REPORT

Former Operating Plant Groundwater Monitoring Plan

Exide Technologies Frisco Recycling Center
7471 Old 5th Street, Frisco, Texas
TCEQ SWR No. 30516
TCEQ Hazardous Waste Permit No. HW-50206
Customer No. CN600129787
Regulated Entity No. RN100218643

STATE OF TEXAS
ANNE M FAETH-BOYD
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5-31-19

GOLDER ASSOCIATES INC.
Geoscience Firm Registration
Certificate Number 50369

Submitted to:

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1.0 INTRODUCTION

The Exide Technologies (Exide) Frisco Recycling Center is a former oxide manufacturing, battery recycling, and secondary lead smelting facility located at 7471 Old 5th Street in Frisco, Collin County, Texas. The Frisco Recycling Center includes the Former Operating Plant (FOP) and formerly included the surrounding undeveloped buffer property. The location of the FOP is shown on Figure 1. Golder Associates, Inc., (Golder) has prepared this Groundwater Monitoring Plan for the FOP as part of the Compliance Plan application for the Site. As there have already been detections of constituents of concern (COCs) in groundwater at the FOP and the May 2019 RCRA Permit Renewal Application includes a Compliance Plan with a Response Action Plan documenting planned corrective action for the FOP, a separate detection monitoring plan has not been prepared. The scope of detection monitoring performed for the FOP is included within the larger scope of groundwater monitoring that is being performed as a part of the Corrective Action monitoring for the FOP, other than the wells near the South Disposal Area (SDA), where no groundwater corrective action is required.

Although it is recognized that as stated above the FOP is required to implement a Corrective Action program, additional information regarding the wells included in this Groundwater Monitoring Plan is presented in the Geology Report, including Table VI.B.3.b-2: Unit Groundwater Detection Monitoring Systems and Table VI.B.3.c-2: Groundwater Detection Monitoring Parameters.

This Groundwater Monitoring Plan presents:

- The rationale for the proposed detection/corrective action monitoring program for the Remediation Consolidation Area (RCA), North Disposal Area (NDA), SDA and Slag Landfill, including the monitoring specifications for the proposed groundwater corrective action program (a funnel and gate groundwater treatment system).
- The procedures for monitoring well sampling, sample management, analytical methods, quality assurance/quality control, sample custody control, and data reduction.

This Groundwater Monitoring Plan does not include a description of the ongoing monitoring at the North Corrective Action Management Unit (North CAMU) as the groundwater monitoring program for the North CAMU is described in the Revised Class 2 Landfill Groundwater Monitoring Plan, prepared by Pastor, Behling & Wheeler and dated July 31, 2013, which TCEQ approved in a letter dated April 4, 2014.

2.0 OVERVIEW OF GROUNDWATER MONITORING PROGRAM

2.1 Monitoring Network

The proposed monitoring well network is shown on Figure 2. Well construction details for existing wells are summarized in Table 1, and boring logs for the monitoring wells are included in Appendix A. Monitoring wells were constructed in general accordance with Texas Water Development Board (TWDB) and the Texas Commission on Environmental Quality (TCEQ) requirements. These requirements include construction and reporting requirements set forth for licensed water well installers by the TWDB (16 TAC Part 4 Chapter 76) and general guidelines developed by the TCEQ (TCEQ Industrial Solid Waste Management Technical Guideline No. 6, Groundwater Monitoring, last issued October 25, 2004).

In some instances, insufficient space was available in the column for placement of both two feet of bentonite above the sand interval and two feet of concrete above the bentonite interval due to the shallow depth of the well (e.g. 5 ft) and the length of the screened interval, (e.g. 2 ft), as was the case for monitoring wells B3R, B4R, MW-21, MW-22, MW-23, and MW-44. Additionally, there are instances where Texas State Well Reports submitted by the drilling contractors differ from construction information provided on the well construction logs prepared by the geologist performing field oversight. Golder will request a variance from the TWDB for wells that have alternate construction due to Site conditions and will work with the drilling contractors to have the Texas State Well Reports corrected where appropriate. If the variance is not granted by TWDB or the drilling contractors responsible for submitting well reports are not able to correct the reports, the surface completions and/or wells will be replaced with wells that meet applicable requirements.

The groundwater monitoring program that will be implemented for the RCA, NDA, Slag Landfill and SDA will ensure that the engineered caps and groundwater corrective action program are performing as designed and confirm that no adverse conditions have been generated as a result of the FOP closure actions.

For the purposes of this Groundwater Monitoring Plan, the points of compliance are the downgradient and crossgradient monitoring wells listed in Sections 2.1.1 and 2.1.2 below.

2.1.1 Corrective Action Monitoring for the RCA, Slag Landfill, and North Disposal Area

The FOP corrective action groundwater monitoring program will consist of the following wells surrounding the RCA, Slag Landfill and NDA. The wells have been selected to provide data 1) upgradient from the area where corrective action is being performed in groundwater (a funnel and gate permeable reactive barrier [PRB] surrounding the RCA, and Slag Landfill and NDA), 2) outside the area of the funnel (slurry wall) portions of the funnel and gate PRB, and 3) directly upgradient and downgradient from the PRB section of the funnel and gate PRB. In addition, piezometers (for monitoring groundwater elevations) will be installed inside the funnel and gate PRB. The groundwater monitoring well and piezometer locations are shown on Figure 2 and include the following:

- FOP Corrective Action Monitoring Wells (* denotes proposed location):
  - Up-gradient monitoring wells (upgradient from funnel and gate PRB system): MW-10 and MW-23
  - Cross-gradient monitoring wells/Points of Compliance (crossgradient or outside of slurry wall/sheet pile): B7N, B9N, DGW-MW-9, MW-16SR*, MW-17, MW-18, MW-21, MW-22, MW-26, MW-27, MW-29, MW-44, MW-48*, MW-49, and *SR-MW-1

- Upgradient PRB monitoring wells (to provide information on groundwater quality for PRB influent): PRB-MW-1* and PRB-MW-2*
- Downgradient PRB monitoring wells/Points of Compliance (to provide information on groundwater quality downgradient (including PRB effluent): PRB-MW-3*, PRB-MW-4*, PRB-MW-5*, PRB-MW-6*, PRB-MW-7*
- Water Elevation Piezometers: PZ-1 through PZ-6.

Generally, downgradient monitoring wells target transmissive zones in the upper Groundwater Bearing Unit (GWBU) where groundwater generally exists under unconfined conditions at depths between approximately 10 and 25 feet below ground surface (ft bgs) and discharges to Stewart Creek and/or the North Tributary. Shallower groundwater has been recorded at depths as high as less than one foot bgs in the vicinity of the former Production Area (within the RCA and most likely attributed to storm water seeping through cracks in the concrete slab).

2.1.2 Detection Monitoring of the South Disposal Area

The groundwater monitoring program will consist of the following wells downgradient from the South Disposal Area (also shown on Figure 2):

- Downgradient monitoring wells: B3R and B4R

2.2 Analytical Parameters

As described in the 2014 Affected Property Assessment Report (the 2014 APAR), during both phases of the APAR investigation, metals, volatile organic compounds (VOCs), semivolatile organic compounds (SVOCs), total petroleum hydrocarbons (TPH), and/or perfluorinated chemicals were either not detected or not detected above the applicable residential assessment levels (RALs) in most of the groundwater samples collected from wells screened to sample the upper GWBU or deeper units within the Eagle Ford Shale. Results of groundwater samples collected between 2012 and 2014 are shown on Tables 5B.1 through 5B.5 of the 2014 APAR. Results of groundwater samples collected since the 2014 Affected Property Assessment Report (APAR) submittal are included in Appendix 3.1 and in Appendix 3.6 to the Response Action Plan (included as Attachment M of the Permit Renewal Application) and have indicated that some metals have exceeded the RALs and protective concentration levels (PCLs).

Exceedances of the RALs included antimony, arsenic, cadmium, and lead. Selenium has historically been detected above the RAL at the North CAMU, but not in the vicinity of the FOP. The proposed groundwater monitoring program at the FOP includes assessment of antimony, arsenic, cadmium, lead, and selenium, as these five metals are the primary contaminants of concern (COCs) identified in soils and groundwater at the FOP.

2.3 Sampling Schedule

Groundwater monitoring of the FOP (including the measurement of water levels in piezometers discussed above), completed as a part of this Groundwater Monitoring Program, is proposed to be conducted quarterly for two years following FOP closure and semiannually thereafter. The groundwater sampling events will be conducted in conjunction with quarterly and semi-annual sampling events for the North CAMU so that water level data and background concentrations from the North CAMU wells can be used for comparison purposes.

3.0 GROUNDWATER SAMPLING

The following activities will occur before and during groundwater sampling:

- Pre-arrangement of sample analytical requests with the analytical testing laboratory
- Assembly and preparation of sampling equipment and supplies
- Groundwater sampling
  - Water-level measurements
  - Well purging
  - Field parameter measurements
  - Sample collection
  - Filtration (if needed)
- Sample preservation
- Sample labeling
- Completion of sample records
- Completion of chain-of-custody records
- Sample shipment

Prior to the sampling event, all sampling equipment will be assembled and properly cleaned and its operating condition will be verified. In addition, all record-keeping materials will be prepared. Sampling procedures will be conducted in general accordance with United States Environmental Protection Agency (EPA) SW-846 methods and in accordance with the applicable standard operating procedures (SOPs) presented in Appendix B. The sampling procedures are further described in the sections below.

3.1 Equipment Assembly and Preparation

3.1.1 Equipment Check

This activity includes the verification that all equipment is in proper operating condition. An equipment check will be performed prior to each sampling event. Arrangements for repair or replacement of any equipment that is inoperative will be made and such repair or replacement will be completed prior to the sampling event.

3.1.2 Equipment Cleaning (Decontamination)

Decontamination of all non-disposable or non-dedicated field measurement, purging, and sampling equipment will be performed for each sampling event before any purging or sampling activities begin, after each well is sampled, and at the end of the sampling event. Equipment decontamination will be conducted in general conformance with ASTM Standard D 5088-15a and is summarized below:

1) Equipment will be washed with low-residue soap and/or detergent solution.

2) Equipment will be rinsed with distilled water.

3) Steps (1) and (2), above, will be repeated as necessary.

If non-dedicated submersible pumps are used for purging and sampling, the outside casing will be washed following the steps outlined above. The interior of the pump will be rinsed by pumping distilled water through the pump.

3.2 Groundwater Sampling Procedures

3.2.1 Well Inspection

Prior to each sampling event, each well will be inspected for signs of damage to the well protective casing and well pad. The lock on each well will be checked to make sure it is present and operable. The well numbering on each well will also be checked for legibility.

3.2.2 Prevention of Cross-Contamination

Special care will be exercised to prevent contamination of the groundwater and extracted samples during the sampling activities. Improperly cleaned equipment is the primary means of cross-contamination.

To prevent such contamination, all non-dedicated sampling equipment will be thoroughly cleaned before and between uses at different sampling locations in accordance with Section 3.1.2. In addition to using properly cleaned equipment, a new pair of disposable latex/nitrile (or similar) gloves will be worn during sampling at each well.

3.2.3 Groundwater Level Measurements

Prior to any sampling activities, a static water level measurement will be obtained. Prior to sampling and during purging, depth-to-water measurements will also be measured from the casing datum to the nearest one-hundredth of a foot using an electronic water level meter with a graduated tape. Total well depths will also be measured in the monitoring wells annually. Water level measurement procedures are described in Appendix B. Water level measurements and total depths will be recorded on a Groundwater Sample Collection Form, which is also included in Appendix B.

3.2.4 Well Purging and Sampling

Well purging and sampling will be conducted in accordance with the SOPs presented in Appendix B. Prior to each sampling event, the wells will be purged using a peristaltic pump and low-flow technique. Submersible pumps will be used if water levels are too low to allow the use of a peristaltic pump. The objective is to withdraw water in a manner that minimizes stress (drawdown) to the system to the extent practicable. When the pump intake is located within the screened interval, the water pumped will be drawn in directly from the formation with little mixing of casing water or disturbance to the sampling zone. Thus, samples are representative of the mobile load of constituents present.

Purging rates during sample collection will be performed at approximately 0.5 liters per minute (L/min) or less. The field parameters will be used to determine when the well has been adequately purged (i.e., when the well has stabilized). Stabilization will be confirmed when successive field parameters including specific conductance, pH, and temperature, readings are within approximately ± 10%. Turbidity measurements will also be collected during purging. Each field instrument will be calibrated according to the manufacturer’s instructions prior to each day’s use.

A dedicated, decontaminated pump line will be attached to the peristaltic pump. The line inlet will be placed within the saturated portion of the well screen. The pump will then be turned on and measurements started for flow rate and field parameters. The pump line will be changed between wells. The pump rate and the parameter measurements will be recorded on the Groundwater Sample Collection Form presented in Appendix B. If a well goes dry during purging, sampling will be performed the following day provided the well has sufficiently recharged to allow sample collection.

Sample extraction will be accomplished by using the same peristaltic pump and pump line used to purge the well. The sample bottle will be filled directly from the pump line. If the turbidity exceeds 10 Nephelometric Turbidity Units (NTUs), the sample will be filtered through a disposable 10-micron filter prior to collection.

3.2.5 Container and Labels

The analytical testing laboratory will provide containers and appropriate container lids. The containers will be filled and container lids will be tightly closed. The following information will be legibly and indelibly written on the label:

- Project identification
- Sample identification
- Location
- Name or initials of collector
- Date and time of collection
- Analysis requested
- Sample preservative, if applicable
- Filtered or unfiltered

3.2.6 Chain-of-Custody Control

After samples have been collected, chain-of-custody procedures will be followed to establish a written record of sample movement between the sampling site and the testing laboratory. Each shipping container will have a chain-of-custody form completed by the sampling personnel packing the samples. Sample custody and shipment procedures are described in detail in the SOPs in Appendix B.

3.2.7 Sample Shipment

Samples awaiting shipment to the laboratory will be stored in a cooler with ice such that the samples maintain a temperature of at most 4 degrees Celsius. Once a set of samples is ready for shipment, the samples will be re-packed with ice such that no water leaks from either the bags of ice or the package (i.e., a cooler) during shipment. Completed chain-of-custody forms will be inserted into a plastic sleeve and placed inside the sample shipment container. The cooler will be labeled with the sample collector's name, address, and telephone number; the laboratory's name, address, and telephone number; and the date of shipment. The cooler will be sealed with a chain-of-custody seal and signed and dated by the sampler before shipment.

3.3 Laboratory Analyses

Samples will be analyzed by a laboratory that is accredited by the National Environmental Laboratory Accreditation Conference (NELAC) and sample analyses will be performed in accordance with the EPA SW-846 methods listed in Table 2. Each groundwater sample will be analyzed for total and dissolved antimony, arsenic, cadmium, lead, and selenium.

3.4 Investigation-Derived Wastes

Investigation-derived waste (IDW) generated from groundwater sampling activities will include primarily purge water, spent decontamination water, and personal protective equipment (PPE). IDW will be containerized and placed in a 55-gallon drum near the former administration building on secondary containment (location specified by Exide). IDW drums will be labeled on the top and sides with a sticker or other form of identification with the following information:

- "Investigation Derived Waste – Analysis Pending"
- The date
- The type of IDW (e.g., water, PPE)
- Exide Frisco Recycling Facility
- 7471 Old 5th Street
- Frisco, Texas 75034-5047

Containers of IDW will be properly disposed of at an approved facility following receipt of analytical results.

4.0 QUALITY ASSURANCE/QUALITY CONTROL

Two of the monitoring wells will be sampled in duplicate for each sampling event. The duplicate samples will be analyzed for all parameters for which the original sample is analyzed. Equipment blanks may be collected to evaluate the effectiveness of decontamination procedures if non-dedicated or disposable equipment is not used. Equipment blanks will be collected at a frequency of one rinse blank per 20 samples (unless non-dedicated or disposable equipment is used) by rinsing the decontaminated equipment with deionized water and collecting the rinse water.

