing Address: 6020 Academy
ABQ, NM 87109

Phone #: 822-9400

email or Fax#:

QA/QC Package:
☒ Standard ☐ Level 4 (Full Validation)

Accreditation
☐ NELAP ☐ Other

☒ EDD (Type) xls

Turn-Around Time:
☐ Standard ☐ **Rush**

Project Name: PZ-13 Lead

Project #: ES08.0072.10

Project Manager: M. Miller

Sampler:

On Ice: ☐ Yes ☒ No

Sample Temperature: 2.4

HALL ENVIRONMENTAL ANALYSIS LABORATORY

www.hallenvironmental.com

4901 Hawkins NE - Albuquerque, NM 87109

Tel. 505-345-3975 Fax 505-345-4107

Analysis Request

Date 2009	Time	Matrix	Sample Request ID	Container Type and #	Preservative Type	HEAL No. 0911475	BTEX + MTBE + TMB's (8021)	BTEX + MTBE + TPH (Gas only)	TPH Method 8015B (Gas/Diesel)	TPH (Method 418.1)	EDB (Method 504.1)	8310 (PNA or PAH)	RCRA 8 Metals	Anions (F,Cl,NO_3,NO_2,PO_4,SO_4)	8081 Pesticides / 8082 PCB's	8260B (VOA)	8270 (Semi-VOA)	Metals (see list)				Air Bubbles (Y or N)
10/23	—	Solid	HSA Flat #4	1	—	-1												✓				
10/23	—	Solid	HSA Round #3	1	—	-2												✓				
10/23	—	Solid	Tri-Cone #2	1	—	-3												✓				

Date:	Time:	Relinquished by:	Received by:	Date	Time
10/23/09	1600	Chris Wolf	Andy	11/23/09	1600
Date:	Time:	Relinquished by:	Received by:	Date	Time

Remarks:
Pb, As, Ba, Cd, Co, Cr, Fe, Mn,
Ni, Sr, Ti, U, V, W, Zn
(call with Pb - preliminary)

If necessary, samples submitted to Hall Environmental may be subcontracted to other accredited laboratories. This serves as notice of this possibility. Any sub-contracted data will be clearly notated on the analytical report.

**HALL
ENVIRONMENTAL
ANALYSIS
LABORATORY**

COVER LETTER

Wednesday, February 03, 2010

Mark Miller
Daniel B. Stephens & Assoc.
6020 Academy NE Suite 100
Albuquerque, NM 87109

TEL: (505) 822-9400
FAX (505) 822-8877

RE: PZ-13

Order No.: 0912387

Dear Mark Miller:

Hall Environmental Analysis Laboratory, Inc. received 8 sample(s) on 12/17/2009 for the analyses presented in the following report.

These were analyzed according to EPA procedures or equivalent. Below is a list of our accreditations. To access our accredited tests please go to www.hallenvironmental.com or the state specific web sites.

Reporting limits are determined by EPA methodology.

Please don't hesitate to contact HEAL for any additional information or clarifications.

Sincerely,

Andy Freeman, Laboratory Manager

NM Lab # NM9425 NM0901
AZ license # AZ0682
ORELAP Lab # NM100001
Texas Lab# T104704424-08-TX

ACCREDITED IN ACCORDANCE WITH nelac

4901 Hawkins NE ■ Suite D ■ Albuquerque, NM 87109
505.345.3975 ■ Fax 505.345.4107
www.hallenvironmental.com

Hall Environmental Analysis Laboratory, Inc. **Date:** *06-Feb-10*

CLIENT:	Daniel B. Stephens & Assoc.
Project:	PZ-13
Lab Order:	0912387

CASE NARRATIVE

For samples 1 and 7 the following applies:
"A" fractions are samples pulled on day 1 from the Di water leach.
'"B" fractions are samples pulled on day 5 from the Di water leach.
"C" fractions are samples pulled on day 28 from the Di water leach.

For samples 2,3,4,5,and 6 the following applies:
"A" fractions are samples pulled on day 1 from the acidified Salado leach.
'"B" fractions are samples pulled on day 5 from the acidified Salado leach.
"C" fractions are samples pulled on day 28 from the acidified Salado leach.

CLIENT:	Daniel B. Stephens & Assoc.		**Client Sample ID:**	PZ-13 74' -75'
Lab Order:	0912387		**Tag Number:**	
Project:	PZ-13		**Collection Date:**	8/21/2007
Lab ID:	0912387-01A	**Date Received:** 12/17/2009	**Matrix:**	LEACHATE

CAS # EPA METHOD 6010B: SPLP METALS Analyst: **SNV**

CAS #	Analyses	Result	Qual	MDL	PQL	Units	DF	Date Analyzed
7440-39-3	Barium	0.19	J	0.0050	0.20	mg/L	10	12/30/2009 7:19:55 PM
7440-43-9	Cadmium	ND		0.0080	0.020	mg/L	10	12/30/2009 7:19:55 PM
7440-47-3	Chromium	ND		0.015	0.060	mg/L	10	12/30/2009 7:19:55 PM
7440-48-4	Cobalt	ND		0.017	0.060	mg/L	10	12/30/2009 7:19:55 PM
7439-89-6	Iron	ND		0.098	0.20	mg/L	10	12/30/2009 7:19:55 PM
7439-92-1	Lead	ND		0.035	0.050	mg/L	10	12/30/2009 7:19:55 PM
7439-96-5	Manganese	ND		0.0027	0.020	mg/L	10	12/30/2009 7:19:55 PM
7440-02-0	Nickel	ND		0.0088	0.10	mg/L	10	12/30/2009 7:19:55 PM
7440-62-2	Vanadium	ND		0.034	0.50	mg/L	10	12/30/2009 7:19:55 PM
7440-66-6	Zinc	ND		0.0063	0.20	mg/L	10	12/31/2009 10:16:31 AM

Qualifiers:

*	Value exceeds Maximum Contaminant Level	B	Analyte detected in the associated Method Blank
E	Estimated value	H	Holding times for preparation or analysis exceeded
J	Analyte detected below quantitation limits	MCL	Maximum Contaminant Level
ND	Not Detected at the Reporting Limit	RL	Reporting Limit
S	Spike recovery outside accepted recovery limits		

CLIENT:	Daniel B. Stephens & Assoc.	**Client Sample ID:**	PZ-13 74' -75'
Lab Order:	0912387	**Tag Number:**	
Project:	PZ-13	**Collection Date:**	8/21/2007
Lab ID:	0912387-01B **Date Received:** 12/17/2009	**Matrix:**	LEACHATE

Analyses		Result	Qual	MDL	PQL	Units	DF	Date Analyzed
CAS #	**EPA METHOD 6010B: SPLP METALS**							Analyst: **SNV**
7440-39-3	Barium	0.18	J	0.0050	0.20	mg/L	10	12/30/2009 7:34:52 PM
7440-43-9	Cadmium	ND		0.0080	0.020	mg/L	10	12/30/2009 7:34:52 PM
7440-47-3	Chromium	ND		0.015	0.060	mg/L	10	12/30/2009 7:34:52 PM
7440-48-4	Cobalt	ND		0.017	0.060	mg/L	10	12/30/2009 7:34:52 PM
7439-89-6	Iron	ND		0.098	0.20	mg/L	10	12/30/2009 7:34:52 PM
7439-92-1	Lead	ND		0.035	0.050	mg/L	10	12/30/2009 7:34:52 PM
7439-96-5	Manganese	ND		0.0027	0.020	mg/L	10	12/30/2009 7:34:52 PM
7440-02-0	Nickel	ND		0.0088	0.10	mg/L	10	12/30/2009 7:34:52 PM
7440-62-2	Vanadium	ND		0.034	0.50	mg/L	10	12/30/2009 7:34:52 PM
7440-66-6	Zinc	ND		0.0063	0.20	mg/L	10	12/31/2009 10:19:01 AM

Qualifiers:

*	Value exceeds Maximum Contaminant Level	B	Analyte detected in the associated Method Blank
E	Estimated value	H	Holding times for preparation or analysis exceeded
J	Analyte detected below quantitation limits	MCL	Maximum Contaminant Level
ND	Not Detected at the Reporting Limit	RL	Reporting Limit
S	Spike recovery outside accepted recovery limits		

Hall Environmental Analysis Laboratory, Inc.

Date: *03-Feb-10*

CLIENT:	Daniel B. Stephens & Assoc.	**Client Sample ID:**	PZ-13 74' -75'
Lab Order:	0912387	**Tag Number:**	
Project:	PZ-13	**Collection Date:**	1/14/2010
Lab ID:	0912387-01C	**Date Received:**	12/17/2009
		Matrix:	LEACHATE

Analyses		**Result**	**Qual**	**MDL**	**PQL**	**Units**	**DF**	**Date Analyzed**
CAS #	**EPA METHOD 300.0: ANIONS**							Analyst: **LJB**
16984-48-8	Fluoride	0.33		0.091	0.10	mg/L	1	1/26/2010 5:36:52 AM
16887-00-6	Chloride	200		0.65	10	mg/L	20	1/27/2010 8:01:02 AM
7727-37-9	Nitrogen, Nitrite (As N)	ND	H	0.12	0.50	mg/L	5	1/27/2010 7:43:38 AM
24959-67-9	Bromide	ND		0.030	0.10	mg/L	1	1/26/2010 5:36:52 AM
7727-37-9	Nitrogen, Nitrate (As N)	0.034	HJ	0.021	0.10	mg/L	1	1/26/2010 5:36:52 AM
7723-14-0	Phosphorus, Orthophosphate (As F	ND	H	0.19	0.50	mg/L	1	1/26/2010 5:36:52 AM
14808-79-8	Sulfate	8.0		0.24	0.50	mg/L	1	1/26/2010 5:36:52 AM
CAS #	**SM 2320B: ALKALINITY**							Analyst: **DAM**
	Alkalinity, Total (As CaCO3)	30		5.0	20	mg/L CaCO3	1	1/15/2010 4:25:00 PM
	Carbonate	ND		2.0	2.0	mg/L CaCO3	1	1/15/2010 4:25:00 PM
	Bicarbonate	30		5.0	20	mg/L CaCO3	1	1/15/2010 4:25:00 PM
CAS #	**EPA 120.1: SPECIFIC CONDUCTANCE**							Analyst: **DAM**
	Specific Conductance	750		0	0.010	µmhos/cm	1	1/15/2010 4:25:00 PM
CAS #	**EPA METHOD 6010B: SPLP METALS**							Analyst: **SNV**
7440-39-3	Barium	0.14		0.00050	0.020	mg/L	1	1/24/2010 3:35:42 PM
7440-43-9	Cadmium	ND		0.00080	0.0020	mg/L	1	1/24/2010 3:35:42 PM
7440-70-2	Calcium	9.1		0.12	0.50	mg/L	1	1/25/2010 3:51:54 PM
7440-47-3	Chromium	ND		0.0015	0.0060	mg/L	1	1/24/2010 3:35:42 PM
7440-48-4	Cobalt	ND		0.0017	0.0060	mg/L	1	1/24/2010 3:35:42 PM
7439-89-6	Iron	0.037		0.0098	0.020	mg/L	1	1/24/2010 3:35:42 PM
7439-92-1	Lead	ND		0.0035	0.0050	mg/L	1	1/24/2010 3:35:42 PM
7439-95-4	Magnesium	6.1		0.026	0.50	mg/L	1	1/25/2010 3:51:54 PM
7439-96-5	Manganese	0.00064	J	0.00027	0.0020	mg/L	1	1/24/2010 3:35:42 PM
7440-02-0	Nickel	0.0013	J	0.00088	0.010	mg/L	1	1/24/2010 3:35:42 PM
7440-09-7	Potassium	0.78	J	0.13	1.0	mg/L	1	1/25/2010 3:51:54 PM
7440-23-5	Sodium	130		0.35	2.5	mg/L	5	1/25/2010 4:05:11 PM
7440-62-2	Vanadium	0.012	J	0.0034	0.050	mg/L	1	1/24/2010 3:35:42 PM
7440-66-6	Zinc	0.0082	J	0.00063	0.020	mg/L	1	1/24/2010 3:35:42 PM
CAS #	**SM4500-H+B: PH**							Analyst: **DAM**
	pH	9.63		0	0.1	pH units	1	1/15/2010 4:25:00 PM
CAS #	**SM2540C MOD: TOTAL DISSOLVED SOLIDS**							Analyst: **MMS**
TDS	Total Dissolved Solids	386		12.9	20.0	mg/L	1	1/22/2010 8:14:00 AM

Qualifiers:				
	*	Value exceeds Maximum Contaminant Level	B	Analyte detected in the associated Method Blank
	E	Estimated value	H	Holding times for preparation or analysis exceeded
	J	Analyte detected below quantitation limits	MCL	Maximum Contaminant Level
	ND	Not Detected at the Reporting Limit	RL	Reporting Limit
	S	Spike recovery outside accepted recovery limits		

CLIENT:	Daniel B. Stephens & Assoc.	**Client Sample ID:**	PZ-13 76' - 77'
Lab Order:	0912387	**Tag Number:**	
Project:	PZ-13	**Collection Date:**	8/21/2007
Lab ID:	0912387-02A **Date Received:** 12/17/2009	**Matrix:**	LEACHATE

Analyses		**Result**	**Qual**	**MDL**	**PQL**	**Units**	**DF**	**Date Analyzed**
CAS #	**EPA METHOD 6010B: SPLP METALS**							Analyst: **SNV**
7440-39-3	Barium	0.34	J	0.025	1.0	mg/L	10	12/30/2009 7:37:44 PM
7440-43-9	Cadmium	ND		0.040	0.10	mg/L	10	12/30/2009 7:37:44 PM
7440-47-3	Chromium	ND		0.075	0.30	mg/L	10	12/30/2009 7:37:44 PM
7440-48-4	Cobalt	ND		0.085	0.30	mg/L	10	12/30/2009 7:37:44 PM
7439-89-6	Iron	ND		0.49	1.0	mg/L	10	12/30/2009 7:37:44 PM
7439-92-1	Lead	0.32		0.18	0.25	mg/L	10	12/30/2009 7:37:44 PM
7439-96-5	Manganese	0.014	J	0.014	0.10	mg/L	10	12/30/2009 7:37:44 PM
7440-02-0	Nickel	ND		0.044	0.50	mg/L	10	12/30/2009 7:37:44 PM
7440-62-2	Vanadium	ND		0.17	2.5	mg/L	10	12/30/2009 7:37:44 PM
7440-66-6	Zinc	0.23	J	0.031	1.0	mg/L	10	12/31/2009 10:21:31 AM

Qualifiers:

*	Value exceeds Maximum Contaminant Level	B	Analyte detected in the associated Method Blank
E	Estimated value	H	Holding times for preparation or analysis exceeded
J	Analyte detected below quantitation limits	MCL	Maximum Contaminant Level
ND	Not Detected at the Reporting Limit	RL	Reporting Limit
S	Spike recovery outside accepted recovery limits		

CLIENT:	Daniel B. Stephens & Assoc.		**Client Sample ID:**	PZ-13 76' - 77'
Lab Order:	0912387		**Tag Number:**	
Project:	PZ-13		**Collection Date:**	8/21/2007
Lab ID:	0912387-02B	**Date Received:** 12/17/2009	**Matrix:**	LEACHATE

Analyses

CAS #	EPA METHOD 6010B: SPLP METALS	Result	Qual	MDL	PQL	Units	DF	Date Analyzed
								Analyst: **SNV**
7440-39-3	Barium	0.31	J	0.025	1.0	mg/L	10	12/30/2009 7:40:35 PM
7440-43-9	Cadmium	ND		0.040	0.10	mg/L	10	12/30/2009 7:40:35 PM
7440-47-3	Chromium	ND		0.075	0.30	mg/L	10	12/30/2009 7:40:35 PM
7440-48-4	Cobalt	ND		0.085	0.30	mg/L	10	12/30/2009 7:40:35 PM
7439-89-6	Iron	ND		0.49	1.0	mg/L	10	12/30/2009 7:40:35 PM
7439-92-1	Lead	0.25	J	0.18	0.25	mg/L	10	12/30/2009 7:40:35 PM
7439-96-5	Manganese	0.014	J	0.014	0.10	mg/L	10	12/30/2009 7:40:35 PM
7440-02-0	Nickel	ND		0.044	0.50	mg/L	10	12/30/2009 7:40:35 PM
7440-62-2	Vanadium	ND		0.17	2.5	mg/L	10	12/30/2009 7:40:35 PM
7440-66-6	Zinc	0.039	J	0.031	1.0	mg/L	10	12/31/2009 10:24:02 AM

Qualifiers:

*	Value exceeds Maximum Contaminant Level	B	Analyte detected in the associated Method Blank
E	Estimated value	H	Holding times for preparation or analysis exceeded
J	Analyte detected below quantitation limits	MCL	Maximum Contaminant Level
ND	Not Detected at the Reporting Limit	RL	Reporting Limit
S	Spike recovery outside accepted recovery limits		

Hall Environmental Analysis Laboratory, Inc.