5.0 DATA REDUCTION AND PRESENTATION

Once the analytical data is received from the laboratory, the laboratory report will be reviewed for any narratives or comments indicating qualified data. Any qualified data will be closely evaluated with the laboratory. Next, the data will be reviewed for results in expected ranges. Anomalous results will be noted for additional review. The laboratory quality control report will also be reviewed to note any qualified data or other indications of anomalous runs. The data will then be deemed validated as appropriate. A Data Usability Summary (DUS) will be prepared in accordance with Texas Risk Reduction Program (TRRP) 13 guidance.

Static groundwater elevations will be plotted on a map of the FOP using the depth to water measurements and top of casing elevations to determine the groundwater flow direction and hydraulic gradient for each sampling event.

Groundwater assessment levels for the Site groundwater COCs are based on the $^{GW}\mathbf{GW}_{\mathbf{Ing}}$ exposure pathways for all areas of the FOP. The $^{SW}\mathbf{GW}$ exposure pathway is also considered to be complete in areas where there is a potential point of discharge of groundwater to surface water (i.e., in the near vicinity of Stewart Creek or the North Tributary). A detailed discussion of groundwater assessment levels is included in the 2014 APAR, and a summary of the applicable protective concentration levels (PCLs) for each of the proposed analytes is provided in Table 3.

Where an initial sampling indicates PCL exceedances in the FOP monitoring wells, appropriate notification will be provided in writing to the TCEQ within 15 days of the receipt of final sampling results documenting the exceedance; the notification will indicate which chemical constituent was found in exceedance. Re-sampling to confirm the existence or non-existence of the exceedance will be conducted within two weeks of the documentation of the initial exceedance, and the results of the confirmation sampling will be reported in writing to the TCEQ within 15 days of the receipt of the final confirmation sampling results. If a release from the RCA, Slag Landfill, NDA or SDA is indicated by a confirmed PCL exceedance in a downgradient monitoring well, this will be considered an indication of affected groundwater and an investigation to determine the extent of the release will be conducted and a report documenting the results of the investigation will be submitted to the TCEQ within 120 days of receipt of the final confirmation sampling results. Additional monitoring and/or investigation will be performed at the written direction of the TCEQ to evaluate whether an exceedance in a cross-gradient or up-gradient well is related to an on-site release.

Semiannual groundwater monitoring reports will be prepared and submitted to the TCEQ on or before January 21 and July 21 of each year for 30 years following Site closure. The reports will include the following:

- Discussions of sampling procedures and analytical results
- Laboratory reports and data usability summaries
- Information on monitoring well conditions, well construction, well yield/purging, development and sampling issues, and any relevant site information (droughts, excessive rainfall, etc.)
- Potentiometric surface maps, hydraulic gradient calculations, and estimates of the groundwater flow rate
- A summary of data in tabular form that lists the constituent, date sampled, monitoring well identification, applicable PCL, analytical results showing detection limits for any constituents that were not detected and showing PCL exceedances as bolded or highlighted values

6.0 CLOSING

Golder appreciates the opportunity to assist Exide with this project. Please contact the undersigned if you have any questions or comments regarding this Groundwater Monitoring Plan.

Sincerely,

Golder Associates Inc.

Emily White

Anne Faeth-Boyd

Emily P. White
Project Geological Engineer

Anne M. Faeth-Boyd, P.G.
Associate and Senior Engineer

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EPW/AMF

TABLES

Table 1
Summary of Well Construction and Location Information
Exide Technologies Frisco Recycling Center - Former Operating Plant

Well Name	Potential Surface Water Discharge[4,5]	Date Drilled[1, 2, 3]	Ground Surface Elevation (ft AMSL)	TOC Elevation (ft AMSL)	Screened Interval (ft bgs)	Well Casing Diameter (inches)	Total Drilled Depth (ft bgs)
B3R	None	07/21/1990	649.23	650.23	4-14	4.0	14.0
B4R	None	07/11/1990	661.40	664.58	4-9	4.0	9.0
B7N	None	05/10/1990	644.08	645.60	14-24	4.0	25.0
B9N	North Tributary	06/12/1990	637.02	640.69	7-17	4.0	18.0
DGW-MW-9	Stewart Creek	5/16/2018	642.22	644.81	10.2-24.7	2.0	25.0
MW-10	Stewart Creek	6/30/1990	645.12	644.82	7-17	4.0	19.0
MW-17	Stewart Creek	06/07/1990	628.58	629.00	7-17	4.0	19.0
MW-18	North Tributary	06/12/1990	631.84	633.00	5.5-15.5	4.0	18.0
MW-21	None	03/05/2013	633.66	635.99	3-13	2.0	15.0
MW-22	None	03/05/2013	633.29	636.89	3-13	2.0	15.0
MW-23	None	03/05/2013	644.32	644.15	4.5-19.5	2.0	20.0
MW-26	Stewart Creek	03/06/2013	628.34	631.93	5-15	2.0	15.0
MW-27	Stewart Creek	03/06/2013	629.89	633.42	5-15	2.0	15.0
MW-29	Stewart Creek	03/06/2013	629.39	633.51	4.5-14.5	2.0	15.0
MW-44	Stewart Creek	01/09/2014	634.33	637.50	5-15	2.0	15.0

Notes:

(1) Monitoring wells installed in 1990-1991 by Lake Engineering Inc.

(2) Monitoring wells installed in 2013-2014 by Strata Core Services, LLC.

(3) Monitoring wells installed in 2018 by W.E.S.T Drilling.

(4) Monitoring wells along Stewart Creek considered a potential point of discharge where the ^{SW}GW PCL (chronic) may apply.

(5) Monitoring wells along the North Tributary of Stewart Creek considered potential point of exposure wells where the ^{SW}GW PCL (acute) may apply.

Abbreviations:

AMSL - above mean sea level
ft bgs - feet below ground surface
TOC - top of casing

Prepared by: DC/EPW
Updated by: EPW
Checked by: MT, BEF
Reviewed by: AMF

Table 2
Groundwater Sampling Protocol
Exide Technologies Frisco Recycling Center - Former Operating Plant

Parameter (Total and Dissolved)	Analytical Method[1]	Volume (ml)	Container[2]	Preservative[2]	Holding Time
Arsenic	SW6010B/6020A	250-500	P	HNO_3 to pH <2	6 months
Cadmium					
Lead					
Selenium					
Antimony					

Notes:

[1] Sample analyses will be performed in accordance with EPA SW-846 methods.

[2] P = plastic, G = glass, HNO_3 = Nitric Acid

Prepared by: DC
Checked by: CH
Reviewed by: JW/AMF

Table 3
Groundwater Protective Concentration Levels
Exide Technologies Frisco Recycling Center - Former Operating Plant

Parameter	Unadjusted MQL (mg/L)	TRRP Tier 1 Residential $^{GW}GW_{Ing}$ PCL (mg/L)	TRRP Tier 1 Commercial/Industrial $^{GW}GW_{Ing}$ PCL (mg/L)	^{SW}GW PCL (chronic aquatic life criteria, with dilution factor of 0.15)^{1,2} (mg/L)	^{SW}GW PCL (acute aquatic life criteria)^{1,2} (mg/L)	^{SW}GW PCL (with dilution factor of 0.15, based on contact recreation) (mg/L)
Contaminants of Concern (COCs)						
Antimony (total and dissolved)	0.00500	0.006	0.006	1.33 (total)	6.60 (total)	1.33
Arsenic (total and dissolved)	0.00300	0.01	0.01	1.00 (dissolved)	0.34 (dissolved)	0.19
Cadmium (total and dissolved)	0.000500	0.005	0.005	0.0017 (dissolved)	0.00908 (dissolved)	0.99
Lead (total and dissolved)	0.00250	0.015	0.015	0.0179 (dissolved)	0.0688 (dissolved)	0.10
Selenium (total and dissolved)	0.00250	0.050	0.050	0.0333 (total)	0.02 (total)	27.5

Notes:

mg/L - milligrams per liter

MQL - method quantitation limit

TRRP - Texas Risk Reduction Program

PCL - protective concentration level

TRRP PCLs are obtained from the April 2018 Tier 1 PCL and supporting tables accessed at http://www.tceq.state.tx.us/remediation/trrp/trrppcls.html.

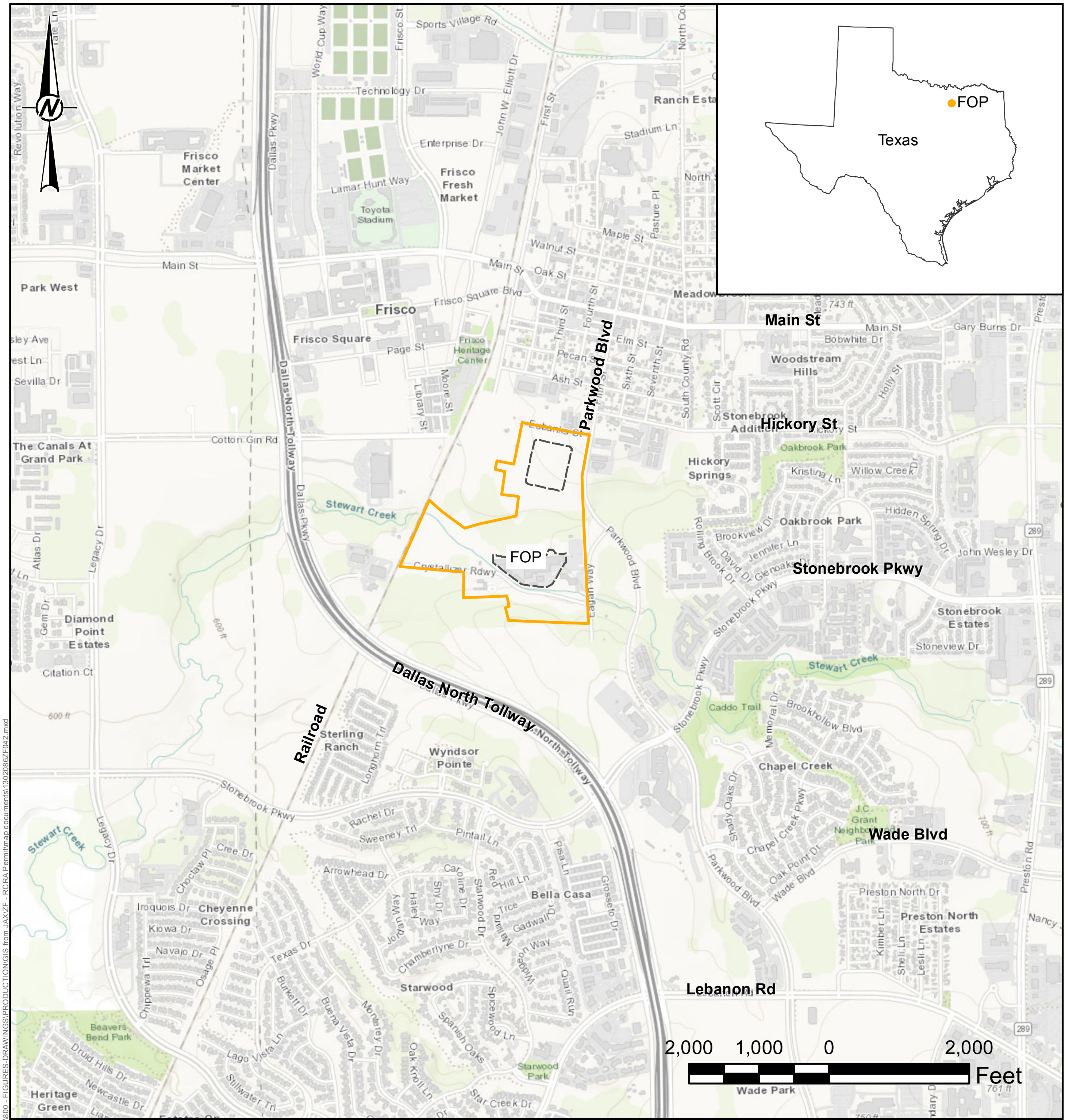
(1) The antimony, arsenic, and selenium ^{SW}GW PCLs are set to the TCEQ's aquatic life surface water benchmarks, updated in January 2017. The cadmium and lead ^{SW}GW PCLs are set to the ^{SW}SW risk-based exposure limits (RBELs) as approved in the 2014 Affected Property Assessment Report. Per TRRP-24, the ^{SW}GW PCLs apply to monitoring wells where there is a potential point of discharge of groundwater to surface water (i.e., in the near vicinity of Stewart Creek or the North Tributary). Chronic ecological criteria apply to monitoring wells along Stewart Creek (a perennial stream) assuming a 0.15 dilution factor (MW-16SR, MW-17, MW-26, MW-27, MW-29, MW-44, PRB-MW-3*, PRB-MW-4*, PRB-MW-5*, PRB-MW-6*, PRB-MW-7*, and *SR-MW-1). Acute ecological criteria apply to wells B9N, MW-18, *MW-48 and *MW-49 along the North Tributary (an intermittent stream).

(2) Per TRRP-24, specific aquatic life criteria for arsenic, cadmium and lead apply to dissolved rather than total concentrations since the dissolved phase represents the bioavailable form. Also per TRRP-24, the SWGW PCL applies to monitoring wells where there is a potential to discharge to surface water. Arsenic, cadmium, and lead RBELs based on hardness value of 106 mg/L for Segment 0823.

* Notes proposed well

Prepared by: BEF
Checked by: EPW
Reviewed by: AMF

FIGURES



LEGEND

▭ Former Operating Plant Property Boundary

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REFERENCE

1.BASE MAP - SOURCES: ESRI, HERE, DELORME, TOMTOM, INTERMAP, INCREMENT P CORP., GEBCO, USGS, FAO, NPS, NRCAN, GEOBASE, IGN, KADASTER NL, ORDNANCE SURVEY, ESRI JAPAN, METI, ESRI CHINA (HONG KONG), SWISSTOPO, MAPMYINDIA, © OPENSTREETMAP CONTRIBUTORS, AND THE GIS USER

CLIENT
EXIDE TECHNOLOGIES

PROJECT
FOP GROUNDWATER MONITORING PLAN

TITLE
SITE LOCATION MAP

CONSULTANT

GOLDER

YYYY-MM-DD	2019-05-30
PREPARED	EFT
DESIGN	CDS
REVIEW	EPW
APPROVED	AMF

PROJECT No.	CONTROL	Rev.	FIGURE
13-02086-06	1302086ZF042.mxd	0	1

LEGEND

- ⊕ North CAMU Detection Monitoring Well
- ⊕ North CAMU Detection/Corrective Action Monitoring Well
- ▲ North CAMU Corrective Action Monitoring Well
- ⊙ FOP Detection Monitoring Well
- ● FOP Corrective Action Monitoring Well
- ⊘ Existing Wells to be Decommissioned
- ▲ Piezometer Location
- ● Sump Reactor Monitoring Point
- — Surface Water Centerline
- - - Proposed PRB (Gate) Location
- - - Proposed Slurry Wall Locations
- - - Proposed Sheet Pile (Funnel) Location
- ☐ Disposal Area
- ☐ Remediation Consolidation Area
- ⬚ Approximate North CAMU Extent
- ⬚ Former Operating Plant Property Boundary

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300 150 0 300
Feet

REFERENCE

1. SITE FEATURES - GOLDER, 2014
2. AERIAL IMAGERY - SOURCE: ESRI, DIGITALGLOBE, GEOEYE, I-CUBED, EARTHSTAR GEOGRAPHICS, CNES/AIRBUS DS, USDA, USGS, AEX, GETMAPPING, AEROGRID, IGN, IGP, SWISSTOPO, AND THE GIS USER COMMUNITY AND SITE AERIAL IMAGERY PROVIDED BY DALLAS AERIAL SURVEY DATED APRIL, 2017.
3. * - PROPOSED NEW MONITORING WELL/PIEZOMETER LOCATION, NOT YET INSTALLED.