Date: *03-Feb-10*

CLIENT:	Daniel B. Stephens & Assoc.		**Client Sample ID:**	PZ-13 76' - 77'
Lab Order:	0912387		**Tag Number:**	
Project:	PZ-13		**Collection Date:**	1/14/2010
Lab ID:	0912387-02C	**Date Received:** 12/17/2009	**Matrix:**	LEACHATE

	Analyses	**Result**	**Qual**	**MDL**	**PQL**	**Units**	**DF**	**Date Analyzed**
CAS #	**EPA METHOD 300.0: ANIONS**							Analyst: **LJB**
16984-48-8	Fluoride	ND		45	50	mg/L	500	1/26/2010 6:11:42 AM
16887-00-6	Chloride	170000		650	10000	mg/L	2E+04	1/26/2010 7:21:20 AM
7727-37-9	Nitrogen, Nitrite (As N)	ND	H	48	200	mg/L	2000	1/26/2010 6:29:06 AM
24959-67-9	Bromide	ND		15	50	mg/L	500	1/26/2010 6:11:42 AM
7727-37-9	Nitrogen, Nitrate (As N)	ND	H	11	50	mg/L	500	1/26/2010 6:11:42 AM
7723-14-0	Phosphorus, Orthophosphate (As F	ND	H	9.3	25	mg/L	50	1/26/2010 5:54:17 AM
14808-79-8	Sulfate	1200		12	25	mg/L	50	1/26/2010 5:54:17 AM
CAS #	**SM 2320B: ALKALINITY**							Analyst: **DAM**
	Alkalinity, Total (As CaCO3)	25		5.0	20	mg/L CaCO3	1	1/15/2010 4:33:00 PM
	Carbonate	ND		2.0	2.0	mg/L CaCO3	1	1/15/2010 4:33:00 PM
	Bicarbonate	25		5.0	20	mg/L CaCO3	1	1/15/2010 4:33:00 PM
CAS #	**EPA 120.1: SPECIFIC CONDUCTANCE**							Analyst: **DAM**
	Specific Conductance	380000		0	1.0	µmhos/cm	100	1/15/2010 8:00:00 PM
CAS #	**EPA METHOD 6010B: SPLP METALS**							Analyst: **SNV**
7440-39-3	Barium	0.30	J	0.025	1.0	mg/L	10	1/24/2010 3:45:31 PM
7440-43-9	Cadmium	ND		0.040	0.10	mg/L	10	1/24/2010 3:45:31 PM
7440-70-2	Calcium	490		5.8	25	mg/L	10	1/25/2010 3:54:21 PM
7440-47-3	Chromium	ND		0.075	0.30	mg/L	10	1/24/2010 3:45:31 PM
7440-48-4	Cobalt	ND		0.085	0.30	mg/L	10	1/24/2010 3:45:31 PM
7439-89-6	Iron	ND		0.49	1.0	mg/L	10	1/24/2010 3:45:31 PM
7439-92-1	Lead	ND		0.18	0.25	mg/L	10	1/24/2010 3:45:31 PM
7439-95-4	Magnesium	140		1.3	25	mg/L	10	1/25/2010 3:54:21 PM
7439-96-5	Manganese	ND		0.014	0.10	mg/L	10	1/24/2010 3:45:31 PM
7440-02-0	Nickel	ND		0.044	0.50	mg/L	10	1/24/2010 3:45:31 PM
7440-09-7	Potassium	140		6.7	50	mg/L	10	1/25/2010 3:54:21 PM
7440-23-5	Sodium	83000		71	500	mg/L	200	1/25/2010 4:38:24 PM
7440-62-2	Vanadium	ND		0.17	2.5	mg/L	10	1/24/2010 3:45:31 PM
7440-66-6	Zinc	ND		0.031	1.0	mg/L	10	1/24/2010 3:45:31 PM
CAS #	**SM4500-H+B: PH**							Analyst: **DAM**
	pH	8.03		0	0.1	pH units	1	1/15/2010 4:33:00 PM
CAS #	**SM2540C MOD: TOTAL DISSOLVED SOLIDS**							Analyst: **MMS**
TDS	Total Dissolved Solids	237000		1290	2000	mg/L	1	1/22/2010 8:14:00 AM

Qualifiers:

*	Value exceeds Maximum Contaminant Level	B	Analyte detected in the associated Method Blank
E	Estimated value	H	Holding times for preparation or analysis exceeded
J	Analyte detected below quantitation limits	MCL	Maximum Contaminant Level
ND	Not Detected at the Reporting Limit	RL	Reporting Limit
S	Spike recovery outside accepted recovery limits		

CLIENT:	Daniel B. Stephens & Assoc.	**Client Sample ID:**	PZ-14 71' - 72'
Lab Order:	0912387	**Tag Number:**	
Project:	PZ-13	**Collection Date:**	8/25/2007
Lab ID:	0912387-03A **Date Received:** 12/17/2009	**Matrix:**	LEACHATE

Analyses		**Result**	**Qual**	**MDL**	**PQL**	**Units**	**DF**	**Date Analyzed**
CAS #	**EPA METHOD 6010B: SPLP METALS**							Analyst: **SNV**
7440-39-3	Barium	0.51	J	0.025	1.0	mg/L	10	12/30/2009 7:53:31 PM
7440-43-9	Cadmium	ND		0.040	0.10	mg/L	10	12/30/2009 7:53:31 PM
7440-47-3	Chromium	ND		0.075	0.30	mg/L	10	12/30/2009 7:53:31 PM
7440-48-4	Cobalt	ND		0.085	0.30	mg/L	10	12/30/2009 7:53:31 PM
7439-89-6	Iron	ND		0.49	1.0	mg/L	10	12/30/2009 7:53:31 PM
7439-92-1	Lead	0.22	J	0.18	0.25	mg/L	10	12/30/2009 7:53:31 PM
7439-96-5	Manganese	0.017	J	0.014	0.10	mg/L	10	12/30/2009 7:53:31 PM
7440-02-0	Nickel	ND		0.044	0.50	mg/L	10	12/30/2009 7:53:31 PM
7440-62-2	Vanadium	ND		0.17	2.5	mg/L	10	12/30/2009 7:53:31 PM
7440-66-6	Zinc	0.039	J	0.031	1.0	mg/L	10	12/31/2009 10:26:33 AM

Qualifiers:

*	Value exceeds Maximum Contaminant Level	B	Analyte detected in the associated Method Blank
E	Estimated value	H	Holding times for preparation or analysis exceeded
J	Analyte detected below quantitation limits	MCL	Maximum Contaminant Level
ND	Not Detected at the Reporting Limit	RL	Reporting Limit
S	Spike recovery outside accepted recovery limits		

Hall Environmental Analysis Laboratory, Inc.

Date: *03-Feb-10*

CLIENT:	Daniel B. Stephens & Assoc.	**Client Sample ID:**	PZ-14 71' - 72'
Lab Order:	0912387	**Tag Number:**	
Project:	PZ-13	**Collection Date:**	8/25/2007
Lab ID:	0912387-03B **Date Received:** 12/17/2009	**Matrix:**	LEACHATE

Analyses		**Result**	**Qual**	**MDL**	**PQL**	**Units**	**DF**	**Date Analyzed**
CAS #	**EPA METHOD 6010B: SPLP METALS**							Analyst: **SNV**
7440-39-3	Barium	0.46	J	0.025	1.0	mg/L	10	12/30/2009 7:56:20 PM
7440-43-9	Cadmium	ND		0.040	0.10	mg/L	10	12/30/2009 7:56:20 PM
7440-47-3	Chromium	ND		0.075	0.30	mg/L	10	12/30/2009 7:56:20 PM
7440-48-4	Cobalt	ND		0.085	0.30	mg/L	10	12/30/2009 7:56:20 PM
7439-89-6	Iron	ND		0.49	1.0	mg/L	10	12/30/2009 7:56:20 PM
7439-92-1	Lead	ND		0.18	0.25	mg/L	10	12/30/2009 7:56:20 PM
7439-96-5	Manganese	0.016	J	0.014	0.10	mg/L	10	12/30/2009 7:56:20 PM
7440-02-0	Nickel	ND		0.044	0.50	mg/L	10	12/30/2009 7:56:20 PM
7440-62-2	Vanadium	ND		0.17	2.5	mg/L	10	12/30/2009 7:56:20 PM
7440-66-6	Zinc	ND		0.031	1.0	mg/L	10	12/31/2009 10:29:05 AM

Qualifiers:

*	Value exceeds Maximum Contaminant Level	B	Analyte detected in the associated Method Blank
E	Estimated value	H	Holding times for preparation or analysis exceeded
J	Analyte detected below quantitation limits	MCL	Maximum Contaminant Level
ND	Not Detected at the Reporting Limit	RL	Reporting Limit
S	Spike recovery outside accepted recovery limits		

Hall Environmental Analysis Laboratory, Inc.

Date: *03-Feb-10*

CLIENT:	Daniel B. Stephens & Assoc.	**Client Sample ID:**	PZ-14 71' - 72'
Lab Order:	0912387	**Tag Number:**	
Project:	PZ-13	**Collection Date:**	1/14/2010
Lab ID:	0912387-03C **Date Received:** 12/17/2009	**Matrix:**	LEACHATE

	Analyses	Result	Qual	MDL	PQL	Units	DF	Date Analyzed
CAS #	**EPA METHOD 300.0: ANIONS**							Analyst: **LJB**
16984-48-8	Fluoride	ND		45	50	mg/L	500	1/26/2010 7:56:08 AM
16887-00-6	Chloride	150000		650	10000	mg/L	2E+04	1/26/2010 8:30:57 AM
7727-37-9	Nitrogen, Nitrite (As N)	ND	H	48	200	mg/L	2000	1/26/2010 8:13:33 AM
24959-67-9	Bromide	ND		15	50	mg/L	500	1/26/2010 7:56:08 AM
7727-37-9	Nitrogen, Nitrate (As N)	ND	H	11	50	mg/L	500	1/26/2010 7:56:08 AM
7723-14-0	Phosphorus, Orthophosphate (As F	ND	H	9.3	25	mg/L	50	1/26/2010 7:38:44 AM
14808-79-8	Sulfate	1300		12	25	mg/L	50	1/26/2010 7:38:44 AM
CAS #	**SM 2320B: ALKALINITY**							Analyst: **DAM**
	Alkalinity, Total (As CaCO3)	26		5.0	20	mg/L CaCO3	1	1/15/2010 4:40:00 PM
	Carbonate	ND		2.0	2.0	mg/L CaCO3	1	1/15/2010 4:40:00 PM
	Bicarbonate	26		5.0	20	mg/L CaCO3	1	1/15/2010 4:40:00 PM
CAS #	**EPA 120.1: SPECIFIC CONDUCTANCE**							Analyst: **DAM**
	Specific Conductance	400000		0	1.0	µmhos/cm	100	1/15/2010 8:01:00 PM
CAS #	**EPA METHOD 6010B: SPLP METALS**							Analyst: **SNV**
7440-39-3	Barium	0.32	J	0.025	1.0	mg/L	10	1/24/2010 3:47:29 PM
7440-43-9	Cadmium	ND		0.040	0.10	mg/L	10	1/24/2010 3:47:29 PM
7440-70-2	Calcium	430		5.8	25	mg/L	10	1/25/2010 3:56:40 PM
7440-47-3	Chromium	ND		0.075	0.30	mg/L	10	1/24/2010 3:47:29 PM
7440-48-4	Cobalt	ND		0.085	0.30	mg/L	10	1/24/2010 3:47:29 PM
7439-89-6	Iron	ND		0.49	1.0	mg/L	10	1/24/2010 3:47:29 PM
7439-92-1	Lead	ND		0.18	0.25	mg/L	10	1/24/2010 3:47:29 PM
7439-95-4	Magnesium	110		1.3	25	mg/L	10	1/25/2010 3:56:40 PM
7439-96-5	Manganese	ND		0.014	0.10	mg/L	10	1/24/2010 3:47:29 PM
7440-02-0	Nickel	ND		0.044	0.50	mg/L	10	1/24/2010 3:47:29 PM
7440-09-7	Potassium	140		6.7	50	mg/L	10	1/25/2010 3:56:40 PM
7440-23-5	Sodium	76000		71	500	mg/L	200	1/25/2010 4:40:40 PM
7440-62-2	Vanadium	ND		0.17	2.5	mg/L	10	1/24/2010 3:47:29 PM
7440-66-6	Zinc	ND		0.031	1.0	mg/L	10	1/24/2010 3:47:29 PM
CAS #	**SM4500-H+B: PH**							Analyst: **DAM**
	pH	8.03		0	0.1	pH units	1	1/15/2010 4:40:00 PM
CAS #	**SM2540C MOD: TOTAL DISSOLVED SOLIDS**							Analyst: **MMS**
TDS	Total Dissolved Solids	239000		1290	2000	mg/L	1	1/22/2010 8:14:00 AM

Qualifiers:	*	Value exceeds Maximum Contaminant Level	B	Analyte detected in the associated Method Blank
	E	Estimated value	H	Holding times for preparation or analysis exceeded
	J	Analyte detected below quantitation limits	MCL	Maximum Contaminant Level
	ND	Not Detected at the Reporting Limit	RL	Reporting Limit
	S	Spike recovery outside accepted recovery limits		

CLIENT:	Daniel B. Stephens & Assoc.	**Client Sample ID:**	HSA Flat #3
Lab Order:	0912387	**Tag Number:**	
Project:	PZ-13	**Collection Date:**	11/23/2009
Lab ID:	0912387-04A **Date Received:** 12/17/2009	**Matrix:**	LEACHATE

Analyses		**Result**	**Qual**	**MDL**	**PQL**	**Units**	**DF**	**Date Analyzed**
CAS #	**EPA METHOD 6010B: DISSOLVED METALS**							Analyst: **SNV**
7440-47-3	Chromium	ND		0.056	0.30	mg/L	50	12/30/2009 2:46:15 PM
7440-48-4	Cobalt	ND		0.056	0.30	mg/L	50	12/30/2009 2:46:15 PM
7439-89-6	Iron	9.5		0.23	1.0	mg/L	50	12/30/2009 2:46:15 PM
7439-92-1	Lead	ND		0.11	0.25	mg/L	50	12/30/2009 2:46:15 PM
7440-02-0	Nickel	ND		0.034	0.50	mg/L	50	12/30/2009 2:46:15 PM
7440-66-6	Zinc	0.20	J	0.018	2.5	mg/L	50	12/30/2009 2:46:15 PM

Qualifiers:

*	Value exceeds Maximum Contaminant Level	B	Analyte detected in the associated Method Blank
E	Estimated value	H	Holding times for preparation or analysis exceeded
J	Analyte detected below quantitation limits	MCL	Maximum Contaminant Level
ND	Not Detected at the Reporting Limit	RL	Reporting Limit
S	Spike recovery outside accepted recovery limits		

Hall Environmental Analysis Laboratory, Inc.

Date: *03-Feb-10*

CLIENT:	Daniel B. Stephens & Assoc.	**Client Sample ID:**	HSA Flat #3
Lab Order:	0912387	**Tag Number:**	
Project:	PZ-13	**Collection Date:**	11/23/2009
Lab ID:	0912387-04B **Date Received:** 12/17/2009	**Matrix:**	LEACHATE

Analyses		**Result**	**Qual**	**MDL**	**PQL**	**Units**	**DF**	**Date Analyzed**
CAS #	**EPA METHOD 6010B: DISSOLVED METALS**							Analyst: **SNV**
7440-47-3	Chromium	ND		0.056	0.30	mg/L	50	12/30/2009 2:49:10 PM
7440-48-4	Cobalt	ND		0.056	0.30	mg/L	50	12/30/2009 2:49:10 PM
7439-89-6	Iron	0.65	J	0.23	1.0	mg/L	50	12/30/2009 2:49:10 PM
7439-92-1	Lead	ND		0.11	0.25	mg/L	50	12/30/2009 2:49:10 PM
7440-02-0	Nickel	ND		0.034	0.50	mg/L	50	12/30/2009 2:49:10 PM
7440-66-6	Zinc	0.073	J	0.018	2.5	mg/L	50	12/30/2009 2:49:10 PM

Qualifiers:

*	Value exceeds Maximum Contaminant Level	B	Analyte detected in the associated Method Blank
E	Estimated value	H	Holding times for preparation or analysis exceeded
J	Analyte detected below quantitation limits	MCL	Maximum Contaminant Level
ND	Not Detected at the Reporting Limit	RL	Reporting Limit
S	Spike recovery outside accepted recovery limits		

CLIENT:	Daniel B. Stephens & Assoc.	**Client Sample ID:**	HSA Flat #3
Lab Order:	0912387	**Tag Number:**	
Project:	PZ-13	**Collection Date:**	1/14/2010
Lab ID:	0912387-04C **Date Received:** 12/17/2009	**Matrix:**	LEACHATE

Analyses		**Result**	**Qual**	**MDL**	**PQL**	**Units**	**DF**	**Date Analyzed**
CAS #	**EPA METHOD 300.0: ANIONS**							Analyst: **LJB**
16887-00-6	Chloride	160000		650	10000	mg/L	2E+04	1/26/2010 9:57:59 AM
CAS #	**EPA METHOD 6010B: DISSOLVED METALS**							Analyst: **RAGS**
7440-39-3	Barium	ND		0.082	1.0	mg/L	50	1/19/2010 3:49:26 PM
7440-43-9	Cadmium	ND		0.029	0.10	mg/L	50	1/19/2010 3:49:26 PM
7440-70-2	Calcium	390		0.99	50	mg/L	50	1/19/2010 3:49:26 PM
7440-47-3	Chromium	ND		0.056	0.30	mg/L	50	1/19/2010 3:49:26 PM
7440-48-4	Cobalt	ND		0.056	0.30	mg/L	50	1/19/2010 3:49:26 PM
7439-89-6	Iron	ND		0.23	1.0	mg/L	50	1/19/2010 3:49:26 PM
7439-92-1	Lead	ND		0.11	0.25	mg/L	50	1/19/2010 3:49:26 PM
7439-95-4	Magnesium	83		0.82	50	mg/L	50	1/19/2010 3:49:26 PM
7439-96-5	Manganese	0.15		0.021	0.10	mg/L	50	1/19/2010 3:49:26 PM
7440-02-0	Nickel	ND		0.034	0.50	mg/L	50	1/19/2010 3:49:26 PM
7440-09-7	Potassium	150		2.6	50	mg/L	50	1/19/2010 3:49:26 PM
7440-23-5	Sodium	86000		27	1000	mg/L	1000	1/19/2010 4:59:37 PM
7440-24-6	Strontium	5.2		0.015	0.30	mg/L	50	1/19/2010 3:49:26 PM
7440-62-2	Vanadium	0.057	J	0.055	2.5	mg/L	50	1/19/2010 3:49:26 PM
7440-66-6	Zinc	0.019	J	0.018	2.5	mg/L	50	1/19/2010 3:49:26 PM

Qualifiers:				
	*	Value exceeds Maximum Contaminant Level	B	Analyte detected in the associated Method Blank
	E	Estimated value	H	Holding times for preparation or analysis exceeded
	J	Analyte detected below quantitation limits	MCL	Maximum Contaminant Level
	ND	Not Detected at the Reporting Limit	RL	Reporting Limit
	S	Spike recovery outside accepted recovery limits		

CLIENT:	Daniel B. Stephens & Assoc.		**Client Sample ID:**	HSA Round #1
Lab Order:	0912387		**Tag Number:**	
Project:	PZ-13		**Collection Date:**	11/23/2009
Lab ID:	0912387-05A	**Date Received:** 12/17/2009	**Matrix:**	LEACHATE

Analyses		**Result**	**Qual**	**MDL**	**PQL**	**Units**	**DF**	**Date Analyzed**
CAS #	**EPA METHOD 6010B: DISSOLVED METALS**							Analyst: **SNV**
7440-47-3	Chromium	ND		0.056	0.30	mg/L	50	12/30/2009 2:54:28 PM
7440-48-4	Cobalt	ND		0.056	0.30	mg/L	50	12/30/2009 2:54:28 PM
7439-89-6	Iron	14		0.23	1.0	mg/L	50	12/30/2009 2:54:28 PM
7439-92-1	Lead	ND		0.11	0.25	mg/L	50	12/30/2009 2:54:28 PM
7440-02-0	Nickel	ND		0.034	0.50	mg/L	50	12/30/2009 2:54:28 PM
7440-66-6	Zinc	0.20	J	0.018	2.5	mg/L	50	12/30/2009 2:54:28 PM

Qualifiers:

*	Value exceeds Maximum Contaminant Level	B	Analyte detected in the associated Method Blank
E	Estimated value	H	Holding times for preparation or analysis exceeded
J	Analyte detected below quantitation limits	MCL	Maximum Contaminant Level
ND	Not Detected at the Reporting Limit	RL	Reporting Limit
S	Spike recovery outside accepted recovery limits		

Hall Environmental Analysis Laboratory, Inc.

Date: *03-Feb-10*

CLIENT:	Daniel B. Stephens & Assoc.	**Client Sample ID:**	HSA Round #1
Lab Order:	0912387	**Tag Number:**	
Project:	PZ-13	**Collection Date:**	11/23/2009
Lab ID:	0912387-05B **Date Received:** 12/17/2009	**Matrix:**	LEACHATE

Analyses		**Result**	**Qual**	**MDL**	**PQL**	**Units**	**DF**	**Date Analyzed**
CAS #	**EPA METHOD 6010B: DISSOLVED METALS**							Analyst: **SNV**
7440-47-3	Chromium	ND		0.056	0.30	mg/L	50	12/30/2009 2:57:24 PM
7440-48-4	Cobalt	ND		0.056	0.30	mg/L	50	12/30/2009 2:57:24 PM
7439-89-6	Iron	25		0.23	1.0	mg/L	50	12/30/2009 2:57:24 PM
7439-92-1	Lead	ND		0.11	0.25	mg/L	50	12/30/2009 2:57:24 PM
7440-02-0	Nickel	ND		0.034	0.50	mg/L	50	12/30/2009 2:57:24 PM
7440-66-6	Zinc	0.27	J	0.018	2.5	mg/L	50	12/30/2009 2:57:24 PM

Qualifiers:

*	Value exceeds Maximum Contaminant Level	B	Analyte detected in the associated Method Blank
E	Estimated value	H	Holding times for preparation or analysis exceeded
J	Analyte detected below quantitation limits	MCL	Maximum Contaminant Level
ND	Not Detected at the Reporting Limit	RL	Reporting Limit
S	Spike recovery outside accepted recovery limits		

CLIENT:	Daniel B. Stephens & Assoc.	**Client Sample ID:**	HSA Round #1
Lab Order:	0912387	**Tag Number:**	
Project:	PZ-13	**Collection Date:**	1/14/2010
Lab ID:	0912387-05C	**Date Received:** 12/17/2009 **Matrix:**	LEACHATE

Analyses		Result	Qual	MDL	PQL	Units	DF	Date Analyzed
CAS #	**EPA METHOD 300.0: ANIONS**							Analyst: **LJB**
16887-00-6	Chloride	150000		650	10000	mg/L	2E+04	1/26/2010 11:42:27 AM
CAS #	**EPA METHOD 6010B: DISSOLVED METALS**							Analyst: **RAGS**
7440-39-3	Barium	0.088	J	0.082	1.0	mg/L	50	1/19/2010 3:51:46 PM
7440-43-9	Cadmium	ND		0.029	0.10	mg/L	50	1/19/2010 3:51:46 PM
7440-70-2	Calcium	380		0.99	50	mg/L	50	1/19/2010 3:51:46 PM
7440-47-3	Chromium	ND		0.056	0.30	mg/L	50	1/19/2010 3:51:46 PM
7440-48-4	Cobalt	0.091	J	0.056	0.30	mg/L	50	1/19/2010 3:51:46 PM
7439-89-6	Iron	28		0.23	1.0	mg/L	50	1/19/2010 3:51:46 PM
7439-92-1	Lead	ND		0.11	0.25	mg/L	50	1/19/2010 3:51:46 PM
7439-95-4	Magnesium	83		0.82	50	mg/L	50	1/19/2010 3:51:46 PM
7439-96-5	Manganese	1.3		0.021	0.10	mg/L	50	1/19/2010 3:51:46 PM
7440-02-0	Nickel	0.034	J	0.034	0.50	mg/L	50	1/19/2010 3:51:46 PM
7440-09-7	Potassium	130		2.6	50	mg/L	50	1/19/2010 3:51:46 PM
7440-23-5	Sodium	87000		27	1000	mg/L	1000	1/20/2010 5:58:31 PM
7440-24-6	Strontium	5.2		0.015	0.30	mg/L	50	1/19/2010 3:51:46 PM
7440-62-2	Vanadium	0.069	J	0.055	2.5	mg/L	50	1/19/2010 3:51:46 PM
7440-66-6	Zinc	0.27	J	0.018	2.5	mg/L	50	1/19/2010 3:51:46 PM

Qualifiers:

*	Value exceeds Maximum Contaminant Level	B	Analyte detected in the associated Method Blank
E	Estimated value	H	Holding times for preparation or analysis exceeded
J	Analyte detected below quantitation limits	MCL	Maximum Contaminant Level
ND	Not Detected at the Reporting Limit	RL	Reporting Limit
S	Spike recovery outside accepted recovery limits		

Hall Environmental Analysis Laboratory, Inc.

Date: *03-Feb-10*

CLIENT:	Daniel B. Stephens & Assoc.	**Client Sample ID:**	Tri Cone #4
Lab Order:	0912387	**Tag Number:**	
Project:	PZ-13	**Collection Date:**	11/23/2009
Lab ID:	0912387-06A **Date Received:** 12/17/2009	**Matrix:**	LEACHATE

Analyses		**Result**	**Qual**	**MDL**	**PQL**	**Units**	**DF**	**Date Analyzed**
CAS #	**EPA METHOD 6010B: DISSOLVED METALS**							Analyst: **SNV**
7440-47-3	Chromium	ND		0.056	0.30	mg/L	50	12/30/2009 3:00:18 PM
7440-48-4	Cobalt	1.1		0.056	0.30	mg/L	50	12/30/2009 3:00:18 PM
7439-89-6	Iron	11		0.23	1.0	mg/L	50	12/30/2009 3:00:18 PM
7439-92-1	Lead	ND		0.11	0.25	mg/L	50	12/30/2009 3:00:18 PM
7440-02-0	Nickel	1.1		0.034	0.50	mg/L	50	12/30/2009 3:00:18 PM
7440-66-6	Zinc	0.24	J	0.018	2.5	mg/L	50	12/30/2009 3:00:18 PM

Qualifiers:				
	*	Value exceeds Maximum Contaminant Level	B	Analyte detected in the associated Method Blank
	E	Estimated value	H	Holding times for preparation or analysis exceeded
	J	Analyte detected below quantitation limits	MCL	Maximum Contaminant Level
	ND	Not Detected at the Reporting Limit	RL	Reporting Limit
	S	Spike recovery outside accepted recovery limits		

CLIENT:	Daniel B. Stephens & Assoc.			**Client Sample ID:**	Tri Cone #4
Lab Order:	0912387			**Tag Number:**	
Project:	PZ-13			**Collection Date:**	11/23/2009
Lab ID:	0912387-06B	**Date Received:**	12/17/2009	**Matrix:**	LEACHATE

Analyses		**Result**	**Qual**	**MDL**	**PQL**	**Units**	**DF**	**Date Analyzed**
CAS #	**EPA METHOD 6010B: DISSOLVED METALS**							Analyst: **SNV**
7440-47-3	Chromium	ND		0.056	0.30	mg/L	50	12/30/2009 3:03:13 PM
7440-48-4	Cobalt	1.3		0.056	0.30	mg/L	50	12/30/2009 3:03:13 PM
7439-89-6	Iron	11		0.23	1.0	mg/L	50	12/30/2009 3:03:13 PM
7439-92-1	Lead	ND		0.11	0.25	mg/L	50	12/30/2009 3:03:13 PM
7440-02-0	Nickel	1.1		0.034	0.50	mg/L	50	12/30/2009 3:03:13 PM
7440-66-6	Zinc	0.30	J	0.018	2.5	mg/L	50	12/30/2009 3:03:13 PM

Qualifiers:

*	Value exceeds Maximum Contaminant Level	B	Analyte detected in the associated Method Blank
E	Estimated value	H	Holding times for preparation or analysis exceeded
J	Analyte detected below quantitation limits	MCL	Maximum Contaminant Level
ND	Not Detected at the Reporting Limit	RL	Reporting Limit
S	Spike recovery outside accepted recovery limits		

CLIENT:	Daniel B. Stephens & Assoc.		**Client Sample ID:**	Tri Cone #4
Lab Order:	0912387		**Tag Number:**	
Project:	PZ-13		**Collection Date:**	1/14/2010
Lab ID:	0912387-06C	**Date Received:** 12/17/2009	**Matrix:**	LEACHATE

Analyses		Result	Qual	MDL	PQL	Units	DF	Date Analyzed
CAS #	**EPA METHOD 300.0: ANIONS**							Analyst: **LJB**
16887-00-6	Chloride	150000		650	10000	mg/L	2E+04	1/26/2010 12:52:04 PM
CAS #	**EPA METHOD 6010B: DISSOLVED METALS**							Analyst: **RAGS**
7440-39-3	Barium	0.087	J	0.082	1.0	mg/L	50	1/19/2010 4:05:53 PM
7440-43-9	Cadmium	ND		0.029	0.10	mg/L	50	1/19/2010 4:05:53 PM
7440-70-2	Calcium	390		0.99	50	mg/L	50	1/19/2010 4:05:53 PM
7440-47-3	Chromium	ND		0.056	0.30	mg/L	50	1/19/2010 4:05:53 PM
7440-48-4	Cobalt	1.9		0.056	0.30	mg/L	50	1/19/2010 4:05:53 PM
7439-89-6	Iron	17		0.23	1.0	mg/L	50	1/19/2010 4:05:53 PM
7439-92-1	Lead	ND		0.11	0.25	mg/L	50	1/19/2010 4:05:53 PM
7439-95-4	Magnesium	86		0.82	50	mg/L	50	1/19/2010 4:05:53 PM
7439-96-5	Manganese	ND		0.021	0.10	mg/L	50	1/19/2010 4:05:53 PM
7440-02-0	Nickel	1.4		0.034	0.50	mg/L	50	1/19/2010 4:05:53 PM
7440-09-7	Potassium	150		2.6	50	mg/L	50	1/19/2010 4:05:53 PM
7440-23-5	Sodium	82000		27	1000	mg/L	1000	1/20/2010 6:00:44 PM
7440-24-6	Strontium	5.2		0.015	0.30	mg/L	50	1/19/2010 4:05:53 PM
7440-62-2	Vanadium	0.069	J	0.055	2.5	mg/L	50	1/19/2010 4:05:53 PM
7440-66-6	Zinc	0.15	J	0.018	2.5	mg/L	50	1/19/2010 4:05:53 PM

Qualifiers:

*	Value exceeds Maximum Contaminant Level	B	Analyte detected in the associated Method Blank
E	Estimated value	H	Holding times for preparation or analysis exceeded
J	Analyte detected below quantitation limits	MCL	Maximum Contaminant Level
ND	Not Detected at the Reporting Limit	RL	Reporting Limit
S	Spike recovery outside accepted recovery limits		

Hall Environmental Analysis Laboratory, Inc.