CLIENT
EXIDE TECHNOLOGIES

PROJECT
FOP GROUNDWATER MONITORING PLAN

TITLE
PROPOSED GROUNDWATER MONITORING NETWORK

CONSULTANT
GOLDER

YYYY-MM-DD	2019-05-30
PREPARED	EFT
DESIGN	BEF
REVIEW	EPW
APPROVED	AMF

PROJECT No.	CONTROL	Rev.	FIGURE
13-0208606	1302086ZF041.mxd	0	2

Path: \\STL1-V-FS1\Common\Projects\130 Projects\1302086-06 - Exide Frisco RCRA Permit Mod\800 - FIGURES-DRAWINGS\PRODUCTION\GIS from JAX\ZF - RCRA Permit\map documents\1302086ZF041.mxd

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET HAS BEEN MODIFIED FROM: ANSI B
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APPENDIX A

BORING LOGS FOR FOP MONITORING WELLS

LAKE ENGINEERING, INC.

Project no. 495.4.5

Project Remedial Investigation
GNB, Incorporated – Frisco, Texas

Boring no. **B-3R**

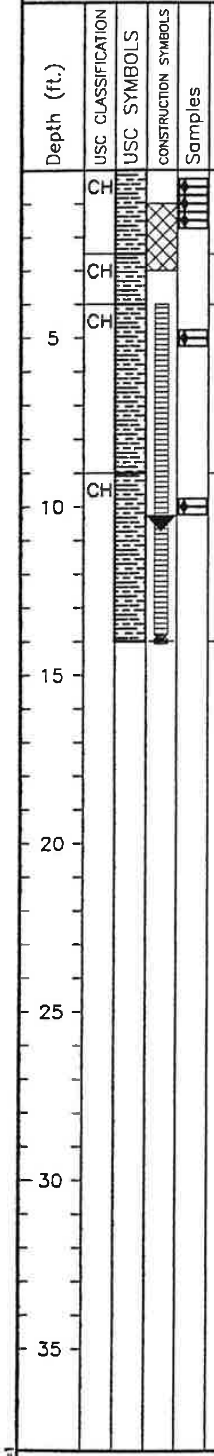
Sheet 1 of 1

Sampling methods: 4.5" Split Spoon | Completion date: 7/21/90 | Boring depth: 14.0

Drilling methods: 8.0" Hollow Stem Auger | Drill rig: CME-55 | Well depth: 14.0

Groundwater elevation: 638.51 (msl) | Date: 7/16/90 | Surface elevation: 649.23 (msl)

STRATUM DESCRIPTION



CLAY, gray

CLAY, gray

CLAY, gray, sandstone layers

SHALEY CLAY

Recovery

% Passing No. 200 Sieve

Log of Boring No. B-3R

⊟ = CHEMICAL ANALYSIS
⊟ = SIEVE ANALYSIS
⊟ = PERMEABILITY SAMPLE

PLATE

495.B-3R PS:1=1

LAKE ENGINEERING, INC.
Project no. 495.4.5

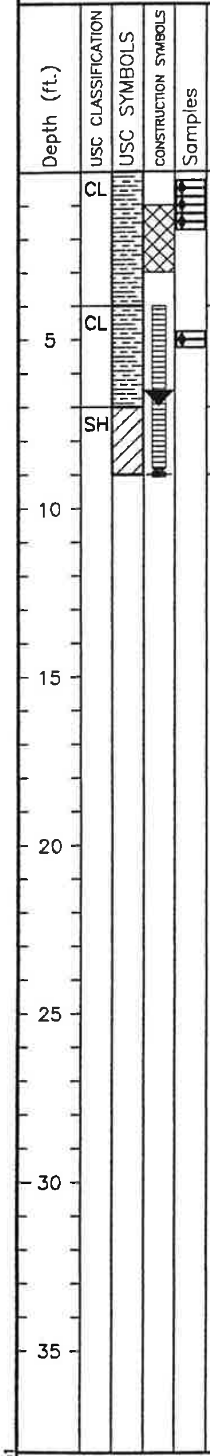
Project Remedial Investigation
GNB, Incorporated – Frisco, Texas

Boring no. **B-4R**
Sheet 1 of 1

Sampling methods: 4.5" Split Spoon | Completion date: 7/11/90 | Boring depth: 9.0

Drilling methods: 8.0" Hollow Stem Auger | Drill rig: CME-55 | Well depth: 9.0

Groundwater elevation: 654.44 (msl) | Date: 7/16/90 | Surface elevation: 661.40 (msl)



STRATUM DESCRIPTION

Recovery | % Passing No. 200 Sieve

CLAY, dry

SHALEY CLAY

SHALE, dark gray

Log of Boring No. B-4R

⊟ = CHEMICAL ANALYSIS
⊞ = SIEVE ANALYSIS
⊟ = PERMEABILITY SAMPLE

PLATE

495 B-4R PS:1=1

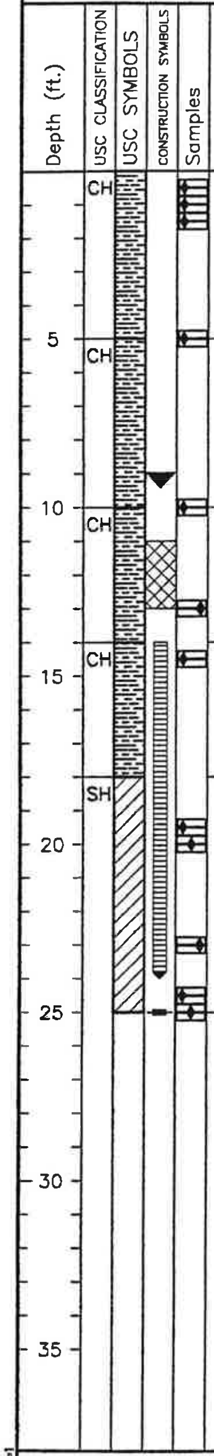
LAKE ENGINEERING, INC.
Project no. 495.4.5
Project Remedial Investigation
GNB, Incorporated – Frisco, Texas
Boring no. **B-7N**
Sheet 1 of 1

Sampling methods: 4.5" Split Spoon
Completion date: 5/10/90
Boring depth: 25.0

Drilling methods: 8.0" Hollow Stem Auger
Drill rig: CME-55
Well depth: 24.0

Groundwater elevation: 634.66 (msl) Date: 7/16/90
Surface elevation: 644.08 (msl)

STRATUM DESCRIPTION



CLAY, dark brown to brown, calcareous, increase in amount and size of calcareous particles at depth

CLAY, gray mottled tan, slightly moist, blocky, with calcareous pebbles

CLAY, gray mottled tan, calcareous, fewer and smaller calcareous particles pebbles than above

SHALEY CLAY, gray, yellow and tan weathering, selenite crystals on parting surfaces

SHALE, dark gray, clayey, moist, very brittle,less brit– tle and more fissile at depth, shell fragments 23–25'

Recovery

% Passing No. 200 Sieve

495.B-7N PS:1=1

Log of Boring No. B-7N

⊟ = CHEMICAL ANALYSIS
⊟ = SIEVE ANALYSIS
⊟ = PERMEABILITY SAMPLE

PLATE

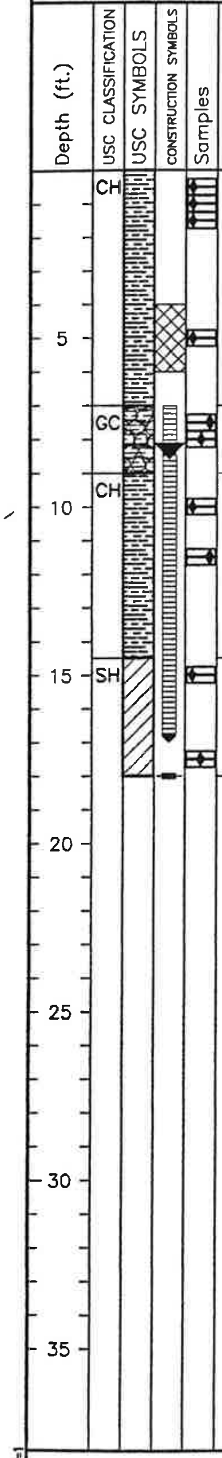
LAKE ENGINEERING, INC. Project **Remedial Investigation GNB, Incorporated – Frisco, Texas** Boring no. **B-9N**

Project no. 495.4.5 Sheet 1 of 1

Sampling methods: 4.5" Split Spoon Completion date: 6/12/90 Boring depth: 18.0

Drilling methods: 8.0" Hollow Stem Auger Drill rig: CME-55 Well depth: 17.0

Groundwater elevation: 628.45 (msl) Date: 7/16/90 Surface elevation: 637.02 (msl)



STRATUM DESCRIPTION

CLAY, dark to medium brown, calcareous, sand to gravel size calcareous pebbles

SAND, silty, clayey, calcareous, with gravel size pebbles

SHALEY CLAY, gray, orange staining on parting surfaces

SHALE, dark gray, fissile, very brittle, interbedded with sand layers 17.5–18.0'

Recovery

% Passing No. 200 Sieve

Log of Boring No. B-9N

⊟ = CHEMICAL ANALYSIS
⊞ = SIEVE ANALYSIS
⊟ = PERMEABILITY SAMPLE

PLATE

495.B-9N PS:1=1

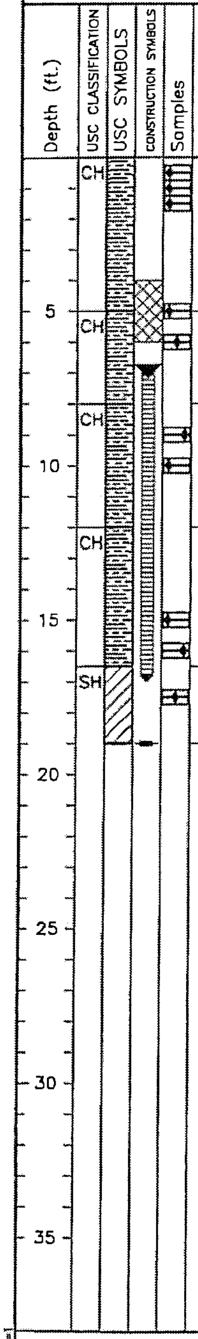
LAKE ENGINEERING, INC.
Project no. 495.4.5
Project Remedial Investigation
GNB, Incorporated – Frisco, Texas
Boring no. **MW10**
Sheet 1 of 1

Sampling methods: 4.5" Split Spoon
Completion date: 6/13/90
Boring depth: 19.0

Drilling methods: 8.0" Hollow Stem Auger
Drill rig: CME-55
Well depth: 17.0

Groundwater elevation: 637.95 (msl) Date: 7/16/90
Surface elevation: 645.12 (msl)

STRATUM DESCRIPTION



USC Classification	Stratum Description	Recovery	% Passing No. 200 Sieve
CH	CLAY, dark to medium brown, with calcareous pebbles		
CH	CLAY, sandy, brown to brown mottled orange, with calcareous pebbles		
CH	CLAY, gray mottled orange-brown, dense, highly plastic		
CH	SHALEY CLAY, gray, moist, yellow and orange staining on parting surfaces		
SH	SHALE, dark gray, fissile, brittle, selenite crystals on parting surfaces		

Log of Boring No. MW10

⊟ = CHEMICAL ANALYSIS
⊞ = SIEVE ANALYSIS
⊟ = PERMEABILITY SAMPLE

PLATE

495 MW10 PS:1=1

LAKE ENGINEERING, INC.
Project no. 495.4.5

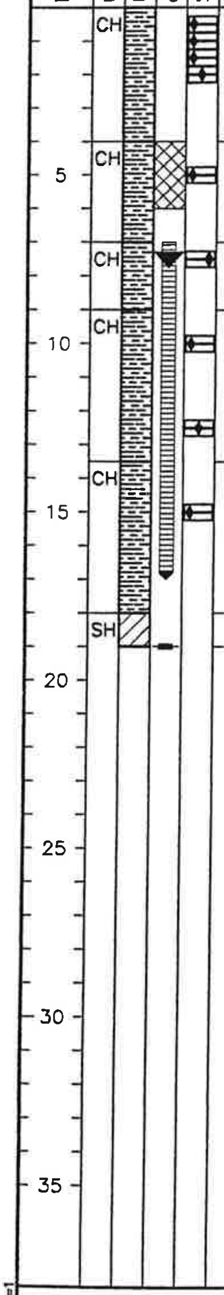
Project Remedial Investigation
GNB, Incorporated – Frisco, Texas

Boring no. **MW17**
Sheet 1 of 1

Sampling methods: 4.5" Split Spoon
Completion date: 6/7/90
Boring depth: 19.0

Drilling methods: 8.0" Hollow Stem Auger
Drill rig: CME-55
Well depth: 17.0

Groundwater elevation: 620.83 (msl)
Date: 7/16/90
Surface elevation: 628.58 (msl)



STRATUM DESCRIPTION

USC CLASSIFICATION	STRATUM DESCRIPTION	Recovery	% Passing No. 200 Sieve
CH	CLAY, silty, dark brown, blocky		
CH	CLAY, dark brown to brown, sand size calcareous pebbles		
CH	CLAY, very soft, blocky, moist		
CH	CLAY, brown mottled gray, with zones of calcareous pebbles varying in grain size from sand to gravel		
CH	SHALEY CLAY, dark gray, light yellow staining on parting surfaces		
SH	SHALE, dark gray		

Log of Boring No. MW17

⊟ = CHEMICAL ANALYSIS
⊞ = SIEVE ANALYSIS
⊟ = PERMEABILITY SAMPLE

PLATE

495 MW17 PS:1=1

LAKE ENGINEERING, INC.

Project no. 495.4.5

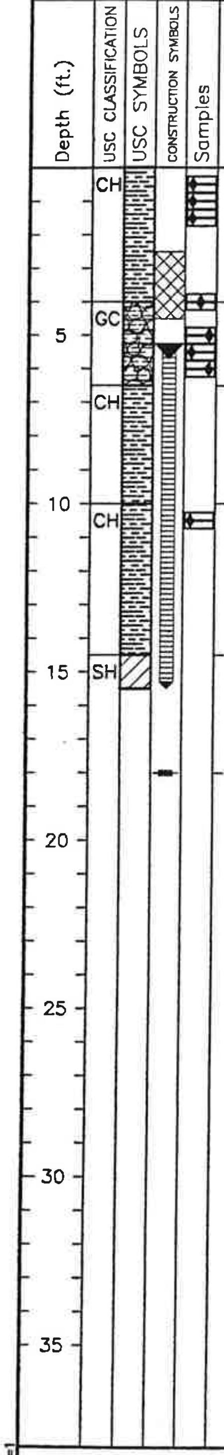
Project Remedial Investigation
GNB, Incorporated – Frisco, Texas

Boring no. MW18

Sheet 1 of 1

Sampling methods:	4.5" Split Spoon	Completion date:	6/12/90	Boring depth:	18.0
Drilling methods:	8.0" Hollow Stem Auger	Drill rig:	CME-55	Well depth:	15.5
Groundwater elevation:	626.17 (msl)	Date:	7/16/90	Surface elevation:	631.84 (msl)

STRATUM DESCRIPTION



CLAY, dark to light brown, with calcareous pebbles

GRAVEL, clayey, sandy, dense, calcareous

CLAY, gray mottled orange, moist, very plastic, inter-bedded with light yellow slit laminae

SHALEY CLAY, gray mottled orange-brown, some interbedded light yellow silt and iron stained laminae

SHALE, dark gray, wet

Recovery

% Passing No. 200 Sieve

Log of Boring No. **MW18**

⊟ = CHEMICAL ANALYSIS
⊞ = SIEVE ANALYSIS
⊟ = PERMEABILITY SAMPLE

PLATE

495 MW18 PS:1=1

Exide Technologies	**Log of Boring: MW-21**

Frisco Recycling Center Frisco, TX	Completion Date:	3/5/2013	Drilling Method:	HSA/DPT
	Drilling Company:	Strata Core Services, LLC	Borehole Diameter (in.):	7.75
	Driller:	Dan Spaust	Total Depth (ft):	15
	Driller's License:	3038M	Northing:	7102518.8983
PBW Project No. 1755	Logged By:	Tim Jennings, P.G.	Easting:	2480490.8249
	Field Supervisor:	Tim Jennings, P.G.	Ground Elev. (ft AMSL):	633.66
	Sampling Method:	5' Split Spoon/5' Samp Tube	TOC Elev. (ft AMSL):	635.99

Depth (ft)	Well Materials	Recovery (ft/ft)	USCS	Sample	Lithologic Description
0		3.8/5.0	CL	0-0.5	(0 - 1.0) Silty CLAY, light grayish brown, abundant orange staining (iron oxide), moist, soft, low to medium plasticity.
				0.5-2	(1.0 - 4.0) Gravelly CLAY, light brownish orange, very moist, soft to firm, low plasticity, ~20% medium gravel in clay matrix.
				2-4	
			CH	4-5	(4.0 - 5.0) CLAY, light grayish brown, abundant orange staining (iron oxide), moist, hard, medium to high plasticity.
5		2.5/2.5	CL		(5.0 - 5.5) Gravelly CLAY, light brown and orange, moist, firm, medium plasticity, 10-30% fine to medium gravel in clay matrix.
					(5.5 - 10.5) Silty CLAY, light brown, orange and gray laminations, moist, hard, medium plasticity, heavily weathered shale.
		2.5/2.5			
10		2.5/2.5	SH		(10.5 - 15.0) SHALE, gray, moist, hard, weathered shale.
		2.5/2.5			
15					

PBW

Pastor, Behling & Wheeler, LLC
2201 Double Creek Dr., Suite 4004
Round Rock, TX 78664
Tel (512) 671-3434 Fax (512) 671-3446

Notes:
This log should not to be used separately from the report to which it is attached.