Date: *03-Feb-10*

CLIENT:	Daniel B. Stephens & Assoc.	**Client Sample ID:**	HSA Flat #2
Lab Order:	0912387	**Tag Number:**	
Project:	PZ-13	**Collection Date:**	11/23/2009
Lab ID:	0912387-07A **Date Received:** 12/17/2009	**Matrix:**	LEACHATE

Analyses		Result	Qual	MDL	PQL	Units	DF	Date Analyzed
CAS #	**EPA METHOD 6010B: DISSOLVED METALS**							Analyst: **SNV**
7440-47-3	Chromium	ND		0.0011	0.0060	mg/L	1	12/30/2009 1:28:38 PM
7440-48-4	Cobalt	0.42		0.0011	0.0060	mg/L	1	12/30/2009 1:28:38 PM
7439-89-6	Iron	0.11		0.0045	0.020	mg/L	1	12/30/2009 1:28:38 PM
7439-92-1	Lead	ND		0.0022	0.0050	mg/L	1	12/30/2009 1:28:38 PM
7440-02-0	Nickel	0.0087	J	0.00067	0.010	mg/L	1	12/30/2009 1:28:38 PM
7440-66-6	Zinc	0.11		0.00035	0.050	mg/L	1	12/30/2009 1:28:38 PM

Qualifiers:

*	Value exceeds Maximum Contaminant Level	B	Analyte detected in the associated Method Blank
E	Estimated value	H	Holding times for preparation or analysis exceeded
J	Analyte detected below quantitation limits	MCL	Maximum Contaminant Level
ND	Not Detected at the Reporting Limit	RL	Reporting Limit
S	Spike recovery outside accepted recovery limits		

CLIENT:	Daniel B. Stephens & Assoc.		**Client Sample ID:**	HSA Flat #2
Lab Order:	0912387		**Tag Number:**	
Project:	PZ-13		**Collection Date:**	11/23/2009
Lab ID:	0912387-07B	**Date Received:** 12/17/2009	**Matrix:**	LEACHATE

Analyses		**Result**	**Qual**	**MDL**	**PQL**	**Units**	**DF**	**Date Analyzed**
CAS #	**EPA METHOD 6010B: DISSOLVED METALS**							Analyst: **SNV**
7440-47-3	Chromium	0.0017	J	0.0011	0.0060	mg/L	1	12/30/2009 1:31:35 PM
7440-48-4	Cobalt	0.37		0.0011	0.0060	mg/L	1	12/30/2009 1:31:35 PM
7439-89-6	Iron	0.49		0.0045	0.020	mg/L	1	12/30/2009 1:31:35 PM
7439-92-1	Lead	ND		0.0022	0.0050	mg/L	1	12/30/2009 1:31:35 PM
7440-02-0	Nickel	0.0074	J	0.00067	0.010	mg/L	1	12/30/2009 1:31:35 PM
7440-66-6	Zinc	0.085		0.00035	0.050	mg/L	1	12/30/2009 1:31:35 PM

Qualifiers:				
	*	Value exceeds Maximum Contaminant Level	B	Analyte detected in the associated Method Blank
	E	Estimated value	H	Holding times for preparation or analysis exceeded
	J	Analyte detected below quantitation limits	MCL	Maximum Contaminant Level
	ND	Not Detected at the Reporting Limit	RL	Reporting Limit
	S	Spike recovery outside accepted recovery limits		

Hall Environmental Analysis Laboratory, Inc. **Date:** *03-Feb-10*

CLIENT:	Daniel B. Stephens & Assoc.		**Client Sample ID:**	HSA Flat #2
Lab Order:	0912387		**Tag Number:**	
Project:	PZ-13		**Collection Date:**	1/14/2010
Lab ID:	0912387-07C	**Date Received:** 12/17/2009	**Matrix:**	LEACHATE

Analyses		Result	Qual	MDL	PQL	Units	DF	Date Analyzed
CAS #	**EPA METHOD 300.0: ANIONS**							Analyst: **LJB**
16887-00-6	Chloride	ND		0.16	2.5	mg/L	5	1/26/2010 8:48:21 AM
CAS #	**EPA METHOD 6010B: DISSOLVED METALS**							Analyst: **RAGS**
7440-39-3	Barium	ND		0.0016	0.020	mg/L	1	1/19/2010 4:08:09 PM
7440-43-9	Cadmium	ND		0.00058	0.0020	mg/L	1	1/19/2010 4:08:09 PM
7440-70-2	Calcium	ND		0.020	1.0	mg/L	1	1/19/2010 4:08:09 PM
7440-47-3	Chromium	0.0011	J	0.0011	0.0060	mg/L	1	1/19/2010 4:08:09 PM
7440-48-4	Cobalt	0.019		0.0011	0.0060	mg/L	1	1/19/2010 4:08:09 PM
7439-89-6	Iron	0.55		0.0045	0.020	mg/L	1	1/19/2010 4:08:09 PM
7439-92-1	Lead	ND		0.0022	0.0050	mg/L	1	1/19/2010 4:08:09 PM
7439-95-4	Magnesium	ND		0.016	1.0	mg/L	1	1/19/2010 4:08:09 PM
7439-96-5	Manganese	0.017		0.00043	0.0020	mg/L	1	1/19/2010 4:08:09 PM
7440-02-0	Nickel	0.0016	J	0.00067	0.010	mg/L	1	1/19/2010 4:08:09 PM
7440-09-7	Potassium	0.30	J	0.052	1.0	mg/L	1	1/19/2010 4:08:09 PM
7440-23-5	Sodium	1.0		0.027	1.0	mg/L	1	1/19/2010 4:08:09 PM
7440-24-6	Strontium	ND		0.00030	0.0060	mg/L	1	1/19/2010 4:08:09 PM
7440-62-2	Vanadium	ND		0.0011	0.050	mg/L	1	1/19/2010 4:08:09 PM
7440-66-6	Zinc	0.0085	J	0.00035	0.050	mg/L	1	1/19/2010 4:08:09 PM

Qualifiers:				
	*	Value exceeds Maximum Contaminant Level	B	Analyte detected in the associated Method Blank
	E	Estimated value	H	Holding times for preparation or analysis exceeded
	J	Analyte detected below quantitation limits	MCL	Maximum Contaminant Level
	ND	Not Detected at the Reporting Limit	RL	Reporting Limit
	S	Spike recovery outside accepted recovery limits		

Hall Environmental Analysis Laboratory, Inc.

Date: *03-Feb-10*

CLIENT:	Daniel B. Stephens & Assoc.	**Client Sample ID:**	Salado solution
Lab Order:	0912387	**Tag Number:**	
Project:	PZ-13	**Collection Date:**	12/17/2009
Lab ID:	0912387-08A **Date Received:** 12/17/2009	**Matrix:**	AQUEOUS

	Analyses	**Result**	**Qual**	**MDL**	**PQL**	**Units**	**DF**	**Date Analyzed**
CAS #	**EPA METHOD 300.0: ANIONS**							Analyst: **LJB**
16984-48-8	Fluoride	ND		45	50	mg/L	500	12/30/2009 9:27:07 PM
16887-00-6	Chloride	160000		650	2000	mg/L	2E+04	1/1/2010 8:58:06 PM
7727-37-9	Nitrogen, Nitrite (As N)	ND	H	46	200	mg/L	2000	1/5/2010 2:44:43 AM
24959-67-9	Bromide	ND		60	200	mg/L	2000	1/6/2010 3:14:03 AM
7727-37-9	Nitrogen, Nitrate (As N)	ND	H	11	50	mg/L	500	12/30/2009 9:27:07 PM
7723-14-0	Phosphorus, Orthophosphate (As F	ND	H	9.3	25	mg/L	50	12/22/2009 8:23:19 PM
14808-79-8	Sulfate	1400		8.1	25	mg/L	50	12/22/2009 8:23:19 PM
CAS #	**SM 2320B: ALKALINITY**							Analyst: **DAM**
	Alkalinity, Total (As CaCO3)	19	J	5.0	20	mg/L CaCO3	1	12/22/2009 4:58:00 PM
	Carbonate	ND		2.0	2.0	mg/L CaCO3	1	12/22/2009 4:58:00 PM
	Bicarbonate	19	J	5.0	20	mg/L CaCO3	1	12/22/2009 4:58:00 PM
CAS #	**EPA 120.1: SPECIFIC CONDUCTANCE**							Analyst: **DAM**
	Specific Conductance	420000		0	1.0	µmhos/cm	100	12/22/2009 4:57:00 PM
CAS #	**SM4500-H+B: PH**							Analyst: **DAM**
	pH	7.84	H	0	0.1	pH units	1	12/22/2009 4:58:00 PM
CAS #	**SM2540C MOD: TOTAL DISSOLVED SOLIDS**							Analyst: **MMS**
TDS	Total Dissolved Solids	243000		1290	2000	mg/L	1	12/24/2009 4:31:00 PM

Qualifiers:				
	*	Value exceeds Maximum Contaminant Level	B	Analyte detected in the associated Method Blank
	E	Estimated value	H	Holding times for preparation or analysis exceeded
	J	Analyte detected below quantitation limits	MCL	Maximum Contaminant Level
	ND	Not Detected at the Reporting Limit	RL	Reporting Limit
	S	Spike recovery outside accepted recovery limits		

Hall Environmental Analysis Laboratory, Inc.

Date: *03-Feb-10*

CLIENT:	Daniel B. Stephens & Assoc.	**Client Sample ID:**	Salado solution
Lab Order:	0912387	**Tag Number:**	
Project:	PZ-13	**Collection Date:**	12/17/2009
Lab ID:	0912387-08B **Date Received:** 12/17/2009	**Matrix:**	AQUEOUS

Analyses		**Result**	**Qual**	**MDL**	**PQL**	**Units**	**DF**	**Date Analyzed**
CAS #	**EPA METHOD 6010B: DISSOLVED METALS**							Analyst: **SNV**
7440-39-3	Barium	0.075	J	0.033	0.40	mg/L	20	12/30/2009 3:39:36 PM
7440-41-7	Beryllium	0.0031	J	0.0024	0.060	mg/L	20	12/30/2009 3:39:36 PM
7440-42-8	Boron	4.3		0.056	0.80	mg/L	20	12/30/2009 3:39:36 PM
7440-43-9	Cadmium	ND		0.012	0.040	mg/L	20	12/30/2009 3:39:36 PM
7440-70-2	Calcium	430		0.40	20	mg/L	20	12/30/2009 4:41:14 PM
7440-47-3	Chromium	ND		0.022	0.12	mg/L	20	12/30/2009 3:39:36 PM
7440-48-4	Cobalt	ND		0.023	0.12	mg/L	20	12/30/2009 3:39:36 PM
7439-89-6	Iron	2.2		0.090	0.40	mg/L	20	12/30/2009 3:39:36 PM
7439-92-1	Lead	ND		0.045	0.10	mg/L	20	12/30/2009 3:39:36 PM
7439-95-4	Magnesium	120		0.33	20	mg/L	20	12/30/2009 4:41:14 PM
7439-96-5	Manganese	0.084		0.0086	0.040	mg/L	20	12/30/2009 3:39:36 PM
7440-02-0	Nickel	ND		0.013	0.20	mg/L	20	12/30/2009 3:39:36 PM
7440-09-7	Potassium	140		1.0	20	mg/L	20	12/30/2009 3:39:36 PM
7440-23-5	Sodium	100000		55	2000	mg/L	2000	12/30/2009 4:56:44 PM
7440-24-6	Strontium	6.6		0.015	0.30	mg/L	50	12/30/2009 4:45:55 PM
7440-62-2	Vanadium	0.032	J	0.022	1.0	mg/L	20	12/30/2009 3:39:36 PM
7440-66-6	Zinc	0.045	J	0.0070	1.0	mg/L	20	12/30/2009 3:39:36 PM

Qualifiers:				
	*	Value exceeds Maximum Contaminant Level	B	Analyte detected in the associated Method Blank
	E	Estimated value	H	Holding times for preparation or analysis exceeded
	J	Analyte detected below quantitation limits	MCL	Maximum Contaminant Level
	ND	Not Detected at the Reporting Limit	RL	Reporting Limit
	S	Spike recovery outside accepted recovery limits		

Client: HALL ENVIRONMENTAL ANALYSIS LAB
Address: 4901 HAWKINS NE SUITE D
ALBUQUERQUE, NM 87109
Attn: ANDY FREEMAN

Batch #: 091223013
Project Name: 0912387

Analytical Results Report

Sample Number	091223013-001	**Sampling Date**	8/21/2007	**Date/Time Received**	12/23/2009 12:12 PM
Client Sample ID	0912387-01A / PZ-13 74-75	**Sampling Time**			
Matrix	Water	**Sample Location**			
Comments					

Parameter	Result	Units	PQL	Analysis Date	Analyst	Method	Qualifier
Arsenic	ND	mg/L	0.1	1/7/2010	ETL	EPA 6020A	
Lead	ND	mg/L	0.1	1/7/2010	ETL	EPA 6020A	
Tungsten	ND	mg/L	0.1	1/14/2010	JTT	EPA 6020A	
Uranium	ND	mg/L	0.1	1/7/2010	ETL	EPA 6020A	

Client:	HALL ENVIRONMENTAL ANALYSIS LAB	**Batch #:**	091223013
Address:	4901 HAWKINS NE SUITE D ALBUQUERQUE, NM 87109	**Project Name:**	0912387
Attn:	ANDY FREEMAN		

Analytical Results Report

Sample Number	091223013-002	**Sampling Date**	8/21/2007	**Date/Time Received**	12/23/2009 12:12 PM
Client Sample ID	0912387-01B / PZ-13 74-75	**Sampling Time**			
Matrix	Water	**Sample Location**			
Comments					

Parameter	Result	Units	PQL	Analysis Date	Analyst	Method	Qualifier
Arsenic	ND	mg/L	0.1	1/7/2010	ETL	EPA 6020A	
Lead	ND	mg/L	0.1	1/7/2010	ETL	EPA 6020A	
Tungsten	ND	mg/L	0.1	1/14/2010	JTT	EPA 6020A	
Uranium	ND	mg/L	0.1	1/7/2010	ETL	EPA 6020A	

Client:	HALL ENVIRONMENTAL ANALYSIS LAB	**Batch #:**	091223013
Address:	4901 HAWKINS NE SUITE D ALBUQUERQUE, NM 87109	**Project Name:**	0912387
Attn:	ANDY FREEMAN		

Analytical Results Report

Sample Number	091223013-003	**Sampling Date**	8/21/2007	**Date/Time Received**	12/23/2009 12:12 PM
Client Sample ID	0912387-02A / PZ-13 76-77	**Sampling Time**			
Matrix	Water	**Sample Location**			
Comments					

Parameter	Result	Units	PQL	Analysis Date	Analyst	Method	Qualifier
Arsenic	ND	mg/L	0.1	1/7/2010	ETL	EPA 6020A	
Lead	0.206	mg/L	0.1	1/7/2010	ETL	EPA 6020A	
Tungsten	ND	mg/L	0.1	1/14/2010	JTT	EPA 6020A	
Uranium	ND	mg/L	0.1	1/7/2010	ETL	EPA 6020A	

Client:	HALL ENVIRONMENTAL ANALYSIS LAB	**Batch #:**	091223013
Address:	4901 HAWKINS NE SUITE D ALBUQUERQUE, NM 87109	**Project Name:**	0912387
Attn:	ANDY FREEMAN		

Analytical Results Report

Sample Number	091223013-004	**Sampling Date**	8/21/2007	**Date/Time Received**	12/23/2009 12:12 PM
Client Sample ID	0912387-02B / PZ-13 76-77	**Sampling Time**			
Matrix	Water	**Sample Location**			
Comments					

Parameter	**Result**	**Units**	**PQL**	**Analysis Date**	**Analyst**	**Method**	**Qualifier**
Arsenic	ND	mg/L	0.1	1/7/2010	ETL	EPA 6020A	
Lead	0.122	mg/L	0.1	1/7/2010	ETL	EPA 6020A	
Tungsten	ND	mg/L	0.1	1/14/2010	JTT	EPA 6020A	
Uranium	ND	mg/L	0.1	1/7/2010	ETL	EPA 6020A	

Client:	HALL ENVIRONMENTAL ANALYSIS LAB	**Batch #:**	091223013
Address:	4901 HAWKINS NE SUITE D ALBUQUERQUE, NM 87109	**Project Name:**	0912387
Attn:	ANDY FREEMAN		

Analytical Results Report

Sample Number	091223013-005	**Sampling Date**	8/25/2007	**Date/Time Received**	12/23/2009 12:12 PM
Client Sample ID	0912387-03A / PZ-14 71-72	**Sampling Time**			
Matrix	Water	**Sample Location**			
Comments					

Parameter	Result	Units	PQL	Analysis Date	Analyst	Method	Qualifier
Arsenic	ND	mg/L	0.1	1/7/2010	ETL	EPA 6020A	
Lead	0.204	mg/L	0.1	1/7/2010	ETL	EPA 6020A	
Tungsten	ND	mg/L	0.1	1/14/2010	JTT	EPA 6020A	
Uranium	ND	mg/L	0.1	1/7/2010	ETL	EPA 6020A	

Client:	HALL ENVIRONMENTAL ANALYSIS LAB	**Batch #:**	091223013
Address:	4901 HAWKINS NE SUITE D ALBUQUERQUE, NM 87109	**Project Name:**	0912387
Attn:	ANDY FREEMAN		

Analytical Results Report

Sample Number	091223013-006	**Sampling Date**	8/25/2007	**Date/Time Received**	12/23/2009 12:12 PM
Client Sample ID	0912387-03B / PZ-14 71-72	**Sampling Time**			
Matrix	Water	**Sample Location**			
Comments					