Annular Materials
(0.0 - 1.0) Concrete
(1.0 - 2.5) Bentonite Hole Plug
(2.5 - 15.0) 20/40 Silica Sand

Well Materials
(+2.33 - 3.0) Casing, 2" Sch 40 FJT PVC
(3.0 - 13.0) Screen, 2" Sch 40 FJT PVC,
0.010 slot

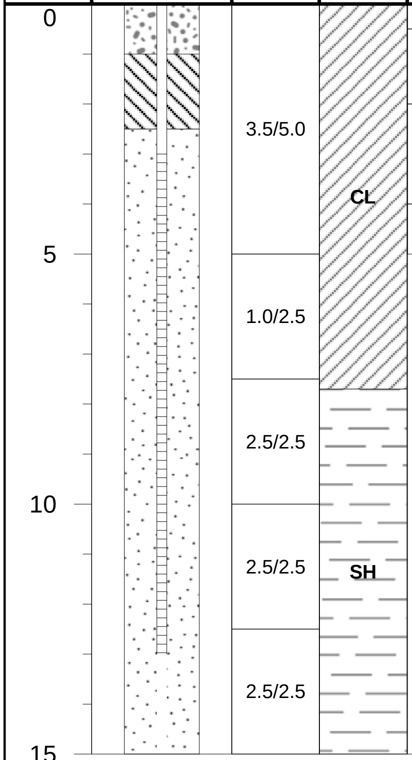
Exide Technologies

Log of Boring: MW-22

Frisco Recycling Center
Frisco, TX

PBW Project No. 1755

Completion Date:	3/5/2013	Drilling Method:	HSA/DPT
Drilling Company:	Strata Core Services, LLC	Borehole Diameter (in.):	7.75
Driller:	Dan Spaust	Total Depth (ft):	15
Driller's License:	3038M	Northing:	7102440.5654
Logged By:	Tim Jennings, P.G.	Easting:	2480046.6732
Field Supervisor:	Tim Jennings, P.G.	Ground Elev. (ft AMSL):	633.29
Sampling Method:	5' Split Spoon/5' Samp Tube	TOC Elev. (ft AMSL):	636.89



Depth (ft)	Well Materials	Recovery (ft/ft)	USCS	Sample	Lithologic Description
0		3.5/5.0	CL	0-0.5	(0 - 1.5) Gravelly CLAY, light grayish brown, abundant orange staining (iron oxide), moist, soft, low plasticity.
				0.5-2	(1.5 - 3.0) Silty CLAY, light grayish brown, abundant orange staining (iron oxide), moist, soft, low plasticity.
				2-4	(3.0 - 5.0) Gravelly CLAY, light grayish brown, abundant orange staining (iron oxide), moist, soft, low plasticity.
				4-5	
5		1.0/2.5			(5.0 - 7.7) Silty CLAY, light brown, orange and gray, moist, firm, medium plasticity.
		2.5/2.5			(7.7 - 12.3) SHALE, gray, brown and orange; moist, firm, weathered.
10		2.5/2.5	SH		
		2.5/2.5			(12.3 - 15.0) SHALE, gray, dry, hard.
15					

PBW

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Notes:
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Annular Materials
(0.0 - 1.0) Concrete
(1.0 - 2.5) Bentonite Hole Plug
(2.5 - 15.0) 20/40 Silica Sand

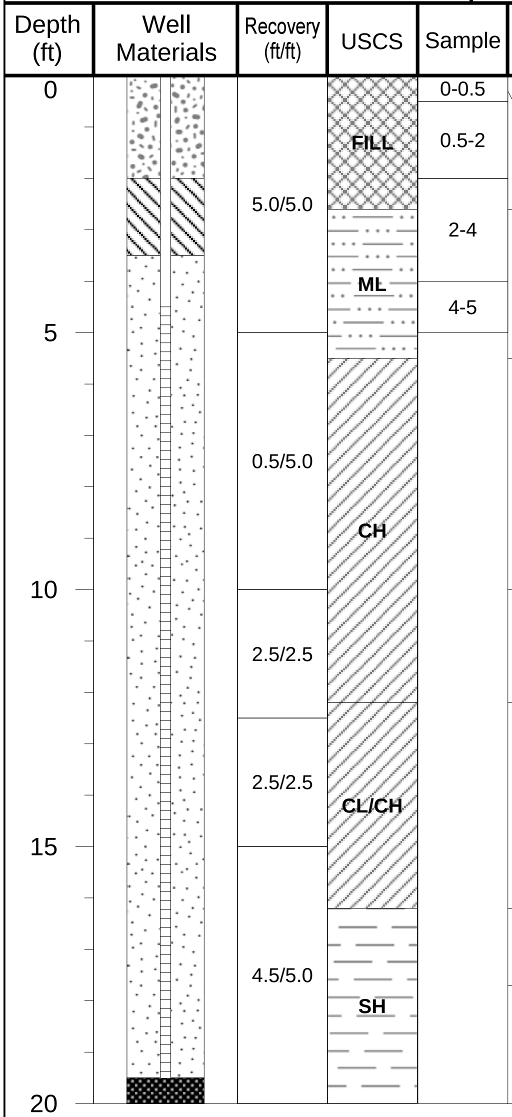
Well Materials
(+3.6 - 3.0) Casing, 2" Sch 40 FJT PVC
(3.0 - 13.0) Screen, 2" Sch 40 FJT PVC,
0.010 slot

Exide Technologies	Log of Boring: MW-23

Frisco Recycling Center
Frisco, TX

PBW Project No. 1755

Completion Date:	3/5/2013	Drilling Method:	HSA/DPT
Drilling Company:	Strata Core Services, LLC	Borehole Diameter (in.):	7.75
Driller:	Dan Spaust	Total Depth (ft):	20
Driller's License:	3038M	Northing:	7102124.8425
Logged By:	Tim Jennings, P.G.	Easting:	2480769.4386
Field Supervisor:	Tim Jennings, P.G.	Ground Elev. (ft AMSL):	644.32
Sampling Method:	5' Split Spoon/5' Samp Tube	TOC Elev. (ft AMSL):	644.15



Lithologic Description

(0 - 0.3) FILL, surficial fill not associated with NDA, no foreign objects (e.g. slag, battery chips or trash) observed, sand with clay, reddish brown, moist, soft.

(0.3 - 2.6) FILL, surficial fill not associated with NDA, no foreign objects (e.g. slag, battery chips or trash) observed, silty clay/clayey silt, trace gravel, dark reddish brown, moist, firm, low plasticity.

(2.6 - 5.5) Clayey SILT, dark reddish brown, dry, hard, low plasticity, ~15% calcareous nodules.

(5.5 - 10) Silty CLAY, light brown, moist, soft to firm, high plasticity, ~10-15% carbonate nodules in clay matrix (based on cuttings).

(10 - 12.2) Gravelly, sandy CLAY; light brown, moist to wet, ~20-30% fine to medium gravel and ~10-20% fine to medium sand in clay matrix.

(12.2 - 16.2) Silty CLAY, light brown, orange and gray, moist, firm to hard, laminated, possibly heavily weathered shale.

(16.2 - 17.7) SHALE, light brown, orange and gray, moist, firm, friable and weathered.

(17.7 - 20.0) SHALE, gray, moist, hard.

PBW

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Notes:
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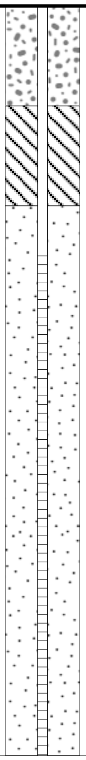
Annular Materials
(0.0 - 2.0) Concrete
(2.0 - 3.5) Bentonite Hole Plug
(3.5 - 19.5) 20/40 Silica Sand
(19.5 - 20.0) Sloughed Material

Well Materials
(-.17 - 4.5) Casing, 2" Sch 40 FJT PVC
(4.5 - 19.5) Screen, 2" Sch 40 FJT PVC, 0.010 slot

Exide Technologies	**Log of Boring: MW-26**

Frisco Recycling Center Frisco, TX	Completion Date:	3/6/2013	Drilling Method:	HSA
	Drilling Company:	Strata Core Services, LLC	Borehole Diameter (in.):	7.75
	Driller:	Dan Spaust	Total Depth (ft):	15
PBW Project No. 1755	Driller's License:	3038M	Northing:	7101865.0034
	Logged By:	Tim Jennings, P.G.	Easting:	2479876.33
	Field Supervisor:	Tim Jennings, P.G.	Ground Elev. (ft AMSL):	628.34
	Sampling Method:	5' Split Spoon	TOC Elev. (ft AMSL):	631.93

Depth (ft)	Well Materials	Recovery (ft/ft)	USCS	Sample	Lithologic Description
0		4.0/5.0	CL		(0 - 1.0) Sandy CLAY, light reddish brown, moist, firm, low plasticity.
					(1.0 - 5.0) Silty CLAY, dark reddish brown, trace iron oxide orange staining, moist, wet at 3', soft to firm, low plasticity.
5		1.5/2.5 2.5/2.5	CH		(5.0 - 9.4) Silty CLAY, brown, moist to wet, firm, high plasticity.
10		1.5/2.5	CL		(9.4 - 10.8) Gravelly CLAY, brown, moist to wet, firm, medium plasticity clay, ~20-40% fine to medium gravel.
					(10.8 - 13.0) Silty CLAY, light brown and orange, laminated with trace iron oxide staining, moist to wet, firm, medium plasticity.
		1.5/2.5	SH		(13.0 - 15.0) SHALE, gray, orange and light brown, trace iron oxide above 14', dry, hard, very hard at 14.5 to 15', low plasticity, weathered.
15					

PBW

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Notes:
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Annular Materials
(0.0 - 2.0) Concrete
(2.0 - 4.0) Bentonite Hole Plug
(4.0 - 15.0) 20/40 Silica Sand

Well Materials
(+3.59 - 5.0) Casing, 2" Sch 40 FJT PVC
(5.0 - 15.0) Screen, 2" Sch 40 FJT PVC, 0.010 slot

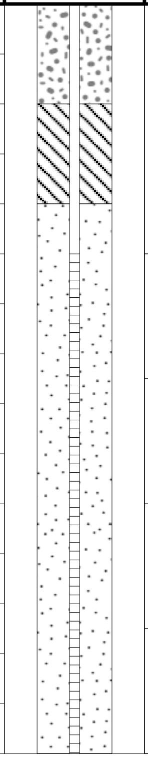
Exide Technologies

Log of Boring: MW-27

Frisco Recycling Center
Frisco, TX

PBW Project No. 1755

Completion Date:	3/6/2013	Drilling Method:	HSA/DPT
Drilling Company:	Strata Core Services, LLC	Borehole Diameter (in.):	7.75
Driller:	Dan Spaust	Total Depth (ft):	15
Driller's License:	3038M	Northing:	7101675.2344
Logged By:	Tim Jennings, P.G.	Easting:	2480260.288
Field Supervisor:	Tim Jennings, P.G.	Ground Elev. (ft AMSL):	629.89
Sampling Method:	5' Split Spoon/5' Samp Tube	TOC Elev. (ft AMSL):	633.42



Depth (ft)	Well Materials	Recovery (ft/ft)	USCS	Sample	PID (ppm)	Lithologic Description
0		4.5/5.0	CL	0-0.5	0.1	(0 - 2.5) Silty CLAY, dark reddish brown, moist, soft, low to medium plasticity, moderate hydrocarbon odor below 1'.
				0.5-2		
				2-4	-	(2.5 - 5.0) Silty CLAY, yellowish brown, wet, very soft, low to medium plasticity, trace sand, some black staining, moderate hydrocarbon odor.
					0.3	
				4-5		
5		2.5/2.5	MH		125.4	(5.0 - 7.0) Sandy, clayey SILT; gray, moist to wet, soft, high plasticity clay, <5% fine gravel, moderate hydrocarbon odor.
		2.5/2.5	CH		65	(7.0 - 8.0) Silty CLAY, gray, moist to wet, soft, high plasticity, trace calcareous nodules, moderate hydrocarbon odor.
					13	(8.0 - 11.5) Sandy, gravelly CLAY; gray, moist to wet, locally wet, firm, high plasticity clay, ~10-20% fine to medium sand, ~5-10% fine gravel.
10		2.5/2.5			0.5	
			CL		0.5	(11.5 - 13.4) Gravelly CLAY, gray, moist, firm, medium plasticity clay, ~20-40% fine to medium gravel in clay matrix.
		2.5/2.5	SH		1.8	(13.4 - 14.6) SHALE, gray and orange, moist, hard, low plasticity, weathered.
15						(14.6 - 15.0) SHALE, gray, dry, hard.

PBW

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Tel (512) 671-3434 Fax (512) 671-3446

Notes:

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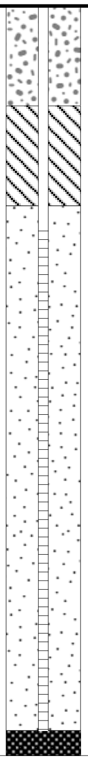
Annular Materials	Well Materials
(0.0 - 2.0) Concrete	(+3.53 - 5.0) Casing, 2" Sch 40 FJT PVC
(2.0 - 4.0) Bentonite Hole Plug	(5.0 - 15.0) Screen, 2" Sch 40 FJT PVC, 0.010 slot
(4.0 - 15.0) 20/40 Silica Sand	

Exide Technologies	**Log of Boring: MW-29**

Frisco Recycling Center Frisco, TX	Completion Date:	3/6/2013	Drilling Method:	HSA/DPT
	Drilling Company:	Strata Core Services, LLC	Borehole Diameter (in.):	7.75
	Driller:	Dan Spaust	Total Depth (ft):	15
PBW Project No. 1755	Driller's License:	3038M	Northing:	7101741.6829
	Logged By:	Tim Jennings, P.G.	Easting:	2480041.8696
	Field Supervisor:	Tim Jennings, P.G.	Ground Elev. (ft AMSL):	629.39
	Sampling Method:	5' Split Spoon/5' Samp Tube	TOC Elev. (ft AMSL):	633.51

Depth (ft)	Well Materials	Recovery (ft/ft)	USCS	Sample	Lithologic Description
0		5.0/5.0	CL/ML	0-0.5 0.5-2 2-4 4-5	(0 - 5.0) Silty CLAY/Clayey SILT, dark reddish brown, orange iron oxide staining from 0-0.5', moist, wet at 4', firm to hard, low plasticity, clayey gravel lens from 2.6-2.7'.
5		2.5/2.5	CH		(5.0 - 8.0) Silty CLAY, dark grayish brown, moist to wet, firm, high plasticity, fine to medium gravel in silty clay matrix at 5-5.8'.
		1.5/2.5			(8.0 - 11.4) Silty CLAY, light brown, moist, firm, high plasticity, <5% fine gravel.
10		1.5/2.5	SH		(11.4 - 14.0) SHALE, gray and orange, trace iron oxide, moist, firm to hard, medium plasticity, weathered.
		2.5/2.5			(14.0 - 15.0) SHALE, gray, dry, hard.
15					

PBW

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Round Rock, TX 78664
Tel (512) 671-3434 Fax (512) 671-3446

Notes:
This log should not to be used separately from the report to which it is attached.