Parameter	Result	Units	PQL	Analysis Date	Analyst	Method	Qualifier
Arsenic	ND	mg/L	0.1	1/7/2010	ETL	EPA 6020A	
Lead	0.111	mg/L	0.1	1/7/2010	ETL	EPA 6020A	
Tungsten	ND	mg/L	0.1	1/14/2010	JTT	EPA 6020A	
Uranium	ND	mg/L	0.1	1/7/2010	ETL	EPA 6020A	

Client:	HALL ENVIRONMENTAL ANALYSIS LAB	**Batch #:**	091223013
Address:	4901 HAWKINS NE SUITE D ALBUQUERQUE, NM 87109	**Project Name:**	0912387
Attn:	ANDY FREEMAN		

Analytical Results Report

Sample Number	091223013-007	**Sampling Date**	11/23/2009	**Date/Time Received**	12/23/2009 12:12 PM
Client Sample ID	0912387-04A / HAS FLAT 3	**Sampling Time**			
Matrix	Water	**Sample Location**			
Comments					

Parameter	Result	Units	PQL	Analysis Date	Analyst	Method	Qualifier
Lead	ND	mg/L	0.1	1/7/2010	ETL	EPA 6020A	
Tungsten	0.351	mg/L	0.1	1/14/2010	JTT	EPA 6020A	

Client:	HALL ENVIRONMENTAL ANALYSIS LAB	**Batch #:**	091223013
Address:	4901 HAWKINS NE SUITE D ALBUQUERQUE, NM 87109	**Project Name:**	0912387
Attn:	ANDY FREEMAN		

Analytical Results Report

Sample Number	091223013-008	**Sampling Date**	11/23/2009	**Date/Time Received**	12/23/2009 12:12 PM
Client Sample ID	0912387-04B / HAS FLAT 3	**Sampling Time**			
Matrix	Water	**Sample Location**			
Comments					

Parameter	Result	Units	PQL	Analysis Date	Analyst	Method	Qualifier
Lead	ND	mg/L	0.1	1/7/2010	ETL	EPA 6020A	
Tungsten	0.201	mg/L	0.1	1/14/2010	JTT	EPA 6020A	

Client:	HALL ENVIRONMENTAL ANALYSIS LAB	**Batch #:**	091223013
Address:	4901 HAWKINS NE SUITE D ALBUQUERQUE, NM 87109	**Project Name:**	0912387
Attn:	ANDY FREEMAN		

Analytical Results Report

Sample Number	091223013-009	**Sampling Date**	11/23/2009	**Date/Time Received**	12/23/2009 12:12 PM
Client Sample ID	0912387-05A / HSA ROUND 1	**Sampling Time**			
Matrix	Water	**Sample Location**			
Comments					

Parameter	Result	Units	PQL	Analysis Date	Analyst	Method	Qualifier
Lead	ND	mg/L	0.1	1/7/2010	ETL	EPA 6020A	
Tungsten	0.359	mg/L	0.1	1/14/2010	JTT	EPA 6020A	

Anatek Labs, Inc.

1282 Alturas Drive • Moscow, ID 83843 • (208) 883-2839 • Fax (208) 882-9246 • email moscow@anateklabs.com
504 E Sprague Ste. D • Spokane WA 99202 • (509) 838-3999 • Fax (509) 838-4433 • email spokane@anateklabs.com

Client:	HALL ENVIRONMENTAL ANALYSIS LAB	**Batch #:**	091223013
Address:	4901 HAWKINS NE SUITE D ALBUQUERQUE, NM 87109	**Project Name:**	0912387
Attn:	ANDY FREEMAN		

Analytical Results Report

Sample Number	091223013-010	**Sampling Date**	11/23/2009	**Date/Time Received**	12/23/2009 12:12 PM
Client Sample ID	0912387-05B / HSA ROUND 1	**Sampling Time**			
Matrix	Water	**Sample Location**			
Comments					

Parameter	Result	Units	PQL	Analysis Date	Analyst	Method	Qualifier
Lead	ND	mg/L	0.1	1/7/2010	ETL	EPA 6020A	
Tungsten	0.699	mg/L	0.1	1/14/2010	JTT	EPA 6020A	

Certifications held by Anatek Labs ID: EPA:ID00013; AZ:0701; CO:ID00013; FL(NELAP):E87893; ID:ID00013; IN:C-ID-01; KY:90142; MT:CERT0028; NM: ID00013; OR:ID200001-002; WA:C1320
Certifications held by Anatek Labs WA: EPA:WA00169; CA:Cert2632; ID:WA00169; WA:C1287

Anatek Labs, Inc.

1282 Alturas Drive • Moscow, ID 83843 • (208) 883-2839 • Fax (208) 882-9246 • email moscow@anateklabs.com
504 E Sprague Ste. D • Spokane WA 99202 • (509) 838-3999 • Fax (509) 838-4433 • email spokane@anateklabs.com

Client:	HALL ENVIRONMENTAL ANALYSIS LAB	**Batch #:**	091223013
Address:	4901 HAWKINS NE SUITE D ALBUQUERQUE, NM 87109	**Project Name:**	0912387
Attn:	ANDY FREEMAN		

Analytical Results Report

Sample Number	091223013-011	**Sampling Date**	11/23/2009	**Date/Time Received**	12/23/2009 12:12 PM
Client Sample ID	0912387-06A / TRI CONE 4	**Sampling Time**			
Matrix	Water	**Sample Location**			
Comments					

Parameter	Result	Units	PQL	Analysis Date	Analyst	Method	Qualifier
Lead	ND	mg/L	0.1	1/7/2010	ETL	EPA 6020A	
Tungsten	1.78	mg/L	0.1	1/14/2010	JTT	EPA 6020A	

Client:	HALL ENVIRONMENTAL ANALYSIS LAB	**Batch #:**	091223013
Address:	4901 HAWKINS NE SUITE D ALBUQUERQUE, NM 87109	**Project Name:**	0912387
Attn:	ANDY FREEMAN		

Analytical Results Report

Sample Number	091223013-012	**Sampling Date**	11/23/2009	**Date/Time Received**	12/23/2009 12:12 PM
Client Sample ID	0912387-06B / TRI CONE 4	**Sampling Time**			
Matrix	Water	**Sample Location**			
Comments					

Parameter	Result	Units	PQL	Analysis Date	Analyst	Method	Qualifier
Lead	ND	mg/L	0.1	1/7/2010	ETL	EPA 6020A	
Tungsten	ND	mg/L	0.1	1/14/2010	JTT	EPA 6020A	

Client:	HALL ENVIRONMENTAL ANALYSIS LAB	**Batch #:**	091223013
Address:	4901 HAWKINS NE SUITE D ALBUQUERQUE, NM 87109	**Project Name:**	0912387
Attn:	ANDY FREEMAN		

Analytical Results Report

Sample Number	091223013-013	**Sampling Date**	11/23/2009	**Date/Time Received**	1/6/2010 12:00 PM
Client Sample ID	0912387-07A / HSA FLAT 2	**Sampling Time**			
Matrix	Water	**Sample Location**			
Comments					

Parameter	Result	Units	PQL	Analysis Date	Analyst	Method	Qualifier
Lead	ND	mg/L	0.1	1/7/2010	ETL	EPA 6020A	
Tungsten	2.83	mg/L	0.1	1/14/2010	JTT	EPA 6020A	

Client:	HALL ENVIRONMENTAL ANALYSIS LAB	**Batch #:**	091223013
Address:	4901 HAWKINS NE SUITE D ALBUQUERQUE, NM 87109	**Project Name:**	0912387
Attn:	ANDY FREEMAN		

Analytical Results Report

Sample Number	091223013-014	**Sampling Date**	11/23/2009	**Date/Time Received**	12/23/2009 12:12 PM
Client Sample ID	0912387-07B / HSA FLAT 2	**Sampling Time**			
Matrix	Water	**Sample Location**			
Comments					

Parameter	Result	Units	PQL	Analysis Date	Analyst	Method	Qualifier
Lead	ND	mg/L	0.1	1/7/2010	ETL	EPA 6020A	
Tungsten	0.695	mg/L	0.1	1/14/2010	JTT	EPA 6020A	

Authorized Signature John W. Coddington

John Coddington, Lab Manager

MCL	EPA's Maximum Contaminant Level
ND	Not Detected
PQL	Practical Quantitation Limit

This report shall not be reproduced except in full, without the written approval of the laboratory.
The results reported relate only to the samples indicated.
Soil/solid results are reported on a dry-weight basis unless otherwise noted.

Anatek Labs, Inc.

1282 Alturas Drive • Moscow, ID 83843 • (208) 883-2839 • Fax (208) 882-9246 • email moscow@anateklabs.com
504 E Sprague Ste. D • Spokane WA 99202 • (509) 838-3999 • Fax (509) 838-4433 • email spokane@anateklabs.com

Client:	HALL ENVIRONMENTAL ANALYSIS LAB	**Batch #:**	100106043
Address:	4901 HAWKINS NE SUITE D ALBUQUERQUE, NM 87109	**Project Name:**	0912387
Attn:	ANDY FREEMAN		

Analytical Results Report

Sample Number	100106043-001	**Sampling Date**	12/17/2009	**Date/Time Received**	1/6/2010 12:30 PM
Client Sample ID	0912387-08B / SALADO SOLUTION				
Matrix	Water				
Comments					

Parameter	Result	Units	PQL	Analysis Date	Analyst	Method	Qualifier
Arsenic	ND	mg/L	0.1	1/19/2010	JTT	EPA 6020A	
Lead	ND	mg/L	0.1	1/19/2010	JTT	EPA 6020A	
Tungsten	ND	mg/L	0.1	1/14/2010	JTT	EPA 6020A	
Uranium	ND	mg/L	0.1	1/19/2010	JTT	EPA 6020A	

Authorized Signature John W. Codd

John Coddington, Lab Manager

MCL EPA's Maximum Contaminant Level
ND Not Detected
PQL Practical Quantitation Limit

This report shall not be reproduced except in full, without the written approval of the laboratory.
The results reported relate only to the samples indicated.
Soil/solid results are reported on a dry-weight basis unless otherwise noted.

Client:	HALL ENVIRONMENTAL ANALYSIS LAB	**Batch #:**	100119001
Address:	4901 HAWKINS NE SUITE D ALBUQUERQUE, NM 87109	**Project Name:**	0912387
Attn:	ANDY FREEMAN		

Analytical Results Report

Sample Number	100119001-001	**Sampling Date**	1/14/2010	**Date/Time Received**	1/15/2010 10:45 AM
Client Sample ID	0912387-01C / PZ-13 74-75	**Sampling Time**			
Matrix	Water				
Comments					

Parameter	Result	Units	PQL	Analysis Date	Analyst	Method	Qualifier
Arsenic	ND	mg/L	0.1	1/28/2010	JTT	EPA 6020A	
Lead	ND	mg/L	0.1	1/28/2010	JTT	EPA 6020A	
Tungsten	ND	mg/L	0.1	1/28/2010	JTT	EPA 6020A	
Uranium	ND	mg/L	0.1	1/28/2010	JTT	EPA 6020A	

Client:	HALL ENVIRONMENTAL ANALYSIS LAB	**Batch #:**	100119001
Address:	4901 HAWKINS NE SUITE D ALBUQUERQUE, NM 87109	**Project Name:**	0912387
Attn:	ANDY FREEMAN		

Analytical Results Report

Sample Number	100119001-002	**Sampling Date**	1/14/2010	**Date/Time Received**	1/15/2010 10:45 AM
Client Sample ID	0912387-02C / PZ-13 76-77	**Sampling Time**			
Matrix	Water				
Comments					

Parameter	Result	Units	PQL	Analysis Date	Analyst	Method	Qualifier
Arsenic	ND	mg/L	0.1	1/28/2010	JTT	EPA 6020A	
Lead	ND	mg/L	0.1	1/28/2010	JTT	EPA 6020A	
Tungsten	ND	mg/L	0.1	1/28/2010	JTT	EPA 6020A	
Uranium	ND	mg/L	0.1	1/28/2010	JTT	EPA 6020A	

Anatek Labs, Inc.

1282 Alturas Drive • Moscow, ID 83843 • (208) 883-2839 • Fax (208) 882-9246 • email moscow@anateklabs.com
504 E Sprague Ste. D • Spokane WA 99202 • (509) 838-3999 • Fax (509) 838-4433 • email spokane@anateklabs.com

Client:	HALL ENVIRONMENTAL ANALYSIS LAB	**Batch #:**	100119001
Address:	4901 HAWKINS NE SUITE D ALBUQUERQUE, NM 87109	**Project Name:**	0912387
Attn:	ANDY FREEMAN		

Analytical Results Report

Sample Number	100119001-003	**Sampling Date**	1/14/2010	**Date/Time Received**	1/15/2010 10:45 AM
Client Sample ID	0912387-03C / PZ-14 71-72	**Sampling Time**			
Matrix	Water				
Comments					

Parameter	Result	Units	PQL	Analysis Date	Analyst	Method	Qualifier
Arsenic	ND	mg/L	0.1	1/28/2010	JTT	EPA 6020A	
Lead	ND	mg/L	0.1	1/28/2010	JTT	EPA 6020A	
Tungsten	ND	mg/L	0.1	1/28/2010	JTT	EPA 6020A	
Uranium	ND	mg/L	0.1	1/28/2010	JTT	EPA 6020A	

Client:	HALL ENVIRONMENTAL ANALYSIS LAB	**Batch #:**	100119001
Address:	4901 HAWKINS NE SUITE D ALBUQUERQUE, NM 87109	**Project Name:**	0912387
Attn:	ANDY FREEMAN		

Analytical Results Report

Sample Number	100119001-004	**Sampling Date**	1/14/2010	**Date/Time Received**	1/15/2010	10:45 AM
Client Sample ID	0912387-04C / HSA FLAT 3	**Sampling Time**				
Matrix	Water					
Comments						

Parameter	Result	Units	PQL	Analysis Date	Analyst	Method	Qualifier
Dissolved Arsenic	ND	mg/L	0.1	1/28/2010	JTT	EPA 6020A	
Dissolved Lead	ND	mg/L	0.1	1/28/2010	JTT	EPA 6020A	
Dissolved Tungsten	ND	mg/L	0.1	1/28/2010	JTT	EPA 6020A	
Dissolved Uranium	ND	mg/L	0.1	1/28/2010	JTT	EPA 6020A	

Client:	HALL ENVIRONMENTAL ANALYSIS LAB	**Batch #:**	100119001
Address:	4901 HAWKINS NE SUITE D ALBUQUERQUE, NM 87109	**Project Name:**	0912387
Attn:	ANDY FREEMAN		

Analytical Results Report

Sample Number	100119001-005	**Sampling Date**	1/14/2010	**Date/Time Received**	1/15/2010 10:45 AM
Client Sample ID	0912387-05C / HSA ROUND 1	**Sampling Time**			
Matrix	Water				
Comments					

Parameter	Result	Units	PQL	Analysis Date	Analyst	Method	Qualifier
Dissolved Arsenic	ND	mg/L	0.1	1/28/2010	JTT	EPA 6020A	
Dissolved Lead	ND	mg/L	0.1	1/28/2010	JTT	EPA 6020A	
Dissolved Tungsten	0.644	mg/L	0.1	1/28/2010	JTT	EPA 6020A	
Dissolved Uranium	ND	mg/L	0.1	1/28/2010	JTT	EPA 6020A	

Client: HALL ENVIRONMENTAL ANALYSIS LAB
Address: 4901 HAWKINS NE SUITE D
ALBUQUERQUE, NM 87109
Attn: ANDY FREEMAN

Batch #: 100119001
Project Name: 0912387

Analytical Results Report

Sample Number	100119001-006	**Sampling Date**	1/14/2010	**Date/Time Received**	1/15/2010 10:45 AM
Client Sample ID	0912387-06C / TRI CONE 4	**Sampling Time**			
Matrix	Water				
Comments					

Parameter	Result	Units	PQL	Analysis Date	Analyst	Method	Qualifier
Dissolved Arsenic	ND	mg/L	0.1	1/28/2010	JTT	EPA 6020A	
Dissolved Lead	ND	mg/L	0.1	1/28/2010	JTT	EPA 6020A	
Dissolved Tungsten	3.46	mg/L	0.1	1/28/2010	JTT	EPA 6020A	
Dissolved Uranium	ND	mg/L	0.1	1/28/2010	JTT	EPA 6020A	

Anatek Labs, Inc.

1282 Alturas Drive • Moscow, ID 83843 • (208) 883-2839 • Fax (208) 882-9246 • email moscow@anateklabs.com
504 E Sprague Ste. D • Spokane WA 99202 • (509) 838-3999 • Fax (509) 838-4433 • email spokane@anateklabs.com

---

Client:	HALL ENVIRONMENTAL ANALYSIS LAB	**Batch #:**	100119001
Address:	4901 HAWKINS NE SUITE D	**Project Name:**	0912387
	ALBUQUERQUE, NM 87109		
Attn:	ANDY FREEMAN		

Analytical Results Report

Sample Number	100119001-007	**Sampling Date**	1/14/2010	**Date/Time Received**	1/15/2010 10:45 AM
Client Sample ID	0912387-07C / HSA FLAT 2	**Sampling Time**			
Matrix	Water				
Comments					

Parameter	Result	Units	PQL	Analysis Date	Analyst	Method	Qualifier
Dissolved Arsenic	ND	mg/L	0.1	1/28/2010	JTT	EPA 6020A	
Dissolved Lead	ND	mg/L	0.1	1/28/2010	JTT	EPA 6020A	
Dissolved Tungsten	0.160	mg/L	0.1	1/28/2010	JTT	EPA 6020A	
Dissolved Uranium	ND	mg/L	0.1	1/28/2010	JTT	EPA 6020A	

Authorized Signature John W. Codd

John Coddington, Lab Manager

MCL	EPA's Maximum Contaminant Level
ND	Not Detected
PQL	Practical Quantitation Limit

This report shall not be reproduced except in full, without the written approval of the laboratory.
The results reported relate only to the samples indicated.
Soil/solid results are reported on a dry-weight basis unless otherwise noted.

Certifications held by Anatek Labs ID: EPA:ID00013; AZ:0701; CO:ID00013; FL(NELAP):E87893; ID:ID00013; IN:C-ID-01; KY:90142; MT:CERT0028; NM: ID00013; OR:ID200001-002; WA:C1320
Certifications held by Anatek Labs WA: EPA:WA00169; CA:Cert2632; ID:WA00169; WA:C1287

Anatek Labs, Inc.

1282 Alturas Drive • Moscow, ID 83843 • (208) 883-2839 • Fax (208) 882-9246 • email moscow@anateklabs.com
504 E Sprague Ste. D • Spokane WA 99202 • (509) 838-3999 • Fax (509) 838-4433 • email spokane@anateklabs.com

Client: HALL ENVIRONMENTAL ANALYSIS LAB
Address: 4901 HAWKINS NE SUITE D
ALBUQUERQUE, NM 87109
Attn: ANDY FREEMAN
Batch #: 100119001
Project Name: 0912387

Analytical Results Report

Quality Control Data

Lab Control Sample

Parameter	LCS Result	Units	LCS Spike	%Rec	AR %Rec	Prep Date	Analysis Date
Uranium	0.0485	mg/L	0.05	97.0	80-120	1/26/2010	1/28/2010
Tungsten	0.0489	mg/L	0.05	97.8	80-120	1/26/2010	1/28/2010
Lead	0.0490	mg/L	0.05	98.0	80-120	1/26/2010	1/28/2010
Arsenic	0.0486	mg/L	0.05	97.2	80-120	1/26/2010	1/28/2010

Matrix Spike

Sample Number	Parameter	Sample Result	MS Result	Units	MS Spike	%Rec	AR %Rec	Prep Date	Analysis Date
100119001-001	Uranium	ND	24.0	mg/L	25	96.0	75-125	1/26/2010	1/28/2010
100119001-001	Tungsten	ND	24.2	mg/L	25	96.8	75-125	1/26/2010	1/28/2010
100119001-001	Lead	ND	24.2	mg/L	25	96.8	75-125	1/26/2010	1/28/2010
100119001-001	Arsenic	ND	24.2	mg/L	25	96.8	75-125	1/26/2010	1/28/2010

Matrix Spike Duplicate

Parameter	MSD Result	Units	MSD Spike	%Rec	%RPD	AR %RPD	Prep Date	Analysis Date
Uranium	24.4	mg/L	25	97.6	1.7	0-20	1/26/2010	1/28/2010
Tungsten	24.7	mg/L	25	98.8	2.0	0-20	1/26/2010	1/28/2010
Lead	24.5	mg/L	25	98.0	1.2	0-20	1/26/2010	1/28/2010
Arsenic	24.0	mg/L	25	96.0	0.8	0-20	1/26/2010	1/28/2010

Method Blank

Parameter	Result	Units	PQL	Prep Date	Analysis Date
Arsenic	ND	mg/L	0.001	1/26/2010	1/28/2010
Lead	ND	mg/L	0.001	1/26/2010	1/28/2010
Tungsten	ND	mg/L	0.01	1/26/2010	1/28/2010
Uranium	ND	mg/L	0.001	1/26/2010	1/28/2010

AR	Acceptable Range
ND	Not Detected
PQL	Practical Quantitation Limit
RPD	Relative Percentage Difference

Comments:

Certifications held by Anatek Labs ID: EPA:ID00013; AZ:0701; CO:ID00013; FL(NELAP):E87893; ID:ID00013; IN:C-ID-01; KY:90142; MT:CERT0028; NM: ID00013; OR:ID200001-002; WA:C1320
Certifications held by Anatek Labs WA: EPA:WA00169; CA:Cert2632; ID:WA00169; WA:C1287

Anatek Labs, Inc.

1282 Alturas Drive • Moscow, ID 83843 • (208) 883-2839 • Fax (208) 882-9246 • email moscow@anateklabs.com
504 E Sprague Ste. D • Spokane WA 99202 • (509) 838-3999 • Fax (509) 838-4433 • email spokane@anateklabs.com

Client:	HALL ENVIRONMENTAL ANALYSIS LAB	**Batch #:**	091223013
Address:	4901 HAWKINS NE SUITE D ALBUQUERQUE, NM 87109	**Project Name:**	0912387
Attn:	ANDY FREEMAN		

Analytical Results Report

Quality Control Data

Lab Control Sample

Parameter	LCS Result	Units	LCS Spike	%Rec	AR %Rec	Prep Date	Analysis Date
Tungsten	0.0517	mg/L	0.05	103.4	80-120	1/6/2010	1/14/2010
Uranium	0.0507	mg/L	0.05	101.4	80-120	1/6/2010	1/7/2010
Lead	0.0511	mg/L	0.05	102.2	80-120	1/6/2010	1/7/2010
Arsenic	0.0505	mg/L	0.05	101.0	80-120	1/6/2010	1/7/2010

Matrix Spike

Sample Number	Parameter	Sample Result	MS Result	Units	MS Spike	%Rec	AR %Rec	Prep Date	Analysis Date
091223013-001	Uranium	ND	0.259	mg/L	0.25	103.6	75-125	1/6/2010	1/7/2010
091223013-001	Tungsten	ND	2.57	mg/L	2.5	102.8	75-125	1/6/2010	1/14/2010
091223013-001	Lead	ND	0.263	mg/L	0.25	105.2	75-125	1/6/2010	1/7/2010
091223013-001	Arsenic	ND	0.285	mg/L	0.25	114.0	75-125	1/6/2010	1/7/2010

Matrix Spike Duplicate

Parameter	MSD Result	Units	MSD Spike	%Rec	%RPD	AR %RPD	Prep Date	Analysis Date
Uranium	0.261	mg/L	0.25	104.4	0.8	0-20	1/6/2010	1/7/2010
Tungsten	2.56	mg/L	2.5	102.4	0.4	0-20	1/6/2010	1/14/2010
Lead	0.272	mg/L	0.25	108.8	3.4	0-20	1/6/2010	1/7/2010
Arsenic	0.277	mg/L	0.25	110.8	2.8	0-20	1/6/2010	1/7/2010

Method Blank

Parameter	Result	Units	PQL	Prep Date	Analysis Date
Arsenic	ND	mg/L	0.001	1/6/2010	1/7/2010
Lead	ND	mg/L	0.001	1/6/2010	1/7/2010
Tungsten	ND	mg/L	0.01	1/6/2010	1/14/2010
Uranium	ND	mg/L	0.001	1/6/2010	1/7/2010

AR	Acceptable Range
ND	Not Detected
PQL	Practical Quantitation Limit
RPD	Relative Percentage Difference

Comments:

Certifications held by Anatek Labs ID: EPA:ID00013; AZ:0701; CO:ID00013; FL(NELAP):E87893; ID:ID00013; IN:C-ID-01; KY:90142; MT:CERT0028; NM: ID00013; OR:ID200001-002; WA:C1320
Certifications held by Anatek Labs WA: EPA:WA00169; CA:Cert2632; ID:WA00169; WA:C1287

Wednesday, February 03, 2010

Anatek Labs, Inc.

1282 Alturas Drive • Moscow, ID 83843 • (208) 883-2839 • Fax (208) 882-9246 • email moscow@anateklabs.com
504 E Sprague Ste. D • Spokane WA 99202 • (509) 838-3999 • Fax (509) 838-4433 • email spokane@anateklabs.com

Client: HALL ENVIRONMENTAL ANALYSIS LAB
Address: 4901 HAWKINS NE SUITE D
ALBUQUERQUE, NM 87109
Attn: ANDY FREEMAN

Batch #: 100106043
Project Name: 0912387

Analytical Results Report

Quality Control Data

Lab Control Sample

Parameter	LCS Result	Units	LCS Spike	%Rec	AR %Rec	Prep Date	Analysis Date
Uranium	0.0529	mg/L	0.05	105.8	80-120	1/15/2010	1/19/2010
Lead	0.0516	mg/L	0.05	103.2	80-120	1/15/2010	1/19/2010
Arsenic	0.0503	mg/L	0.05	100.6	80-120	1/15/2010	1/19/2010
Tungsten	0.0517	mg/L	0.05	103.4	80-120	1/6/2010	1/14/2010

Matrix Spike

Sample Number	Parameter	Sample Result	MS Result	Units	MS Spike	%Rec	AR %Rec	Prep Date	Analysis Date
100108019-001A	Uranium	0.00110	0.0534	mg/L	0.05	104.6	75-125	1/15/2010	1/19/2010
100108019-001A	Lead	ND	0.0500	mg/L	0.05	100.0	75-125	1/15/2010	1/19/2010
100108019-001A	Arsenic	0.00180	0.0508	mg/L	0.05	98.0	75-125	1/15/2010	1/19/2010
091223013-001	Tungsten	ND	2.57	mg/L	2.5	102.8	75-125	1/6/2010	1/14/2010

Matrix Spike Duplicate

Parameter	MSD Result	Units	MSD Spike	%Rec	%RPD	AR %RPD	Prep Date	Analysis Date
Uranium	0.0527	mg/L	0.05	103.2	1.3	0-20	1/15/2010	1/19/2010
Lead	0.0495	mg/L	0.05	99.0	1.0	0-20	1/15/2010	1/19/2010
Arsenic	0.0512	mg/L	0.05	98.8	0.8	0-20	1/15/2010	1/19/2010
Tungsten	2.56	mg/L	2.5	102.4	0.4	0-20	1/6/2010	1/14/2010

Method Blank

Parameter	Result	Units	PQL	Prep Date	Analysis Date
Arsenic	ND	mg/L	0.001	1/15/2010	1/19/2010
Lead	ND	mg/L	0.001	1/15/2010	1/19/2010
Tungsten	ND	mg/L	0.01	1/6/2010	1/14/2010
Uranium	ND	mg/L	0.001	1/15/2010	1/19/2010

AR	Acceptable Range
ND	Not Detected
PQL	Practical Quantitation Limit
RPD	Relative Percentage Difference

Comments:

QA/QC SUMMARY REPORT

Client: Daniel B. Stephens & Assoc.
Project: PZ-13
Work Order: 0912387

Method: **EPA Method 300.0: Anions**

Analyte	Result	Units	PQL	SPK Va	SPK ref	%Rec	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Sample ID: MB		*MBLK*				Batch ID:	**R36685**	Analysis Date:		12/22/2009 8:29:29 AM	
Fluoride	ND	mg/L	0.10								
Chloride	ND	mg/L	0.10								
Nitrogen, Nitrite (As N)	ND	mg/L	0.10								
Bromide	ND	mg/L	0.10								
Nitrogen, Nitrate (As N)	ND	mg/L	0.10								
Phosphorus, Orthophosphate (As P)	ND	mg/L	0.50								
Sulfate	ND	mg/L	0.50								
Sample ID: MB		*MBLK*				Batch ID:	**R36685**	Analysis Date:		12/23/2009 3:03:45 AM	
Fluoride	ND	mg/L	0.10								
Chloride	ND	mg/L	0.10								
Nitrogen, Nitrite (As N)	ND	mg/L	0.10								
Bromide	ND	mg/L	0.10								
Nitrogen, Nitrate (As N)	ND	mg/L	0.10								
Phosphorus, Orthophosphate (As P)	ND	mg/L	0.50								
Sulfate	ND	mg/L	0.50								
Sample ID: MB		*MBLK*				Batch ID:	**R36767**	Analysis Date:		12/30/2009 3:27:43 AM	
Fluoride	ND	mg/L	0.10								
Chloride	ND	mg/L	0.10								
Nitrogen, Nitrite (As N)	ND	mg/L	0.10								
Bromide	ND	mg/L	0.10								
Nitrogen, Nitrate (As N)	ND	mg/L	0.10								
Phosphorus, Orthophosphate (As P)	ND	mg/L	0.50								
Sulfate	ND	mg/L	0.50								
Sample ID: MB		*MBLK*				Batch ID:	**R36767**	Analysis Date:		12/30/2009 10:19:21 PM	
Fluoride	ND	mg/L	0.10								
Chloride	ND	mg/L	0.10								
Nitrogen, Nitrite (As N)	ND	mg/L	0.10								
Bromide	ND	mg/L	0.10								
Nitrogen, Nitrate (As N)	ND	mg/L	0.10								
Phosphorus, Orthophosphate (As P)	ND	mg/L	0.50								
Sulfate	ND	mg/L	0.50								
Sample ID: MB		*MBLK*				Batch ID:	**R36786**	Analysis Date:		1/1/2010 7:13:39 PM	
Fluoride	ND	mg/L	0.10								
Chloride	ND	mg/L	0.10								
Nitrogen, Nitrite (As N)	ND	mg/L	0.10								
Bromide	ND	mg/L	0.10								
Nitrogen, Nitrate (As N)	ND	mg/L	0.10								
Phosphorus, Orthophosphate (As P)	ND	mg/L	0.50								
Sulfate	ND	mg/L	0.50								
Sample ID: MB		*MBLK*				Batch ID:	**R36802**	Analysis Date:		1/4/2010 11:04:29 AM	
Fluoride	ND	mg/L	0.10								
Chloride	ND	mg/L	0.10								
Nitrogen, Nitrite (As N)	ND	mg/L	0.10								

Qualifiers:

E	Estimated value	H	Holding times for preparation or analysis exceeded
J	Analyte detected below quantitation limits	ND	Not Detected at the Reporting Limit
R	RPD outside accepted recovery limits	S	Spike recovery outside accepted recovery limits

QA/QC SUMMARY REPORT

Client: Daniel B. Stephens & Assoc.
Project: PZ-13
Work Order: 0912387

Method: EPA Method 300.0: Anions

Sample ID: MB *MBLK* Batch ID: **R36802** Analysis Date: 1/4/2010 11:04:29 AM

Analyte	Result	Units	PQL	SPK Va	SPK ref	%Rec	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Nitrogen, Nitrate (As N)	ND	mg/L	0.10								
Phosphorus, Orthophosphate (As P)	ND	mg/L	0.50								
Sulfate	ND	mg/L	0.50								

Sample ID: MB *MBLK* Batch ID: **R36825** Analysis Date: 1/5/2010 7:58:49 PM

Analyte	Result	Units	PQL	SPK Va	SPK ref	%Rec	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Fluoride	ND	mg/L	0.10								
Chloride	ND	mg/L	0.10								
Nitrogen, Nitrite (As N)	ND	mg/L	0.10								
Bromide	ND	mg/L	0.10								
Nitrogen, Nitrate (As N)	ND	mg/L	0.10								
Phosphorus, Orthophosphate (As P)	ND	mg/L	0.50								
Sulfate	ND	mg/L	0.50								

Sample ID: MB *MBLK* Batch ID: **R36996** Analysis Date: 1/18/2010 12:47:19 PM

Analyte	Result	Units	PQL	SPK Va	SPK ref	%Rec	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Fluoride	ND	mg/L	0.10								
Chloride	ND	mg/L	0.50								
Nitrogen, Nitrite (As N)	ND	mg/L	0.10								
Bromide	ND	mg/L	0.10								
Nitrogen, Nitrate (As N)	ND	mg/L	0.10								
Phosphorus, Orthophosphate (As P)	ND	mg/L	0.50								
Sulfate	ND	mg/L	0.50								