Annular Materials
(0.0 - 2.0) Concrete
(2.0 - 4.0) Bentonite Hole Plug
(4.0 - 14.5) 20/40 Silica Sand
(14.5 - 15.0) Sloughed Material

Well Materials
(+4.12 - 4.5) Casing, 2" Sch 40 FJT PVC
(4.5 - 14.5) Screen, 2" Sch 40 FJT PVC,
0.010 slot

Golder Associates

LOG OF MW-44

DATE/TIME: 01/09/2014, 1230
TOTAL DEPTH: 15 FT BGS
DRILLING METHOD: HSA
DRILLER: SCI, Dan Spaust
RIG: CME-75
NORTHING: 7,101,660 FT
EASTING: 2,480,550 FT
SURFACE ELEVATION: 634.33 FT AMSL

DEPTH (Feet)	RUN No.	PID (PPM)	REC (Feet)	SAMPLE	USCS	GRAPHIC LOG	DESCRIPTION AND COMMENTS
	1		$\frac{4.8}{5.0}$	0.0-0.5 (1245) 0.5-2.0 (1248) 2.0-4.0 (1250)	CH	▨	0.0-5.0 FT, (CH) CLAY, trace fine gravel; dark brown; damp, stiff.
5	2	NA	$\frac{1.8}{5.0}$		CL	▨	5.0-9.5 FT, (CL) SANDY CLAY, trace fine gravel; brown; very moist, soft.
10					CH	▨	9.5-11.0 FT, (CH) CLAY, trace fine gravel; dark brown; damp, stiff.
	3		$\frac{5.0}{5.0}$		CL/GC	▨	11.0-13.5 FT, (CL/GC) gravelly CLAY, trace silt; brown, gray and reddish yellow mottling; damp, stiff.
						▤	13.5-14.5 FT, SHALE; dark gray, yellowish red mottling, weathered, friable; dry, stiff.
						▤	14.5-15.0 FT, SHALE; dark gray; dry, very stiff.
15							End of borehole at 15 FT BGS Borehole completed with above ground monitoring well and protective steel casing. See well construction log for well installation and completion information.

PROJECT No: 130-2086
PROJECT: Exide Frisco
LOCATION: Truck Wash Station
COMPILED BY: BEF
CHECKED BY: JDJ
REVIEWED BY: JW

Golder Associates

LOG OF DGW-MW-9

DATE/TIME: 5/16/2018, 1535 - 1605
TOTAL DEPTH: 25 FT BGS
DRILLING METHOD: Direct Push/HSA
DRILLER: West Drilling, Gus Alejandro
RIG: CME-75
NORTHING: 7,101,771 FT
EASTING: 2,480,655 FT
SURFACE ELEVATION: 642.22 FT AMSL

DEPTH (Feet)	RUN No.	PID (PPM)	REC (Feet)	SAMPLE	USCS	GRAPHIC LOG	DESCRIPTION AND COMMENTS
	1		3.0/5.0		SC	▨	(0.0-9.0) (SC) CLAYEY SAND, fine sand, low to medium plastic fines; moderate brown (5YR 3/4); non-cohesive, dry, compact.
5	2		3.0/5.0			▨	(5.0) Increasing fines content
					CH	▨	(9.0-10.0) (CH) sandy CLAY, high plastic fines, fine sand; dark yellowish brown (10YR 4/2); cohesive, W<PL, stiff.
10	3		5.0/5.0		CH	▨	(10.0-12.5) (CH) CLAY, high plastic fines, trace fine sand; dusky yellowish brown (10YR 2/2); cohesive, W<PL, stiff.
					CH	▨	(12.5-15.0) (CH) sandy CLAY, high plastic fines, fine sand; brownish gray (5YR 4/1); cohesive, W<PL, soft.
15	4		5.0/5.0		CH	▨	(15.0-16.0) (CH) sandy CLAY, high plastic fines, fine sand; brownish gray (5YR 4/1); cohesive, W<PL, stiff.
					CH	▨	(16.0-20.0) (CH) gravelly CLAY, high plastic fines, fine to coarse well graded sub-rounded to sub-angular gravel, some fine sand; brownish gray (5YR 4/1), iron staining; cohesive, W~PL, stiff.
20	5		5.0/5.0		CH	▨	(20.0-22.0) (CH) sandy CLAY, high plastic fines, fine sand, some fine sub-rounded to rounded gravel; brownish gray (5YR 4/1); cohesive, W~PL, soft.
					CH	▨	(22.0-24.0) (CH) sandy gravelly CLAY, high plastic fines, fine sand, fine to coarse well graded gravel; pale yellowish brown (10YR 6/2); cohesive, W~PL, very stiff.
						☰	(24.0-25.0) SHALE; dark gray (N3); moist, very stiff.
25							END OF BORING AT 25 FEET BELOW GROUND SURFACE.
30							
35							

PROJECT No: 130-2086-06
PROJECT: Exide Frisco
LOCATION: Near Admin Building
COMPILED BY: BCW
CHECKED BY: PJJ
REVIEWED BY: THR/AMF

APPENDIX B

STANDARD OPERATING PROCEDURES

TECHNICAL GUIDELINE FOR MANUAL GROUNDWATER LEVEL MEASUREMENT

TG-1.4-6a

Rev. #5
8/21/2009

Table of Contents

List of Exhibits

TG-1.4-6a Manual groundwater level measurement

1.0 PURPOSE

This technical guideline is to be used to establish a uniform procedure for measuring groundwater levels in borings, drill holes, monitoring wells, and piezometers, by manual methods using an electric water-level sounder.

An alternate technical guideline (TG-1.4-6b, “Automated Groundwater Level Measurement”) is to be used in conjunction with this guideline when making automatic water-level measurements using a pressure transducer and datalogger system.

2.0 APPLICABILITY

This technical guideline is applicable to all personnel measuring water levels in wells manually using a calibrated electric water-level sounder. It is not applicable to the measurement of water levels in flowing (Artesian) wells, unless sufficient additional casing is added to prevent the flowing conditions.

This guideline is not applicable for the measurement of water levels by other methods, such as wetted tape, air line, or pressure transducer.

3.0 DEFINITIONS

3.1. Electric Water Level Sounder

An instrument for manually measuring water levels in wells or boreholes. Electric water-level sounders are available in a variety of different types, but each works in essentially the same way, and consists of an open circuit involving a battery, ammeter, bulb, and/or audible beeper mounted within a reel of insulated two-wire electric cable. At the end of the two-wire cable is a weighted metal probe containing a partly-shielded electrode. The cable is graduated or marked to indicate the length of cable above the tip of the electrode in the probe. The circuit is closed when the exposed electrode in the probe is immersed in water. Current flow through the closed circuit is registered on the meter by illumination of the bulb and/or sounding of the beeper on the reel. This indicates that the probe has contacted water. Some sounders may have a sensitivity adjustment.

3.2. Well or Borehole

For the purpose of this guideline, any hole in the ground (cased or open) that may contain groundwater, e.g., a boring, borehole, drill hole, test pit, water well, monitoring well, observation well, pumping well, or standpipe piezometer.

3.3. Measuring Point (MP)

A reference or datum established to provide a consistent point from which the water level is measured, usually a mark on the casing at the top of a well or borehole. The elevation of the measuring point should be established by surveying (differential leveling) from a bench mark of known elevation above the local or national vertical datum. The elevation of the measuring point should be established to an accuracy of 0.01 ft or better. Use of the ground surface as a measuring point is acceptable for measuring water levels in wells and boreholes during drilling, and in other situations (e.g., test pits) where no other stable reference point is available. The measuring point should be clearly described in the field notes so that measurements to the same reference point can be reproduced, if necessary.

3.4. Diptube

A small-diameter (1- to 2-inch) tube (usually PVC) with slots over the lower 1 or 2 feet that is placed in a pumping well to provide a stilling effect that counteracts turbulence.

3.5. Pressure Transducer

A piece of electronic equipment used for measuring pressure (see TG-1.4-6b).

3.6. Datalogger

An electronic unit designed to collect and store data from a pressure transducer (see TG-1.4-6b).

3.7. Wetted Tape

Use of chalk on a measuring tape to sound the depth of water in a well. (This method is no longer in common use.)

4.0 DISCUSSION

4.1. Accuracy, Precision and Repeatability

The prime objectives in measuring a groundwater level are to obtain the depth to groundwater below a measuring point of known elevation, at a specific time, and in a manner that is both precise, accurate and repeatable (if the water level is static). Measurement precision of 0.01 ft is achievable with the fully graduated tapes available on modern electric water-level sounders. However, practical difficulties of calibrating long sounder tapes (e.g., >500 feet), and their sensitivity to stretching, reduce the accuracy of readings to, at best, 0.05 ft. This is usually adequate for most practical purposes. However, if a fixed measuring point is not available and the measurement is made in relation to the ground surface, this degree of accuracy and precision is not practical. Measurements made to ground surface should be recorded to the nearest 0.5 or 1.0 foot, and noted in the water-level record.

4.2. Measurements in Pumping Wells

Turbulence caused by pumping can make measurements of dynamic water levels difficult in wells that are being pumped. In this situation, a small-diameter diptube can be used to act as a stilling well. Measurements should be made inside the tube, provided it is long enough for the end of the tube to be submerged by at least 5 ft. If the top of the diptube is higher than the measuring point, this may be used as an alternate measuring point, but the difference must be recorded in the field notebook and on the Water Level Reading Forms (Exhibit A).

4.3. Potential Sources of Error

Be aware of the potential sources of error that can affect water-level measurements:

- Dirt, scum, oil, or floating product on the water surface can affect closure of the electric circuit in the water-level probe.
- The meter may not register if the electrical conductivity of the water is extremely low (e.g., deionized water).
- Cascading water, leaking casing, drilling mud, or excessive condensation in the wellbore can cause the water-level probe to signal contact with water before the probe encounters the static water level in the well. This effect may be overcome using the sensitivity adjustment (if

available).

- Changes in air pressure can cause small fluctuations in the water level.
- The water-level probe will not produce a signal if the battery is flat, if the switch on the reel is in the “Off” position, or if the sensitivity adjustment is set too low.
- In very deep wells (i.e., over 500 ft), the measurement of the water levels may be affected by non-verticality of the well, and by stretching of the electrical sounder tape.
- It is all too easy to misread the calibrated tape. Check each reading again immediately after noting it down.

4.4. Care of the Equipment

The electric water-level sounder is an expensive piece of equipment that should be treated with care:

- Avoid situations where the probe may become caught or stuck down-hole, for example, near casing centralizers or pump riser columns.
- Exercise control over the tape as it unwinds, especially into deep and/or uncased holes.
- Avoid abrasion of the electric tape against the lip of the casing: this causes excessive wear and eventual failure of the electric wires inside the tape.
- Rewind the tape evenly with markings visible, and avoid twisting or pulling on the tape.
- Clean and dry the tape and probe as they are removed from each well.
- Replace the probe in its protective sleeve (if available) after cleaning.
- Store the electric water-level sounder in a clean and dry, secure place.

5.0 RESPONSIBILITY

5.1. Field Engineer/Geologist/Hydrogeologist/Technician

Responsible for making and recording measurements in compliance with this technical guideline and taking reasonable care of the equipment while it is in their possession.

5.2. Task Leader

Responsible for:

- Direct supervision of personnel taking the measurements
- Designation of measuring points on wells or boreholes
- Determination of the maximum cable length required for the electric water-level sounder
- Guidance on the purpose, number, timing, and/or frequency of water-level measurements required
- Assurance that equipment and materials are available to complete the task

5.3. Equipment Manager (Where Applicable)

Responsible for:

- Maintenance of the electric water-level sounder in full working order
- Replacement or repair of damaged tape, probe, or other malfunctioning parts of the sounder
- Periodic calibration of the sounder tape to ensure markings are correct
- Procuring, checking, calibrating, and returning any water-level sounder obtained by rental.

6.0 EQUIPMENT AND MATERIAL

- Electric water-level sounder with integral cable of sufficient length for the well(s) being measured.
- Field notebook and/or appropriate Water Level Reading forms (Exhibit A).
- Data on well locations, identification number, depth, measuring point description and elevation above survey datum, and previous or most recent water-level measurements (if available).
- Decontamination solution, distilled/deionized rinse water, and a clean cloth or paper towels.
- Indelible ink pens.
- Spare battery for electric water-level sounder.

7.0 GUIDELINE

- Each water level probe or measuring tape used for recording water levels shall have the depth graduations calibrated by the Equipment Manager. Confirm that calibration is current by checking the “next due” date on the calibration sticker located on the equipment.
- Record project number, project name, location, and state.
- At each well, record the date, time, well identification number, measuring point description (e.g., top of PVC casing), measuring device type, manufacturer, and serial number and Golder equipment identification number (if applicable).
- Clean all downhole instruments and equipment before and after measurements and between wells with a non-phosphate detergent rinse followed by a rinse with approved tap water, then rinse with organic-free distilled/deionized water. The probe should be dried with a clean cloth or paper towel after cleaning.
- At least once at each well: measure and record the approximate distance from ground level to the measuring point. Measure the vertical distance from the top of casing, standpipe, monument, or other relevant points of reference to the measuring point, as appropriate.
- Turn on the electric water-level sounder, check the battery using the test switch or button, lower the probe into the well and stop at the depth where the bulb or audible beeper indicates a completed circuit. Raise and lower the water-level sounder a small distance to break and remake the circuit, confirming that the water level can be repeatedly identified, and carefully establish the point at which the sounder circuit just closes. Record the length of the tape

below the measuring point by reading the value indicated on the tape directly level with the measuring point, to the nearest 0.01 ft.

- Enter all water level measurements in a field notebook, or directly on a Water Level Readings Form (Exhibit A). The personnel making the measurement should initial or sign each measurement recorded, and make any additional comments pertinent to the data collected.
- If a field notebook is used, water-level measurements should be carefully transferred to a Water Level Readings Form (Exhibit A), if required, at the earliest convenient time. All water level measurement records shall be maintained in the project records files.
- Water-level measurements should be tabulated in a spreadsheet or entered into an electronic database file for project use. The spreadsheet or database should facilitate the calculation of water levels as elevations relative to the appropriate survey datum. New water levels should be reviewed for consistency with previous measurements from the same location (for example, by plotting a hydrograph). Significant deviations that lack a clear physical cause (e.g., seasonal recharge, influence of pumping, borehole construction changes, use of packers or slug tests, barometric influences, etc.) should be investigated. If necessary, spurious water-level measurements should be retaken and erroneous values annotated in the data record.

8.0 REFERENCED GUIDELINES

Golder Technical Guideline TG-1.4-6b, “Automated Groundwater Level Measurement”.

9.0 ADDITIONAL GUIDELINES AND PROCEDURES

Driscoll, F.G., 1986. Groundwater and Wells. (2nd Edition) Johnson Filtration Systems Inc., St. Paul, Minnesota.

American Society for Testing and Materials, 2001. Standard Test Method for Determining Subsurface Liquid Levels in a Borehole or Monitoring Well (Observation Well), ASTM D-4750-87(2001).