Sample ID: MB *MBLK* Batch ID: **R36996** Analysis Date: 1/19/2010 1:12:05 AM

Analyte	Result	Units	PQL	SPK Va	SPK ref	%Rec	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Fluoride	ND	mg/L	0.10								
Chloride	ND	mg/L	0.50								
Nitrogen, Nitrite (As N)	ND	mg/L	0.10								
Bromide	ND	mg/L	0.10								
Nitrogen, Nitrate (As N)	ND	mg/L	0.10								
Phosphorus, Orthophosphate (As P)	ND	mg/L	0.50								
Sulfate	ND	mg/L	0.50								

Sample ID: MB *MBLK* Batch ID: **R37129** Analysis Date: 1/26/2010 2:01:42 PM

Analyte	Result	Units	PQL	SPK Va	SPK ref	%Rec	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Fluoride	ND	mg/L	0.10								
Chloride	ND	mg/L	0.50								
Nitrogen, Nitrite (As N)	ND	mg/L	0.10								
Bromide	ND	mg/L	0.10								
Nitrogen, Nitrate (As N)	ND	mg/L	0.10								
Phosphorus, Orthophosphate (As P)	ND	mg/L	0.50								
Sulfate	ND	mg/L	0.50								

Sample ID: LCS *LCS* Batch ID: **R36685** Analysis Date: 12/22/2009 8:46:54 AM

Analyte	Result	Units	PQL	SPK Va	SPK ref	%Rec	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Fluoride	0.5462	mg/L	0.10	0.5	0	109	90	110			
Chloride	5.265	mg/L	0.10	5	0	105	90	110			
Nitrogen, Nitrite (As N)	0.9280	mg/L	0.10	1	0	92.8	90	110			
Bromide	2.642	mg/L	0.10	2.5	0	106	90	110			
Nitrogen, Nitrate (As N)	2.726	mg/L	0.10	2.5	0	109	90	110			
Phosphorus, Orthophosphate (As P)	5.368	mg/L	0.50	5	0	107	90	110			
Sulfate	10.59	mg/L	0.50	10	0	106	90	110			

Qualifiers:

E	Estimated value	H	Holding times for preparation or analysis exceeded
J	Analyte detected below quantitation limits	ND	Not Detected at the Reporting Limit
R	RPD outside accepted recovery limits	S	Spike recovery outside accepted recovery limits

QA/QC SUMMARY REPORT

Client: Daniel B. Stephens & Assoc.
Project: PZ-13 **Work Order:** 0912387

Method: **EPA Method 300.0: Anions**

Analyte	Result	Units	PQL	SPK Va	SPK ref	%Rec	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Sample ID: LCS		*LCS*				Batch ID:	**R36685**	Analysis Date:		12/23/2009 3:21:10 AM	
Fluoride	0.5587	mg/L	0.10	0.5	0	112	90	110			S
Chloride	5.191	mg/L	0.10	5	0	104	90	110			
Nitrogen, Nitrite (As N)	0.9388	mg/L	0.10	1	0	93.9	90	110			
Bromide	2.613	mg/L	0.10	2.5	0.0764	101	90	110			
Nitrogen, Nitrate (As N)	2.667	mg/L	0.10	2.5	0	107	90	110			
Phosphorus, Orthophosphate (As P)	5.298	mg/L	0.50	5	0	106	90	110			
Sulfate	10.42	mg/L	0.50	10	0	104	90	110			
Sample ID: LCS		*LCS*				Batch ID:	**R36767**	Analysis Date:		12/30/2009 3:45:08 AM	
Fluoride	0.5375	mg/L	0.10	0.5	0	108	90	110			
Chloride	4.964	mg/L	0.10	5	0	99.3	90	110			
Nitrogen, Nitrite (As N)	1.068	mg/L	0.10	1	0	107	90	110			
Bromide	2.523	mg/L	0.10	2.5	0	101	90	110			
Nitrogen, Nitrate (As N)	2.487	mg/L	0.10	2.5	0	99.5	90	110			
Phosphorus, Orthophosphate (As P)	4.989	mg/L	0.50	5	0	99.8	90	110			
Sulfate	10.02	mg/L	0.50	10	0	100	90	110			
Sample ID: LCS		*LCS*				Batch ID:	**R36767**	Analysis Date:		12/30/2009 10:36:46 PM	
Fluoride	0.5330	mg/L	0.10	0.5	0	107	90	110			
Chloride	4.937	mg/L	0.10	5	0	98.7	90	110			
Nitrogen, Nitrite (As N)	1.041	mg/L	0.10	1	0	104	90	110			
Bromide	2.516	mg/L	0.10	2.5	0	101	90	110			
Nitrogen, Nitrate (As N)	2.471	mg/L	0.10	2.5	0	98.8	90	110			
Phosphorus, Orthophosphate (As P)	5.068	mg/L	0.50	5	0	101	90	110			
Sulfate	10.01	mg/L	0.50	10	0	100	90	110			
Sample ID: LCS		*LCS*				Batch ID:	**R36786**	Analysis Date:		1/1/2010 7:31:03 PM	
Fluoride	0.5358	mg/L	0.10	0.5	0	107	90	110			
Chloride	4.994	mg/L	0.10	5	0	99.9	90	110			
Nitrogen, Nitrite (As N)	1.050	mg/L	0.10	1	0	105	90	110			
Bromide	2.547	mg/L	0.10	2.5	0	102	90	110			
Nitrogen, Nitrate (As N)	2.520	mg/L	0.10	2.5	0	101	90	110			
Phosphorus, Orthophosphate (As P)	5.036	mg/L	0.50	5	0	101	90	110			
Sulfate	10.11	mg/L	0.50	10	0	101	90	110			
Sample ID: LCS		*LCS*				Batch ID:	**R36802**	Analysis Date:		1/4/2010 11:21:54 AM	
Fluoride	0.5157	mg/L	0.10	0.5	0	103	90	110			
Chloride	4.890	mg/L	0.10	5	0	97.8	90	110			
Nitrogen, Nitrite (As N)	0.9792	mg/L	0.10	1	0	97.9	90	110			
Nitrogen, Nitrate (As N)	2.487	mg/L	0.10	2.5	0	99.5	90	110			
Phosphorus, Orthophosphate (As P)	4.897	mg/L	0.50	5	0	97.9	90	110			
Sulfate	9.950	mg/L	0.50	10	0	99.5	90	110			
Sample ID: LCS		*LCS*				Batch ID:	**R36825**	Analysis Date:		1/5/2010 8:16:13 PM	
Fluoride	0.5182	mg/L	0.10	0.5	0	104	90	110			
Chloride	5.105	mg/L	0.10	5	0	102	90	110			
Nitrogen, Nitrite (As N)	0.9946	mg/L	0.10	1	0	99.5	90	110			
Bromide	2.648	mg/L	0.10	2.5	0	106	90	110			

Qualifiers:

E	Estimated value	H	Holding times for preparation or analysis exceeded
J	Analyte detected below quantitation limits	ND	Not Detected at the Reporting Limit
R	RPD outside accepted recovery limits	S	Spike recovery outside accepted recovery limits

QA/QC SUMMARY REPORT

Client: Daniel B. Stephens & Assoc.
Project: PZ-13
Work Order: 0912387

Analyte	Result	Units	PQL	SPK Va	SPK ref	%Rec	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Method: EPA Method 300.0: Anions											
Sample ID: LCS		*LCS*				Batch ID:	**R36825**	Analysis Date:		1/5/2010 8:16:13 PM	
Nitrogen, Nitrate (As N)	2.572	mg/L	0.10	2.5	0	103	90	110			
Phosphorus, Orthophosphate (As P)	5.090	mg/L	0.50	5	0	102	90	110			
Sulfate	10.17	mg/L	0.50	10	0	102	90	110			
Sample ID: LCS		*LCS*				Batch ID:	**R36996**	Analysis Date:		1/18/2010 1:04:44 PM	
Fluoride	0.4672	mg/L	0.10	0.5	0	93.4	90	110			
Chloride	4.613	mg/L	0.50	5	0	92.3	90	110			
Nitrogen, Nitrite (As N)	0.9746	mg/L	0.10	1	0	97.5	90	110			
Bromide	2.326	mg/L	0.10	2.5	0	93.0	90	110			
Nitrogen, Nitrate (As N)	2.282	mg/L	0.10	2.5	0	91.3	90	110			
Phosphorus, Orthophosphate (As P)	4.537	mg/L	0.50	5	0	90.7	90	110			
Sulfate	9.016	mg/L	0.50	10	0	90.2	90	110			
Sample ID: LCS		*LCS*				Batch ID:	**R36996**	Analysis Date:		1/19/2010 1:29:29 AM	
Fluoride	0.4886	mg/L	0.10	0.5	0	97.7	90	110			
Chloride	4.775	mg/L	0.50	5	0	95.5	90	110			
Nitrogen, Nitrite (As N)	1.015	mg/L	0.10	1	0	101	90	110			
Bromide	2.418	mg/L	0.10	2.5	0	96.7	90	110			
Nitrogen, Nitrate (As N)	2.361	mg/L	0.10	2.5	0	94.4	90	110			
Phosphorus, Orthophosphate (As P)	4.811	mg/L	0.50	5	0	96.2	90	110			
Sulfate	9.456	mg/L	0.50	10	0	94.6	90	110			
Sample ID: LCS		*LCS*				Batch ID:	**R37129**	Analysis Date:		1/26/2010 2:19:07 PM	
Fluoride	0.5131	mg/L	0.10	0.5	0	103	90	110			
Chloride	4.880	mg/L	0.50	5	0	97.6	90	110			
Nitrogen, Nitrite (As N)	1.031	mg/L	0.10	1	0	103	90	110			
Bromide	2.500	mg/L	0.10	2.5	0	100	90	110			
Nitrogen, Nitrate (As N)	2.418	mg/L	0.10	2.5	0	96.7	90	110			
Phosphorus, Orthophosphate (As P)	4.842	mg/L	0.50	5	0	96.8	90	110			
Sulfate	9.839	mg/L	0.50	10	0	98.4	90	110			
Method: SM 2320B: Alkalinity											
Sample ID: MB		*MBLK*				Batch ID:	**R36679**	Analysis Date:		12/22/2009 3:13:00 PM	
Alkalinity, Total (As CaCO3)	ND	mg/L Ca	20								
Carbonate	ND	mg/L Ca	2.0								
Bicarbonate	ND	mg/L Ca	20								
Sample ID: MB		*MBLK*				Batch ID:	**R36985**	Analysis Date:		1/15/2010 3:22:00 PM	
Alkalinity, Total (As CaCO3)	ND	mg/L Ca	20								
Carbonate	ND	mg/L Ca	2.0								
Bicarbonate	ND	mg/L Ca	20								
Sample ID: LCS		*LCS*				Batch ID:	**R36679**	Analysis Date:		12/22/2009 3:19:00 PM	
Alkalinity, Total (As CaCO3)	81.08	mg/L Ca	20	80	0	101	92.5	110			
Sample ID: LCS		*LCS*				Batch ID:	**R36985**	Analysis Date:		1/15/2010 3:28:00 PM	
Alkalinity, Total (As CaCO3)	79.80	mg/L Ca	20	80	0	99.7	92.5	110			

Qualifiers:

E	Estimated value	H	Holding times for preparation or analysis exceeded
J	Analyte detected below quantitation limits	ND	Not Detected at the Reporting Limit
R	RPD outside accepted recovery limits	S	Spike recovery outside accepted recovery limits

QA/QC SUMMARY REPORT

Client: Daniel B. Stephens & Assoc.
Project: PZ-13
Work Order: 0912387

Method: EPA 120.1: Specific Conductance

Analyte	Result	Units	PQL	SPK Va	SPK ref	%Rec	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Sample ID: 0912451-02A DUP		*DUP*				Batch ID: **R36679**		Analysis Date:		12/22/2009 5:20:00 PM	
Specific Conductance	34720	µmhos/c	0.50						1.66	20	
Sample ID: 1001200-02C DUP		*DUP*				Batch ID: **R36985**		Analysis Date:		1/15/2010 7:00:00 PM	
Specific Conductance	4.656	µmhos/c	0.010						35.9	20	R

Qualifiers:

E	Estimated value	H	Holding times for preparation or analysis exceeded
J	Analyte detected below quantitation limits	ND	Not Detected at the Reporting Limit
R	RPD outside accepted recovery limits	S	Spike recovery outside accepted recovery limits

QA/QC SUMMARY REPORT

Client: Daniel B. Stephens & Assoc.
Project: PZ-13
Work Order: 0912387

Method: **EPA Method 6010B: Dissolved Metals**

Sample ID: MB *MBLK* Batch ID: **R36756** Analysis Date: 12/30/2009 11:31:05 AM

Analyte	Result	Units	PQL	SPK Va	SPK ref	%Rec	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Barium	ND	mg/L	0.020								
Beryllium	ND	mg/L	0.0030								
Boron	ND	mg/L	0.040								
Cadmium	ND	mg/L	0.0020								
Chromium	ND	mg/L	0.0060								
Cobalt	ND	mg/L	0.0060								
Iron	ND	mg/L	0.020								
Lead	ND	mg/L	0.0050								
Manganese	ND	mg/L	0.0020								
Nickel	ND	mg/L	0.010								
Potassium	ND	mg/L	1.0								
Sodium	ND	mg/L	1.0								
Vanadium	ND	mg/L	0.050								
Zinc	ND	mg/L	0.050								

Sample ID: MB *MBLK* Batch ID: **R36756** Analysis Date: 12/30/2009 4:36:10 PM

Analyte	Result	Units	PQL	SPK Va	SPK ref	%Rec	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Calcium	ND	mg/L	1.0								
Magnesium	ND	mg/L	1.0								
Sodium	ND	mg/L	1.0								
Strontium	ND	mg/L	0.0060								

Sample ID: MB *MBLK* Batch ID: **R36777** Analysis Date: 12/31/2009 11:58:01 AM

Analyte	Result	Units	PQL	SPK Va	SPK ref	%Rec	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Chromium	ND	mg/L	0.0060								
Iron	ND	mg/L	0.020								
Lead	ND	mg/L	0.0050								
Zinc	ND	mg/L	0.050								

Sample ID: MB *MBLK* Batch ID: **R37019** Analysis Date: 1/19/2010 1:13:05 PM

Analyte	Result	Units	PQL	SPK Va	SPK ref	%Rec	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Barium	ND	mg/L	0.020								
Cadmium	ND	mg/L	0.0020								
Calcium	ND	mg/L	1.0								
Chromium	ND	mg/L	0.0060								
Cobalt	ND	mg/L	0.0060								
Iron	ND	mg/L	0.020								
Lead	ND	mg/L	0.0050								
Magnesium	ND	mg/L	1.0								
Manganese	ND	mg/L	0.0020								
Nickel	ND	mg/L	0.010								
Potassium	ND	mg/L	1.0								
Sodium	ND	mg/L	1.0								
Strontium	ND	mg/L	0.0060								
Vanadium	ND	mg/L	0.050								
Zinc	ND	mg/L	0.050								

Sample ID: MB *MBLK* Batch ID: **R37052** Analysis Date: 1/20/2010 5:54:08 PM

Analyte	Result	Units	PQL	SPK Va	SPK ref	%Rec	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Sodium	ND	mg/L	1.0								

Sample ID: LCS *LCS* Batch ID: **R36756** Analysis Date: 12/30/2009 11:33:59 AM

Qualifiers:

E	Estimated value	H	Holding times for preparation or analysis exceeded
J	Analyte detected below quantitation limits	ND	Not Detected at the Reporting Limit
R	RPD outside accepted recovery limits	S	Spike recovery outside accepted recovery limits

QA/QC SUMMARY REPORT

Client: Daniel B. Stephens & Assoc.
Project: PZ-13 **Work Order:** 0912387

Analyte	Result	Units	PQL	SPK Va	SPK ref	%Rec	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Method: EPA Method 6010B: Dissolved Metals											
Sample ID: LCS		*LCS*				Batch ID:	**R36756**	Analysis Date:	12/30/2009 11:33:59 AM		
Barium	0.4854	mg/L	0.020	0.5	0	97.1	80	120			
Beryllium	0.4956	mg/L	0.0030	0.5	0	99.1	80	120			
Boron	0.5142	mg/L	0.040	0.5	0	103	80	120			
Cadmium	0.5024	mg/L	0.0020	0.5	0	100	80	120			
Chromium	0.4864	mg/L	0.0060	0.5	0	97.3	80	120			
Cobalt	0.5047	mg/L	0.0060	0.5	0	101	80	120			
Iron	0.4900	mg/L	0.020	0.5	0	98.0	80	120			
Lead	0.4964	mg/L	0.0050	0.5	0	99.3	80	120			
Manganese	0.4872	mg/L	0.0020	0.5	0	97.4	80	120			
Nickel	0.4788	mg/L	0.010	0.5	0	95.8	80	120			
Potassium	52.44	mg/L	1.0	55	0.1033	95.2	80	120			
Sodium	54.10	mg/L	1.0	50.5	0.0384	107	80	120			
Vanadium	0.5011	mg/L	0.050	0.5	0	100	80	120			
Zinc	0.4889	mg/L	0.050	0.5	0	97.8	80	120			
Sample ID: LCS		*LCS*				Batch ID:	**R36756**	Analysis Date:	12/30/2009 4:38:47 PM		
Calcium	51.36	mg/L	1.0	50.5	0	102	80	120			
Magnesium	51.85	mg/L	1.0	50.5	0	103	80	120			
Sodium	51.12	mg/L	1.0	50.5	0	101	80	120			
Strontium	0.08609	mg/L	0.0060	0.1	0	86.1	80	120			
Sample ID: LCS		*LCS*				Batch ID:	**R36777**	Analysis Date:	12/31/2009 12:00:50 PM		
Chromium	0.4842	mg/L	0.0060	0.5	0	96.8	80	120			
Iron	0.4570	mg/L	0.020	0.5	0	91.4	80	120			
Lead	0.4860	mg/L	0.0050	0.5	0	97.2	80	120			
Zinc	0.4859	mg/L	0.050	0.5	0	97.2	80	120			
Sample ID: LCS		*LCS*				Batch ID:	**R37019**	Analysis Date:	1/19/2010 1:15:14 PM		
Barium	0.4837	mg/L	0.020	0.5	0	96.7	80	120			
Cadmium	0.5012	mg/L	0.0020	0.5	0	100	80	120			
Calcium	49.78	mg/L	1.0	50.5	0	98.6	80	120			
Chromium	0.4847	mg/L	0.0060	0.5	0	96.9	80	120			
Cobalt	0.4852	mg/L	0.0060	0.5	0	97.0	80	120			
Iron	0.4929	mg/L	0.020	0.5	0	98.6	80	120			
Lead	0.4973	mg/L	0.0050	0.5	0	99.5	80	120			
Magnesium	49.72	mg/L	1.0	50.5	0	98.4	80	120			
Manganese	0.4811	mg/L	0.0020	0.5	0	96.2	80	120			
Nickel	0.4734	mg/L	0.010	0.5	0.0011	94.5	80	120			
Potassium	51.81	mg/L	1.0	55	0	94.2	80	120			
Sodium	52.36	mg/L	1.0	50.5	0	104	80	120			
Strontium	0.09526	mg/L	0.0060	0.1	0	95.3	80	120			
Vanadium	0.4950	mg/L	0.050	0.5	0	99.0	80	120			
Zinc	0.4814	mg/L	0.050	0.5	0	96.3	80	120			
Sample ID: LCS		*LCS*				Batch ID:	**R37052**	Analysis Date:	1/20/2010 5:56:19 PM		
Sodium	50.08	mg/L	1.0	50.5	0.0539	99.1	80	120			

Qualifiers:

E	Estimated value	H	Holding times for preparation or analysis exceeded
J	Analyte detected below quantitation limits	ND	Not Detected at the Reporting Limit
R	RPD outside accepted recovery limits	S	Spike recovery outside accepted recovery limits

QA/QC SUMMARY REPORT

Client: Daniel B. Stephens & Assoc.
Project: PZ-13 **Work Order:** 0912387

Analyte	Result	Units	PQL	SPK Va	SPK ref	%Rec	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Method: EPA Method 6010B: SPLP Metals											
Sample ID: 0912387-03CMSD		*MSD*				Batch ID:	**21210**	Analysis Date:		1/24/2010 3:51:36 PM	
Barium	2.930	mg/L	1.0	2.5	0.3156	105	75	125	0.601	20	
Cadmium	2.817	mg/L	0.10	2.5	0	113	75	125	18.0	20	
Chromium	2.592	mg/L	0.30	2.5	0	104	75	125	0.935	20	
Cobalt	2.583	mg/L	0.30	2.5	0	103	75	125	0.598	20	
Iron	2.725	mg/L	1.0	2.5	0	109	75	125	4.77	20	
Lead	2.705	mg/L	0.25	2.5	0	108	75	125	13.5	20	
Manganese	2.568	mg/L	0.10	2.5	0	103	75	125	8.75	20	
Nickel	2.535	mg/L	0.50	2.5	0	101	75	125	0.626	20	
Vanadium	2.718	mg/L	2.5	2.5	0	109	75	125	0.0618	20	
Zinc	2.764	mg/L	1.0	2.5	0	111	75	125	1.28	20	
Sample ID: 0912387-03CMSD		*MSD*				Batch ID:	**21210**	Analysis Date:		1/25/2010 4:30:04 PM	
Calcium	1612	mg/L	13	1250	424	95.0	75	125	0.271	20	
Magnesium	1322	mg/L	13	1250	113.8	96.7	75	125	0.463	20	
Potassium	1593	mg/L	25	1250	138.3	116	75	125	1.26	20	
Sample ID: MB-21210 (DI)		*MBLK*				Batch ID:	**21210**	Analysis Date:		1/24/2010 3:31:26 PM	
Barium	ND	mg/L	0.020								
Cadmium	ND	mg/L	0.0020								
Chromium	ND	mg/L	0.0060								
Cobalt	ND	mg/L	0.0060								
Iron	ND	mg/L	0.020								
Lead	ND	mg/L	0.0050								
Manganese	ND	mg/L	0.0020								
Nickel	ND	mg/L	0.010								
Vanadium	ND	mg/L	0.050								
Zinc	ND	mg/L	0.020								
Sample ID: MB-21210		*MBLK*				Batch ID:	**21210**	Analysis Date:		1/25/2010 3:47:22 PM	
Calcium	ND	mg/L	0.50								
Magnesium	ND	mg/L	0.50								
Potassium	ND	mg/L	1.0								
Sodium	ND	mg/L	0.50								
Sample ID: LCS-21210 (DI)		*LCS*				Batch ID:	**21210**	Analysis Date:		1/24/2010 3:33:29 PM	
Barium	0.4864	mg/L	0.020	0.5	0	97.3	80	120			
Cadmium	0.4763	mg/L	0.0020	0.5	0	95.3	80	120			
Chromium	0.4819	mg/L	0.0060	0.5	0	96.4	80	120			
Cobalt	0.4827	mg/L	0.0060	0.5	0	96.5	80	120			
Iron	0.4939	mg/L	0.020	0.5	0	98.8	80	120			
Lead	0.4856	mg/L	0.0050	0.5	0	97.1	80	120			
Manganese	0.4827	mg/L	0.0020	0.5	0	96.5	80	120			
Nickel	0.4755	mg/L	0.010	0.5	0	95.1	80	120			
Vanadium	0.4818	mg/L	0.050	0.5	0	96.4	80	120			
Zinc	0.4687	mg/L	0.020	0.5	0	93.7	80	120			
Sample ID: LCS-21210		*LCS*				Batch ID:	**21210**	Analysis Date:		1/25/2010 4:07:23 PM	
Calcium	47.19	mg/L	0.50	50	0	94.4	80	120			

Qualifiers:

E	Estimated value	H	Holding times for preparation or analysis exceeded
J	Analyte detected below quantitation limits	ND	Not Detected at the Reporting Limit
R	RPD outside accepted recovery limits	S	Spike recovery outside accepted recovery limits

QA/QC SUMMARY REPORT

Client: Daniel B. Stephens & Assoc.
Project: PZ-13
Work Order: 0912387

Method: EPA Method 6010B: SPLP Metals

Sample ID: LCS-21210 *LCS* Batch ID: **21210** Analysis Date: 1/25/2010 4:07:23 PM

Analyte	Result	Units	PQL	SPK Va	SPK ref	%Rec	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Magnesium	47.65	mg/L	0.50	50	0	95.3	80	120			
Potassium	49.18	mg/L	1.0	50	0	98.4	80	120			
Sodium	46.94	mg/L	0.50	50	0	93.9	80	120			

Sample ID: 0912387-03CMS *MS* Batch ID: **21210** Analysis Date: 1/24/2010 3:49:31 PM

Analyte	Result	Units	PQL	SPK Va	SPK ref	%Rec	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Barium	2.948	mg/L	1.0	2.5	0.3156	105	75	125			
Cadmium	2.352	mg/L	0.10	2.5	0	94.1	75	125			
Chromium	2.617	mg/L	0.30	2.5	0	105	75	125			
Cobalt	2.599	mg/L	0.30	2.5	0	104	75	125			
Iron	2.858	mg/L	1.0	2.5	0	114	75	125			
Lead	2.363	mg/L	0.25	2.5	0	94.5	75	125			
Manganese	2.353	mg/L	0.10	2.5	0	94.1	75	125			
Nickel	2.551	mg/L	0.50	2.5	0	102	75	125			
Vanadium	2.720	mg/L	2.5	2.5	0	109	75	125			
Zinc	2.800	mg/L	1.0	2.5	0	112	75	125			

Sample ID: 0912387-03CMS *MS* Batch ID: **21210** Analysis Date: 1/25/2010 4:27:45 PM

Analyte	Result	Units	PQL	SPK Va	SPK ref	%Rec	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Calcium	1608	mg/L	13	1250	424	94.7	75	125			
Magnesium	1316	mg/L	13	1250	113.8	96.2	75	125			
Potassium	1573	mg/L	25	1250	138.3	115	75	125			

Method: SM4500-H+B: pH

Sample ID: 0912451-02A DUP *DUP* Batch ID: **R36679** Analysis Date: 12/22/2009 4:18:00 PM

Analyte	Result	Units	PQL	SPK Va	SPK ref	%Rec	LowLimit	HighLimit	%RPD	RPDLimit	Qual
pH	8.500	pH units	0.1						0		

Sample ID: 1001165-08A DUP *DUP* Batch ID: **R36985** Analysis Date: 1/15/2010 5:47:00 PM

Analyte	Result	Units	PQL	SPK Va	SPK ref	%Rec	LowLimit	HighLimit	%RPD	RPDLimit	Qual
pH	8.120	pH units	0.1						0.247		

Method: SM2540C MOD: Total Dissolved Solids

Sample ID: 0912387-08AMSD *MSD* Batch ID: **20963** Analysis Date: 12/24/2009 4:31:00 PM

Analyte	Result	Units	PQL	SPK Va	SPK ref	%Rec	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Total Dissolved Solids	346300	mg/L	2000	1E+05	243000	103	80	120	0.317	20	

Sample ID: MB-20963 *MBLK* Batch ID: **20963** Analysis Date: 12/24/2009 4:31:00 PM

Analyte	Result	Units	PQL	SPK Va	SPK ref	%Rec	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Total Dissolved Solids	ND	mg/L	20.0								

Sample ID: MBLK-21196 *MBLK* Batch ID: **21196** Analysis Date: 1/22/2010 8:14:00 AM

Analyte	Result	Units	PQL	SPK Va	SPK ref	%Rec	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Total Dissolved Solids	ND	mg/L	20.0								

Sample ID: LCS-20963 *LCS* Batch ID: **20963** Analysis Date: 12/24/2009 4:31:00 PM

Analyte	Result	Units	PQL	SPK Va	SPK ref	%Rec	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Total Dissolved Solids	1025	mg/L	20.0	1000	0	103	80	120			

Sample ID: LCS1-21196 *LCS* Batch ID: **21196** Analysis Date: 1/22/2010 8:14:00 AM

Analyte	Result	Units	PQL	SPK Va	SPK ref	%Rec	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Total Dissolved Solids	1024	mg/L	20.0	1000	0	102	80	120			

Sample ID: 0912387-08AMS *MS* Batch ID: **20963** Analysis Date: 12/24/2009 4:31:00 PM

Analyte	Result	Units	PQL	SPK Va	SPK ref	%Rec	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Total Dissolved Solids	347400	mg/L	2000	1E+05	243000	104	80	120			

Qualifiers:

E	Estimated value	H	Holding times for preparation or analysis exceeded
J	Analyte detected below quantitation limits	ND	Not Detected at the Reporting Limit
R	RPD outside accepted recovery limits	S	Spike recovery outside accepted recovery limits

Hall Environmental Analysis Laboratory, Inc.

Sample Receipt Checklist

Client Name DBS

Date Received: 12/17/2009

Work Order Number 0912387

Received by: AMF

Sample ID labels checked by: Initials

Checklist completed by: Signature Date 12/17/09

Matrix:

Carrier name Client drop-off

Shipping container/cooler in good condition?	Yes ☑	No ☐	Not Present ☐	
Custody seals intact on shipping container/cooler?	Yes ☐	No ☐	Not Present ☐	Not Shipped ☑
Custody seals intact on sample bottles?	Yes ☐	No ☐	N/A ☑	
Chain of custody present?	Yes ☑	No ☐		
Chain of custody signed when relinquished and received?	Yes ☑	No ☐		
Chain of custody agrees with sample labels?	Yes ☑	No ☐		
Samples in proper container/bottle?	Yes ☑	No ☐		
Sample containers intact?	Yes ☑	No ☐		
Sufficient sample volume for indicated test?	Yes ☑	No ☐		
All samples received within holding time?	Yes ☑	No ☐		
Water - VOA vials have zero headspace?	No VOA vials submitted ☑	Yes ☐	No ☐	
Water - Preservation labels on bottle and cap match?	Yes ☐	No ☐	N/A ☑	
Water - pH acceptable upon receipt?	Yes ☐	No ☐	N/A ☑	
Container/Temp Blank temperature?	**25.0°**	*<6° C Acceptable* If given sufficient time to cool.		

Number of preserved bottles checked for pH: ______

<2 >12 unless noted below.

COMMENTS:

Client contacted ______ Date contacted: ______ Person contacted ______

Contacted by: ______ Regarding: ______

Comments: ______

Corrective Action ______

Chain-of-Custody Record

Client: Daniel B Stephens
& Assoc

Mailing Address: 6020 Academy
ABQ NM 87109

Phone #: 822-9400

email or Fax#: cwolf@dbstephens.com

QA/QC Package:
☒ Standard ☐ Level 4 (Full Validation)

Accreditation
☐ NELAP ☐ Other

☒ EDD (Type) xls

Turn-Around Time:
☒ Standard ☐ **Rush**

Project Name: PZ-13 Pb

Project #: ES08.0072.10

Project Manager: M. Miller

Sampler: Wolf

On Ice: ☒ Yes ☐ No

Sample Temperature:

HALL ENVIRONMENTAL ANALYSIS LABORATORY

www.hallenvironmental.com

4901 Hawkins NE - Albuquerque, NM 87109

Tel. 505-345-3975 Fax 505-345-4107

Analysis Request

Date	Time	Matrix	Sample Request ID	Container Type and #	Preservative Type	HEAL No.	BTEX + MTBE + TMB's (8021)	BTEX + MTBE + TPH (Gas only)	TPH Method 8015B (Gas/Diesel)	TPH (Method 418.1)	EDB (Method 504.1)	8310 (PNA or PAH)	RCRA 8 Metals	Anions (F,Cl,NO_3,NO_2,PO_4,SO_4)	8081 Pesticides / 8082 PCB's	8260B (VOA)	8270 (Semi-VOA)	Modified SPLP/Brine	Metal - low DL *	DI leach	~~Ultra Sonic~~ CMW	Air Bubbles (Y or N) 12-17-09
8/21/07	—	solid	PZ-13 74'-75'	1	—	0912387-1											12-17-09	✓	✓	✓		
8/21/07	—	solid	PZ-13 76'-77'	1	—	-2											CMW	✓	✓			
8/25/07	—	solid	PZ-14 71'-72'	1	—	-3												✓	✓			
11/23/09	—	solid	HSA Flat # 3	1	—	-4												✓	✓		✓	
11/23/09	—	solid	HSA Round # 1	1	—	-5												✓	✓		✓	
11/23/09	—	solid	Tri-Cone # 4	1	—	-6												✓	✓		✓	
11/23/09	—	solid	HSA Flat # 2	1	—	-7													✓	✓	✓	

Date:	Time:	Relinquished by:	Received by:	Date	Time
11/25/09	925	C Wolf	Andy	11/25/09	9:25
Date:	Time:	Relinquished by:	Received by:	Date	Time

Remarks: *See Andy for methods and analyses
* 1 day, 5 day, 28 day samples
Retain all sample materials!

If necessary, samples submitted to Hall Environmental may be subcontracted to other accredited laboratories. This serves as notice of this possibility. Any sub-contracted data will be clearly notated on the analytical report.