EXHIBIT A

Golder Associates

RECORD OF WATER LEVEL READINGS

Project Name: ____________________________ **Location:** _____________________________________ **Project No.:** ______________________________

Borehole No.	Date	Time	Measuring Device / Serial No.	Measurement Point (M.P)	Water Level Below M.P.	Correction To Survey Mark	Survey Mark Elevation	Water Level Elevation	By	Comments

Sheet ___ of ___

TECHNICAL GUIDELINE FOR
CHAIN OF CUSTODY
TG-1.2-23
Rev. #2
8/20/2009

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List of Exhibits

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TG-1.2-23 Chain of Custody

1.0 PURPOSE

This technical guideline establishes the requirements for documenting and maintaining environmental sample chain of custody from point of origin to receipt of the sample at the analytical laboratory.

2.0 APPLICABILITY

When specifically invoked by project work plans, sampling plans, or QA plans, this technical guideline shall apply to all types of air, soil, water, sediment, biological, and/or core samples to be analytically tested in support of environmental investigations by Golder Associates Inc., and is applicable from the time of sample acquisition until custody of the sample is transferred to an analytical laboratory.

3.0 DEFINITIONS

3.1. Custody

Custody refers to the physical responsibility for sample integrity, handling, and/or transportation. Custody responsibilities are effectively met if the samples are:

- in the responsible individual's physical possession;
- in the responsible individual's visual range after having taken possession;
- secured by the responsible individual so that no tampering can occur; or
- secured or locked by the responsible individual in an area in which access is restricted to authorized personnel.

3.2. Chain of Custody

Chain of custody refers to the history of the physical transfer of samples between the sampler, the transporter, or carrier, and the laboratory technician. Chain of custody documentation is required as evidence that the integrity of samples was maintained during transfer.

4.0 DISCUSSION

Environmental samples must be tracked, handled and transported in a manner such that sample integrity and identification (to the location and interval at which they were obtained) is maintained. The sample custodian must maintain proper storage and custody of samples from the time of collection until transport to the laboratory. The sampler shall initiate Chain of Custody forms which accompany samples from the collection site to the laboratory and provide documentation of any transfer of custody throughout transport. Sample identification and integrity shall be ensured by the application of seals and labels to the sample containers at the time of sample collection. Seals and labels shall be verified upon receipt of samples at the analytical laboratory; unacceptable samples shall be identified on the Chain of Custody form, and referred to the Geologist/Field Engineer or Project Manager for evaluation and appropriate disposition.

5.0 RESPONSIBILITIES

5.1. Project Manager

The Project Manager is responsible for the overall management of environmental sampling activities, for designating the sample shipment method (considering permitted sample holding times), for delegating sampling responsibilities to qualified personnel, and reviewing any Field Change Requests that may be initiated during the investigation.

5.2. Geologist/Field Engineer

The Geologist/Field Engineer is responsible for: 1) providing general supervision of sampling operations as directed by the Project Manager; 2) ensuring proper temporary storage of samples and proper transportation of samples from the sampling site to the laboratory; and 3) initiating Field Change Requests when required. The Geologist/Field Engineer is also responsible for tracking Chain of Custody forms for samples to ensure timely receipt of the completed original, for reviewing Chain of Custody forms to ensure appropriate documentation of sample transfers, and for advising the Project Manager of any problems observed that are related to sample integrity and chain of custody. The Geologist/Field Engineer may delegate document tracking and review responsibilities to suitably qualified personnel.

5.3. Sampler

The sampler may be the same individual as the Geologist/Field Engineer and is responsible for: 1) sample acquisition in compliance with applicable guidelines and procedures; 2) checking sample integrity and documentation prior to transfer; 3) initiating the Chain of Custody form; 4) maintaining custody of the samples while completing the sampling project; and 5) physically transferring the samples to the transporter or directly to the laboratory.

5.4. Laboratory Sample Custodian

The laboratory sample custodian or designated sample receiving technician is responsible for: 1) inspecting transferred samples to ensure that seals are intact, that labels are affixed, that sample condition is acceptable, and that Sample Integrity Data Sheets are completed, when required for a particular project; 2) completing the Chain of Custody form upon receipt; 3)forwarding copies of the completed Chain of Custody form to the Project Manager; and 4) segregating and identifying unacceptable samples, and subsequently notifying the Golder Project Manager.

5.5. Document Custodian

The document custodian (project manager or administrative assistant) is responsible for maintaining completed Chain of Custody forms in the project files.

6.0 EQUIPMENT AND MATERIALS

- Seals and labels (Exhibit A)
- Sample Integrity Data Sheets (Exhibit B), if required by the applicable sampling procedure, work plan, sampling plan, or quality assurance (QA) plan, or if requested by the Project Manager
- Chain of Custody forms (Exhibit C)
- Field Change Request form (Exhibit D)
- Packing and shipping materials, which may include coolers or insulated packing boxes, ice, "blue ice" or dry ice, cardboard packing boxes, wooden core storage boxes, and shipping labels. If dry ice is used, caution should be used so that samples do not freeze resulting in broken jars and negative impact to other samples in the same carrier.

7.0 GUIDELINE

7.1. Seals, Labels, and Initial Storage

At the time of collection, all samples shall be sealed, labeled, and appropriately stored in the custody of the sample custodian as defined in 3.1 above. Examples of standard seals and labels are included in Exhibit A.

7.2. Sample Packaging

All samples shall be packaged appropriately for shipping to protect them from damage, to ensure that moisture content is maintained where necessary, and to ensure that appropriate temperatures are maintained as required. All sample shipping containers shall be sealed (see Exhibit A) to prevent tampering.

Environmental core sample boxing, marking, and labeling shall be in compliance with TG-1.2-2, "Geotechnical Rock Core Logging." Other types of environmental samples stored in jars or bottles may be packaged in insulated coolers, or, if sample temperature is not a concern, in the original sample container packing boxes. Where cooling is required, samples shall be shipped in insulated coolers containing bagged or pre-packaged ice sufficient to keep the samples at 4°C ± 2°. All samples should be carefully placed in the appropriate container(s) and packaged with paper or bubble-wrap to prevent significant movement or breakage during transport.

Samples from boreholes shall be packaged, where appropriate, by placing the jars in shipping containers from the top right corner downward, and from left to right, beginning with the first sample taken as shown in Figure 8-1. An alternative packaging order may be appropriate to isolate contaminated samples to minimize the risk for cross-contamination.

A label containing the following information should be affixed to the front of each shipping container containing environmental samples:

- Project Number
- Location
- Borehole number(s) (if appropriate)
- Date collected
- Sample numbers enclosed

Boxes should be numbered consecutively; the last box from a borehole or drillhole shall also be identified "EOH," (i.e., end of hole).

7.3. Sample Examination

Prior to transfer of samples, the sampler shall ensure that:

- labels and seals are affixed and completely filled out;
- Chain of Custody documentation corresponds to the samples in the shipment;
- special handling and storage requirements are identified where required;
- Sample Integrity Data Sheets are available where required by applicable sampling guidelines or the Project Manager;

- there are no indications of sample container leaks or other questionable conditions that may affect the integrity of the sample; and
- hazardous and/or radioactive samples are clearly identified as such.

Samples that do not meet the requirements for initial transfer shall be referred to the Geologist/Field Engineer or Project Manager for disposition.

7.4. Chain of Custody Form Initiation

The sampler shall initiate the Chain of Custody form (Exhibit C) for the initial transfer of samples. Chain of Custody forms supplied by the analytical laboratory may be used in lieu of the form shown in Exhibit C. At a minimum, the following information shall be entered on the form:

- the destination of the samples and the transporter or carrier;
- the project identification and sampling site;
- the date and time of sample collection;
- the sample identification numbers and descriptions (e.g., media, container);
- analysis required for samples included in the shipment; and
- QA and reporting instructions for the laboratory.

When all required information has been entered the sampler shall sign and date the Chain of Custody form as the initiator.

7.5. Transfer of Custody

To document the initial transfer of samples, the sampler relinquishing custody and the transporter accepting custody shall sign, date, and note the time of transfer on the Chain of Custody form. If the transporter is not an employee of Golder Associates Inc., the sampler may identify the carrier and reference the bill of lading number in lieu of the transporter's signature. The Chain of Custody form should be in triplicate. One copy of the Chain of Custody form shall be forwarded to the Geologist/Field Engineer by the sampler. The original form and the remaining copy shall accompany the samples.

7.6. Receipt at Destination

The laboratory sample custodian shall inspect the transferred samples to ensure that:

- the seals are intact;
- the labels are affixed and legible;
- Sample Integrity Data Sheets are available where required;
- the physical condition of the samples is acceptable; and
- the samples being transferred directly correspond to those listed on the Chain of Custody form.

If the integrity of the samples is questionable, the laboratory technician shall notify the Golder Project Manager, segregate the unacceptable samples and identify them on the Chain of Custody Form. Otherwise, the laboratory sample custodian and the transporter shall sign, date, and note the time of transfer on the Chain of Custody form. If the transporter is not an employee of Golder Associates Inc., the laboratory sample custodian may identify the carrier and reference the bill of lading number in lieu of the transporter's signature. The laboratory sample custodian shall retain the remaining copy of the Chain of Custody form and forward the original signed copy to the Geologist/Field Engineer. Appropriate laboratory custody procedures shall be initiated upon completion of transfer of custody in compliance with the laboratory's internal QA program requirements.

7.7. Document Tracking

The copy of the Chain of Custody form recording the initial transfer of samples shall be forwarded to the Geologist/Field Engineer, followed by the completed original. The Geologist/Field Engineer shall track the Chain of Custody form to ensure timely completion and receipt of the original, based on the laboratory acknowledgement due date indicated on the form and/or subcontractor agreement.

After receipt of the completed original, the Geologist/Field Engineer may discard the copy. The completed original Chain of Custody form shall be placed in the project files. Chain of Custody forms determined to be overdue or incorrectly completed shall be referred to the Project Manager for appropriate action.

7.8. Field Change Request

Variation from established guideline requirements may be necessary due to unique circumstances encountered on individual projects. All variations from established guidelines shall be documented on a Field Change Request form (Exhibit D) and reviewed by the Project Manager.

The Project Manager may authorize individual Geologist/Field Engineers to initiate necessary variations. If possible, the request for variation shall be reviewed by the Project Manager prior to implementation. If prior review is not possible, the variation may be implemented immediately at the direction of the Geologist/Field Engineer, provided that the Project Manager is notified of the variation within 24 hours of the implementation, and the Field Change Request is forwarded to the Project Manager within 2 working days of implementation. If the variation is unacceptable to either reviewer, the activity shall be redone or action shall be taken as indicated in the comments section of the reviewed Field Change Request. All completed Field Change Requests shall be maintained in project records.

8.0 REFERENCED GUIDELINES

Golder Associates Technical Guideline TG-1.2-2, "Geotechnical Rock Core Logging."

9.0 ADDITIONAL GUIDELINES AND PROCEDURES

EPA, 2002, “Standard Operating Procedure for Chain of Custody of Samples,” EPA Region 1 Office of Environmental Measurement and Evaluation, North Chelmsford, Massachusetts.

American Society for Testing and Materials, 2004. Standard Guide for Sampling Chain-of-Custody Procedures, ASTM D-4840-99(2004).

Figure 8-1

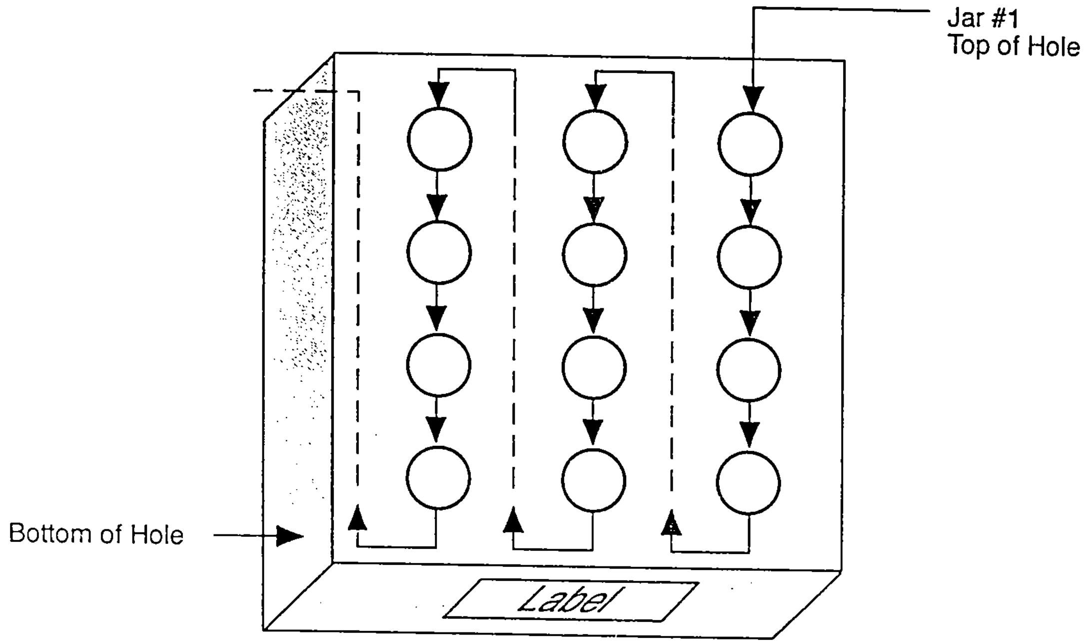

FIGURE **8-1**
SAMPLE CONTAINER PACKING ARRANGEMENT
TP-1.2-23

PROJECT NO IP3 1024.200 DRAWING NO. 66972 DATE 8/15/96 DRAWN BY EA

Golder Associates

EXHIBIT A

Golder Associates

Location ____________________
Job No. ________ Date __________
Boring No. ______ Sample No. ______
Depth ________ Blows __________
Description ____________________
____
____
____
Driller ________ Engr. __________

Golder Associates

Sample I.D. No.

Date ________ Time __________
Station ________ Depth __________
Media ____________________
Preservative ____________________
Sampled by ____________________

Golder Associates Sent By: __________
Seal Number
2455
Date: __________
Golder Associates

EXHIBIT **A**
SEALS AND LABELS
TP-1.2-23

PROJECT NO.IP3-1024 DRAWING NO. 67021 DATE 8/7/96/96 DRAWN BY DD

Golder Associates

EXHIBIT B

SAMPLE INTEGRITY DATA SHEET

Plant/Site ______________________ Project No. ______________

Site Location ______________________ Sample ID ______________

Sampling Location ____

Technical Procedure Reference(s) ______________________________

Type of Sampler ____

Date ________________ Time ______________________

Media ________________ Station ______________________

Sample Type: grab time composite space composite

Sample Acquisition Measurements (depth, volume of static well water and purged water, etc.)

Sample Description ____

Field Measurements on Sample(pH, conductivity, etc.) ______________________

Aliquot Amount	Container	Preservation/Amount

Sampler (signature) ______________________ Date ______________

Superviser (signature) ______________________ Date ______________

Golder Associates

EXHIBIT **B**

Sample Integrity Data Sheet

TP-1.2-23

PROJECT NO. IPE-1024 DRAWING NO. 67020 DATE 7/17/96 DRAWN BY DD

Golder Associates

EXHIBIT C

CHAIN OF CUSTODY RECORD

PROJ. NO.

SITE/LOCATION

SAMPLERS: *(Signature)*

STA. NO.	DATE	TIME	SAMPLE TYPE	MEDIA	SAMPLE IDENTIFICATION	NO. OF CON-TAINERS	AMOUNT/ PRESERVATIVE						SEAL NO.	SEAL INTACT ? (Y or N)	REMARKS (with initials)

Relinquished by: *(Signature/Firm)*	Date/Time	Received by: *(Signature/Firm)*	Relinquished by: *(Signature/Firm)*	Date/Time	Received by: *(Signature/Firm)*
Relinquished by: *(Signature/Firm)*	Date/Time	Received by: *(Signature/Firm)*	Relinquished by: *(Signature/Firm)*	Date/Time	Received by: *(Signature/Firm)*
Relinquished by: *(Signature/Firm)*	Date/Time	Received by: *(Signature/Firm)*	Date/Time	Remarks (attachments if necessary)	

EXHIBIT **C**

CHAIN OF CUSTODY FORM

TP-1.2-23

PROJECT NO. IP3 1024 DRAWING NO. 67019 DATE 7/17/96 DRAWN BY CB

Golder Associates

EXHIBIT D

FIELD CHANGE REQUEST

Golder Associates

Job/Task Number:

Other Affected Documents:

Requested Change:

Reason for Change:

Change Requested by: Date

Reviewed by: Date
GAI Project Manager

Comments:

Reviewed by: Date
GAI QA Manager

Comments:

Golder Associates Inc.

EXHIBIT **D**

FIELD CHANGE REQUEST FORM

TP-1.2-23

PROJECT NO. IP3 1024 DRAWING NO. 67018 DATE 7/17/96 DRAWN BY CB

Golder Associates

TECHNICAL GUIDELINE FOR
COLLECTION OF GROUNDWATER QUALITY SAMPLES

TG-1.2-20

Rev. #3
8/20/2009

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TG-1.2-20 Collection of groundwater quality samples

1.0 PURPOSE

This technical training guideline establishes a standard methodology for collecting groundwater samples for chemical analysis that are representative of aquifer water quality.

2.0 APPLICABILITY

This technical training guideline is applicable to field personnel engaged in the collection of groundwater samples from wells for purposes of chemical analysis. This document should be read in conjunction with any and all regulatory, workplan, order, client specific, and other project-specific guidelines.

3.0 DEFINITIONS

3.1. Dedicated Pump System

A dedicated pump system is a permanently installed device for removing water from a well. The system is not removed from the well and does not have the potential to become cross-contaminated between uses.

3.2. Well Bore Storage Volume

Well bore storage volume is defined as the volume of water enclosed by the well casing and screen gravel/sand pack at equilibrium.

3.3. Bailer

A bailer is a tubular device with a check-valve at the top and/or bottom for collecting and removing groundwater from wells.

3.4. Non-Dedicated Sampling Apparatus

Non-dedicated sampling apparatus is sampling equipment that may contact groundwater samples from more than one well. This term is also used to describe equipment that is only used for sampling a single well, but is removed from the well and could potentially become contaminated.

3.5. Groundwater Sample

A groundwater sample is defined as water acquired from a well for analyses of chemical or biological parameters that is representative of groundwater within the aquifer or the portion of the groundwater in the subsurface being sampled.

3.6. Positive Pressure Pump

A positive pressure pump is a device for removing water from a well by forcing water to the surface through positive pressure when operated below the well's water level. A positive pressure pump may be operated electrically, mechanically, or by gas pressure. Submersible impeller, bladder, and check valve pumps are common types of positive pressure pumps.

3.7. Negative Pressure Pump

A negative pressure pump is a device for removing groundwater from a well by suction (negative pressure). Peristaltic and centripetal pumps are common types of negative pressure pumps. The limitation for lifting water by suction is usually 20 to 25 feet. These pumps are typically only acceptable for non-volatile analytes and analytes that are not affected by aeration or changes in pH or pressure. They are useful as purging devices for shallow groundwater wells.

3.8. Sample Bottles

Sample bottles are containers specifically designed and prepared for storing aliquots of a sample. Sample container type, material, size, and type of lid are specific for particular groups of analytes. Sample bottles must typically be properly cleaned and prepared by a certified laboratory.

3.9. Acceptable Material

Acceptable materials are defined as the only materials that are allowed to contact groundwater samples, and are dependent on the analytes being tested.

3.10. Permissible Pump

Permissible pumps are defined as pump systems that have acceptable effects on water quality when used to obtain groundwater samples from wells. The use of permissible pumps is dependent on the analyses being conducted on the acquired samples. The parts of permissible pumps that will contact the groundwater sample contain only acceptable materials.

4.0 DISCUSSION

In order to generate appropriate, quality data using these guidelines, it is incumbent on the field personnel to have reviewed these guidelines as well as other referenced and/or pertinent technical guidelines. This document should be read in conjunction with any and all regulatory requirements, site-specific work plans, administrative orders, and client- specific or other project-specific guidelines.

Groundwater samples shall be collected in quantities and types as directed by the Project Manager and project work documents. If applicable, sampling or monitoring shall be conducted for any potential floating immiscible layers prior to well purging and sampling. All instruments used for field analyses shall be calibrated in accordance with appropriate guidelines. The guidelines in Golder Associates Quality Procedure QP-1, "Calibration and Maintenance of Measuring and Test Equipment" may be applicable, however it is important to be familiar with local regulatory and project-specific requirements.

All non-dedicated sampling equipment shall be decontaminated before and after each use. If directed by the Project Manager or as specified in project work documents, purge water and decontamination fluids shall be captured and contained for disposal. Samples shall be collected in properly prepared containers of the appropriate size and type (see Table 1). All samples shall be appropriately labeled and sealed (see Exhibit A) an appropriate groundwater sample collection forms (Exhibit B) must be used to document raw field information for each sample. Chain of custody (see Exhibit C) shall be maintained in accordance with guideline TG-1.2-23, "Chain of Custody." The Field Report Form (see Exhibit D) and Sample Integrity Data Sheet (see Exhibit E) and bound field notebooks shall be used to document daily site activities and sample collection. All variations from established guideline shall be documented on the Field Change Request (see Exhibit F) and shall be approved by the Project Manager.

5.0 RESPONSIBILITIES

5.1. Sampling Technician

The Sampling Technician is responsible for sample collection, sample custody in the field, preservation, field testing, total and accurate completion of data sheets, sample shipment and delivery of data to the Project Manager, all as described in this technical guideline.

5.2. Task Leader

The Task Leader is responsible for supervising Sampling Technicians. Supervision includes ensuring that samples are collected, documented, preserved, field analyzed, handled and shipped to the appropriate laboratory as specified in project work documents and this technical guideline. In many cases, the Task Leader will also fill the role of the Sampling Technician.

5.3. Project Manager

The Project Manager has overall management responsibilities for the project, is responsible for designing the sampling program, for arranging the logistics of the program, and for providing any required clarifications in the use of this guideline.

6.0 EQUIPMENT AND MATERIALS

If wells are equipped with permissible and dedicated pump systems, equipment to operate the dedicated pump systems (i.e., air compressor, compressed air or nitrogen cylinders, electric generator, etc.); non-dedicated sampling apparatus such as surface discharge tubing and valving; or bailer(s) for sampling free floating product may be necessary.

If wells do not have permissible and dedicated pump systems, permissible pump systems or bailers and accessories of small enough diameter to enter the wells will be necessary. All equipment that could contact the sample shall be made of acceptable materials.

Additional supplies should include: sample bottles, properly cleaned and prepared by a certified laboratory with preservatives appropriate for the parameters to be sampled.

Field test equipment

- multi parameter meter and calibration standards (meter should be capable of measuring pH, specific conductance, redox, dissolved oxygen and temperature);
- turbidity meter and calibration standards;
- flow through cell for collection of field measurements;
- Filtration apparatus (0.45 micron and prefilter), if necessary;
- Depth to water measuring device;
- Interface probe if necessary;
- Well specifications;
- Sample labels and seals (Exhibit A);
- Groundwater Sample Collection Forms (Exhibit B);
- Chain of Custody Forms (Exhibit C);
- Field Report Forms (Exhibit D);
- Sample Integrity Data Sheet (Exhibit E);
- Coolers and ice packs or wet ice contained in zippered plastic bags;
- HPLC/distilled/deionized/Type II water as necessary;

- Isopropyl alcohol;
- 1% solution of trace metal grade nitric acid;
- Cleaning equipment and solutions;
- Indelible ink pens;
- Field notebooks;
- Container(s) for capturing, containing, treating and measuring waste decontamination solutions, if necessary;
- OVA or OVM with accessories and calibration gases;
- As required, 55 gallon steel drums fitted with bung holes, or suitable vessels(s) for containing purged groundwater;
- Field Change Request (Exhibit F);and
- Appropriate PPE, notably suitable gloves for handling samples. Various gloves may react to potential contaminants, so glove selection should be made carefully prior to mobilizing to the field.

7.0 GUIDELINE

7.1. General Considerations

7.1.1. Regulatory Considerations

At most locations, groundwater sampling and the characterization and disposal of purge fluids are specifically regulated by local, or state regulations, or may have client specific requirements. All such client and regulatory requirements must be reviewed before groundwater sampling. At a minimum, the following actions must be taken:

Ensure that groundwater sampling is performed by an entity that meets all requirements for conducting such operations in that particular location; and

Ensure that all follow up well reports required by appropriate agencies are submitted to the appropriate authorities or in some cases that we have informed the client of such requirements.

7.1.2. Decontamination

All non-dedicated sampling equipment that may contact the sample must be decontaminated before and after each use. Non-dedicated pumps or bailers require decontamination of internal and external parts prior to being lowered into the well. Non-dedicated equipment shall typically first be washed with clean tap water (whose chemistry is known and acceptable), non-phosphate detergent (e.g., Alconox), and rinsed with clean tap water. For inorganic analytes 1% nitric acid solution shall be used for a second rinse. For organic analytes, reagent-grade isopropyl alcohol is often used for the second rinse. A final rinse with HPLC/distilled/deionized/Type II water shall complete the decontamination. At a minimum, all acid and isopropyl alcohol wash solutions must be captured (see Section 7.4.2).

7.1.3. Sample Quantities, Types, and Documentation

Samples shall be collected in quantities and types as directed by the Project Manager or as specified in the project work documents. The Field Report Form (Exhibit D) or field notebook and the Sample Integrity Data Sheet (Exhibit E) shall be used to document daily site activities and sample collection (see Section 7.5). Samples shall be transferred to the analytical laboratory under formal chain of custody, which shall be documented (Exhibit C) and maintained in accordance with guideline TG-1.2-23, "Chain of Custody".

7.1.4. Sample Containers

Table 1 provides a summary of the typical type and minimum size of the sample bottles, preservation, storage/handling requirements, and maximum holding times for some common chemical analyses performed on groundwater samples for environmental investigations. All sample bottles must be properly cleaned and prepared by a certified laboratory. All groundwater samples shall be labeled and typically sealed (see Section 7.5) and immediately placed in coolers that have been pre-cooled to 4°C or less and that have securely closed lids for storage and transport. Samples must be received by the analytical laboratory in sufficient time to conduct the requested analyses within the specified holding time. All samples should be placed on ice and stored at 4°C immediately following sampling unless otherwise indicated in the site-specific work plan.

7.1.5. Acceptable Materials

The choice of materials used in the construction of sampling devices should be based upon knowledge of what analytes may be present in the sampling environment and how the sample material may interact.

Typically acceptable materials that may contact groundwater sample are stainless steel and fluorocarbon resin (Teflon, PTFE, FEP, or PFA). Glass is an acceptable material for contacting some samples. Plastics (PVC, polyethylene, polypropylene, tygon) are an acceptable material for contacting some samples, often when the analyses are for inorganic analytes (metals, radionuclides, anions, cations).

7.1.6. Sample Acquisition

Groundwater samples shall typically be removed from the well with the use of a permissible pump or bailer. Electric positive-pressure pumps made of acceptable materials as defined in Section 3.0 are permissible to use for acquiring any groundwater sample. Gaseous, typically air or nitrogen pressure activated positive-pressure pumps made of acceptable materials are permissible to use for acquiring any groundwater sample if the gas does not contact the sample. Positive-pressure pumps operated by mechanically forcing water through check valves are often permissible for acquiring any groundwater samples. Bailers made of acceptable materials are permissible for acquiring groundwater samples in some circumstances.

Peristaltic pumps and air-lift pumps are not preferred for acquiring groundwater samples but are often permissible when samples are to be analyzed for analytes that are not affected by aeration, and are not affected by changes in pH or pressure.

Other types of pumps (peristaltic, centrifugal, air lift, recirculation, etc.) may typically be used for purging groundwater from wells prior to sample acquisition, if: (1) pump materials contacting well water are acceptable; (2) pumping does not aerate or change the pH of the remaining well water; and (3) pumped water does not mix with remaining well water during pumping or after the pumping is stopped.

The appropriate pump should be selected by the Project Manager prior to mobilizing to the field.

7.2. Groundwater Sample Acquisition

7.2.1. Floating or Sinking Non-Aqueous Fluids

Groundwater shall be examined for the presence of any floating or sinking non-aqueous fluids, in unknown situations or where they may be potentially present, at the direction of the Project Manager. If detected, they shall be sampled prior to purging any water from the well. An interface probe is often used for this purpose along with measurement of the liquid/water level. Guideline TG-1.4-6, "Water Level Measurement" may be applicable. A bailer (preferably with a check valve at the bottom only and made of transparent Teflon or glass) may be lowered into the well to retrieve a sample of floating non-aqueous fluid. The bailer shall not become completely submerged. A sample of sinking non-aqueous fluid can often be obtained using a stainless steel device designed specifically for discrete interval sampling. If a non-aqueous fluid is sampled, it may be transferred to a 40 ml or 125 ml glass vial with an air-tight, Teflon-lined septum cap. The sample shall not be filtered or preserved with additives, but shall typically be placed in a metal can with vermiculite and then in a cooler that has been pre-cooled to 4°C and secured for storage and transport. There are often very stringent requirements for transport of such samples.

7.2.2. Purging the Well

It is often preferable to conduct well purging using a low flow/low stress methodology. Purging shall be conducted by starting the pump at its lowest setting and slowly increasing the pumping rate until flow occurs (typically flow rates on the order of 0.1 to 0.4 l/min). Ideally at this pumping rate, there should be a minimum level of water level drawdown (generally less than 10 cm). Monitor and record the pumping rate and water level as appropriate during purging. During purging, monitor indicator field parameters (e.g., turbidity, temperature, specific conductance, pH, ORP, DO) every three to five minutes. Purging is considered complete and sampling may begin when the indicator parameters have stabilized. Stabilization is considered to be achieved when three consecutive readings, taken on 3 to 5–minute intervals, are within the following tolerance:

- Turbidity (within 10% and preferably less than 5 NTU);
- Temperature (within 0.5 degrees C);
- Specific conductance (within 10%);
- pH (within 0.1 stnd pH units);
- ORP (within 10%); and
- DO (within 10%).

If the low flow/low stress methodology is not used, the pump or bailer shall be used and operated in accordance with the manufacturer's operational manual. Before collecting the actual groundwater sample field parameters of at least pH, redox, temperature, and specific conductivity should come to stabilize or approach asymptotical values. In general this will require that a minimum of three (3) well bore storage volumes of water shall be purged from the well by pumping. Calculate this volume by measuring the depth to water and subtracting this depth from the total depth of the well. If a gravel/sand pack surrounds the screen the pore volume of the gravel/sand pack (assume a porosity of 25 percent if unknown) shall be added to the total well volume. While purging water from the well, parameters specified by the Project Manager will be monitored.

A flow-through cell is advantageous for the monitoring of field indicators. Typically, if the parameters are within the ranges specified above, then the water has stabilized. Rarely are more than ten well volumes removed before sampling using these criteria. If the parameters of interest in the investigation include VOCs, care must be taken to ensure that purging does not induce degassing within the well. Where the well screen and sand pack are completely below the water table, the rate of purging should be controlled such that it does not draw the water level in the well below the top of the well screen. Where the well screen and sandpack are intersected by the groundwater level, the rate of purging should correspond with the rate of sampling, if continuous sampling methods are used. Large drawdowns in water table wells should be avoided. Purged groundwater that has a reasonable potential of containing hazardous substances shall be captured and characterized prior to discharge or disposal (see Section 7.4.1). Where a low yielding well is encountered, the Project Manager shall be contacted for direction (see Section 7.6).

7.2.3. Samples for Major Cation, Metal and Metallic Radionuclide Analyses

Samples for major cations and metallic radionuclide analyses are sometimes filtered immediately or within two hours after acquisition. However, most projects require that samples for cations are not filtered. Filtration is best accomplished with the use of an in-line filter system in which the sample is directly fed from the discharge port of permissible positive-pressure pump through the filter and into the appropriate sample bottle. A less preferred but acceptable method is the collection of an adequate amount of sample from a permissible positive-pressure pump or bailer into a properly cleaned and prepared high-density linear polyethylene or glass prefiltration bottle. The prefiltration bottle does not contain any chemical preservative. Aliquots shall be immediately fed through the filter and collected directly into the appropriate sample bottle. The final filter pore size should typically be 0.45 microns. (Note: New filters made of material specified by the Project Manager shall be used for each sample and the filter system must be decontaminated before and after each sample.) These groundwater samples shall be preserved with nitric acid (HNO3) to a pH less than 2. A new capillary tube can be used to remove fluid from the bottle and dabbed onto pH indicator paper to check that the pH is less than 2.

An unfiltered aliquot of a sample can typically be obtained (in addition to the filtered aliquot) directly from a permissible positive-pressure pump discharge port or from the bailer into appropriate sample bottles (see Table 1) and preserved with nitric acid to a pH less than 2. Note that for various cations, including chromium VI, no acid and typically no other chemical preservative is added to the aliquot.

7.2.4. Samples for Semi-Volatile Organics Including Extractable Base-Neutral/Acid Compounds, Phenolic Compounds, Pesticides, PCBs and Herbicides

Samples for semi-volatile organics including extractable base-neutral/acid compounds, phenolic compounds, PCBs, pesticides, or herbicides analyses shall typically be collected directly from a positive-pressure pump discharge port or bailer in appropriate sample bottles often with a Teflon lined lid and in some cases an appropriate chemical preservative. Sample should not be allowed to overflow the sample bottle and in the vast majority of cases shall not be filtered unless specified in a project-specific work plan.

7.2.5. Samples for Purgeable Volatile Organics

Samples for purgeable volatile organics are obtained before samples for other analytes have been acquired for each well. In wells with low productivity, volatile organics should be the first samples taken, unless otherwise directed by the Project Manager. Samples for purgeable volatile organics shall typically be obtained from the well using a permissible positive-pressure pump or bailer and shall be collected directly from the pump discharge tube or bailer into properly cleaned and prepared 40 ml vial.

The sample should not be allowed to overflow the sample bottle as this may remove acid preservative that is usually added at the laboratory either prior to sample shipment to the field or by field staff before filling the vials. The pH of the aliquot should be checked if acid preservative is used and the buffering capacity of the groundwater is high or unknown or more turbid than usual from a carbonate rich strata. A new capillary tube can be used to remove fluid from the bottle and dabbed onto pH indicator paper to check that the pH is less that specified by the methodology for acid preserved samples – often less than pH 2.

Air contact and sample agitation should be minimized. Pumping rates should be significantly reduced during sampling for volatile organics to reduce potential agitation of the sample. These samples shall not be filtered or preserved except as noted below. The bottle should be filled until there is a convex meniscus to facilitate an airtight seal when capped. Immediately after collection, a Teflon lined silicon septum cap shall be placed Teflon side down tightened onto the vial. There should be no air bubbles remaining within the vial once the cap has been fastened; if air is present, a new sample shall be taken by the same guideline.

Samples for many volatile methods are preserved with hydrochloric acid (HCl) to increase holding time. However, in some waters the acid will react with the sample producing bubbles due to production of carbon dioxide or sulfur compounds. If bubbles are found due to reactions with the acid, contact the Project Manager if this eventuality has not been described in the work plan. The Project Manager may require that samples are taken without acid preservative with the resulting shorter holding times. In this case a new unpreserved vial should be used. An unpreserved sample vial can be obtained by pouring the acid out of a preserved vial if no unpreserved vials are available. It is unlikely that the remaining acid will be sufficient to produce bubbles. However, if bubbles are still found one may slowly fill and empty the vial once or more times to remove the remaining acid. Samples that are not preserved should be noted as such on both the bottle labels and the Chain of Custody documents.

7.2.6. Samples for Cyanide Analyses

Samples for cyanide analyses shall be collected directly into appropriate sample bottles from the bailer or the port of a permissible positive-pressure pump. Samples shall not be filtered nor shall they be allowed to overflow the sample bottle. A pre-preserved bottle is typically made available. Otherwise, samples shall be immediately preserved with sodium hydroxide (NaOH) to a pH greater than 12. A new capillary tube can be used to remove fluid from the bottle and dabbed onto pH indicator paper to check that the pH is greater than pH 12.

7.2.7. Samples for Major Anion and Biological Oxygen Demand (BOD) Analyses

Samples for major anions (chloride, fluoride, sulfate, alkalinity, acidity, total silica, bromide) and for biological oxygen demand shall be collected directly into appropriate sample bottles from the port of the pump or from the bailer. These samples do not require filtration, but may be filtered if explicitly required in the sampling plan. Chemical preservatives shall only be added as required by the method.

7.2.8. Samples for Total Phosphate and Orthophosphate Analyses

Groundwater samples for total phosphate and orthophosphate analyses shall typically be immediately filtered after initial sample acquisition. However, these parameters often are specified to be taken without filtration. Filtration is best accomplished with an in-line system in which a positive-pressure pump discharge port feeds groundwater directly through the filter system into an appropriate sample bottle. A less preferred but acceptable method to obtain a filtered sample is to collect a liter of sample from a permissible positive-pressure pump or bailer in a properly cleaned and prepared high-density polyethylene or glass bottle, and then immediately feed the sample through a filter system (e.g., syringe filters) which discharges into the appropriate sample bottle. This process should be completed within two hours; otherwise, the results will be suspect. The final filter pore size shall typically be 0.45 micron. (Note: New filters made of most any material must be used for each sample and the filter system must be decontaminated before and after each use.) Samples shall be immediately placed on ice and preserved by cooling to 4°C or lower.

7.2.9. Samples for Total Phosphorus, Nitrogen Compounds, Chemical Oxygen Demand, Total Organic Carbon, and Total Organic Halogen Analyses

Groundwater samples for total phosphorus, nitrogen compounds, chemical oxygen demand, and total organic carbon analyses shall be collected directly into appropriate sample bottles from a permissible positive pressure pump discharge port or from the bailer. These samples shall not be filtered and shall be chemically preserved as required by the various methods.

7.2.10. Samples for Analysis of Total Dissolved Solids

Groundwater samples for analyses of total dissolved solids shall be immediately filtered in the field by methods discussed in Section 7.2.3 above or collected without filtration depending on sampling plan, and put directly into an appropriate sample bottle. Samples shall not be preserved with chemicals.

7.2.11. Samples for Oil and Grease or Hydrocarbons

Groundwater samples for oil and grease or hydrocarbons shall be collected directly into the appropriate sample container from the discharge port of a permissible positive pressure pump or from the bailer. These samples shall not be filtered and in some cases shall be preserved with hydrochloride acid (HCL, 1 + 1 Vol/Vol) to a pH less than 2. A new capillary tube can be used to remove fluid from the bottle and dabbed onto pH indicator paper to check that the pH is less than 2. Do not preserve with sulfuric acid due to potential interferences in the analytical procedure from co-extraction of elemental sulfur.

7.2.12. Samples for Fuel Fingerprinting

Groundwater sample for fuel fingerprinting shall be collected directly into the appropriate sample container using a permissible positive pressure pump or bailer and shall be collected directly from the pump discharge tube or bailer. Some guidelines require that the sample be allowed to overflow approximately 2 to 3 sample container volumes minimizing agitation and contact with air. These samples shall not be filtered but typically must be preserved to a pH <2 with HCL (1:1 vol/vol). A new capillary tube can be used to remove fluid from the bottle and dabbed onto pH indicator paper to check that the pH is less than 2. The sample container is then often capped with a Teflon lined silicon septum cap excluding all headspace. Otherwise the sample is often split into two or three aliquots for different analyses as dictated in the sampling plan or as specified by the Project Manager.

7.3. Field Analyses

7.3.1. Calibration of Instruments

All instruments used for field analyses shall be calibrated in accordance with guidelines required by the sampling and analysis plan; or by the most strict single guideline or combination of guidelines compiled from procedure QP-1, "Calibration and Maintenance of Measuring and Test Equipment;" or by the method or manufacturer's procedure. Only equipment with a calibration tag showing a validity date later than the anticipated date of use shall be taken to the field unless, as is usual, field calibration is performed. Each instrument should be accompanied by a copy of the manufacturer's operation manual and appropriate instrument calibration records.

7.3.2. Water Temperature

A meter and a flow though cell are the preferred tools for measuring this parameter. The meter shall be calibrated in accordance with the sampling plan, and if more stringent, with the manufacturer's procedures (provided with the instrument). If a meter is unavailable, a thermometer shall be used to measure the temperature of the water on an aliquot of purged water obtained just before sampling. The thermometer reading shall be allowed to stabilize and shall be recorded to the nearest 0.5°C. The thermometer shall be rinsed with distilled/deionized water before and after each use.

7.3.3. pH Measurement

A meter and a flow though cell are the preferred tools for measuring this parameter. Alternately, a pH meter may be used to measure the pH of the sample on an aliquot of purged water that was obtained just before sampling. Measurements shall be made immediately on the obtained aliquot. (Note: If possible, measure pH continuously on the purged water in an air-space free and closed flow-through system.) Calibration shall be in accordance with the sampling plan or, if more stringent, with the manufacturer's procedures (provided with the instrument). At a minimum, calibration shall be performed at the beginning and ending of each day's use and every four hours in between. Calibration shall be performed with standardized buffered pH solutions and conducted as required by the more stringent of the sampling plan or manufacturer’s specifications. Typically, the probe shall be thoroughly rinsed with distilled/deionized water after each sample when using a flow through cell or after each sample reading when the probe is placed in a discrete aliquot of sample. The pH shall be recorded to one-hundredth, if the meter is stable enough of a pH unit.

7.3.4. Conductivity Measurement

A meter and a flow though cell are the preferred tools for measuring this parameter. Alternately, a conductivity probe may be used for conductivity measurement on an aliquot of purged water obtained just before sampling. Measurements shall be made as soon as possible on the obtained aliquot. The meter shall be calibrated in accordance with sampling plan or, if more stringent with the manufacturer's procedures (provided with the instrument) with standardized calibration solutions. It is preferable to have a range of calibration solutions that bracket the site conductivity range. At a minimum calibration shall be performed at the beginning and ending of each day's use and every four hours in between. The conductivity shall typically be recorded to two significant figures and rarely more than three significant figures. The temperature of the sample at the time of conductivity measurement shall also be recorded. The probe must be thoroughly rinsed with distilled/deionized water before and after each use. It is imperative that the Sampling Technician record the correct units in which the conductivity measurements were taken.

7.3.5. Dissolved Oxygen Measurement

A meter and a flow though cell are the preferred tools for measuring this parameter. Alternately, a dissolved oxygen meter is used to measure dissolved oxygen (DO) in water samples. This test should be at best considered a rough estimation with most meters as the measurements are subject to a number of environmental interferences that may affect the results. Measurements shall be made immediately on aliquots obtained just before sample acquisition. (Note: If possible, measure DO continuously on the purge water in a closed flow-through system.)

The meter shall be calibrated in accordance with the sampling plan or, if more stringent, with the manufacturer's procedures (provided with the instrument). Any salinity adjustment shall be made to the approximate salinity of the water (one may use knowledge of the subsurface or some conductivity meters or dedicated salinity meters to obtain the salinity of the water). The probe must be thoroughly rinsed with distilled/deionized water before and after each use. Measurements shall typically be recorded to the nearest 0.1 ppm concentration.

7.3.6. Turbidity Measurements

A turbidity meter shall typically be used to make turbidity measurements on aliquots of water samples obtained just before sample acquisition. Measurements shall be made as soon as possible on the obtained aliquot. Operation and calibration shall be in accordance with the sampling plan or, if more stringent, with the manufacturer's procedures (provided with the instrument). It is preferable to have a range of calibration solutions that bracket the site turbidity range. At a minimum calibration shall be performed at the beginning and ending of each day's use and every four hours in between. Calibration shall be performed with calibration solution specified for the project. Measurements shall be recorded to the nearest 0.1 NTU when less than 1 NTU; the nearest 1 NTU when between 1 and 10 NTU; and the nearest 10 NTU when between 10 and 100 NTU.

7.3.7. Redox Potential Measurements

A meter and a flow though cell is a preferred way to measure this parameter. Alternately, a redox meter may be used to obtain redox potential measurements. However, there are many other ways to measure redox couples. When a meter is used the reading should be obtained on an aliquot of purged water that was obtained just before sampling. Measurements shall be made immediately on the obtained aliquot. (Note: The best results using a redox meter usually come from measuring the redox on the purged water in an air-space free and closed flow-through system.) Calibration and operation shall be in accordance with the sampling plan and if more stringent with the manufacturer's procedures (provided with the instrument). It is preferable to have a range of calibration solutions that bracket the site redox potential range. At a minimum calibration shall be performed at the beginning and ending of each day's use and every four hours in between. Calibration shall be performed with calibration solution specified for the project. Typically, the probe shall be thoroughly rinsed with distilled/deionized water after each sample when using a flow through cell or after each sample reading when the probe is placed in a discrete aliquot of sample. The redox using a probe shall be recorded in millivolts to the number of significant figures required by the sampling plan - which is typically three significant figures.

7.4. Capture and Disposal of Purge Water and Decontamination Solutions

7.4.1. Purge Water

Purged groundwater shall be handled as specified in the sampling plan. Typically purge water will be captured and contained in 55-gallon steel drums or suitable vessel(s). If required, each drum or tank containing captured purge water shall be properly labeled with a weather proof label as to the contents, the well(s) from which the contained purge water originated and the date in which the contents were generated. Storage of the drums or tanks shall be as specified in the project work documents or as directed by the Project Manager. In many cases there is specific wording required for the labels and this should be found in the sampling plan.

Captured and contained purge water shall be characterized for discharge, treatment and/or disposal. Characterization of the captured and contained purge water should be specified in the sampling plan or other project work documents or by the Project Manager, but could rely on site knowledge, the analytical results of groundwater samples associated with each drum or other vessel, or could involve direct sampling and analyses of the contained water.

The requirements and options available for discharge, treatment and/or disposal are dependent upon many variables such as client requirements, chemical consistency, local and state and other regulations and location of site. Discharge, treatment and/or disposal of captured and contained purge water must be in accordance with all applicable requirements such as, but not limited to, client specific procedures. Local, state and Federal regulations and shall be specified in the sampling plan or in other project work documents.

7.4.2. Decontamination Waste Solutions

Decontamination waste solutions that are generated during groundwater sampling include: spent detergent wash solutions; spent tap water rinses; any spent acid or alkali rinses, any spent organic (such as isopropyl alcohol) rinses; and spent final distilled/deionized water rinses. All decontamination waste solutions shall be captured and contained in appropriately sized vessels as required by the sampling plan or other project documentation. In any cases where this is not clear, the Project Manager shall be contacted so they can determine (with input from others as needed) whether spent decontamination solutions require capture and containment.

Captured and contained decontamination waste solutions shall be subject to requirements of the sampling plan or other project documentation. These are often generally the same guidelines as described for purge water. A noteworthy typical requirement is that all acid and alkali solutions shall be neutralized prior to discharge or disposal.

7.5. Documentation

Documentation for sampling groundwater includes labeling sample bottles; and other requirements as specified by the sampling plan or other project documentation. These further requirements often include project field notebooks, Sample Integrity Data Sheets, Field Report Forms, and Chain of Custody Records; additional documentation requirements may warrant securing individual samples or sample coolers with chain of custody seals.

7.5.1. Sample Labels

Samples shall be immediately labeled (see Exhibit A for an example label). Labels shall be water proof. Information shall be recorded on each label with indelible ink. All blanks shall be filled in (N/A if not applicable). Groundwater sample designations will be as specified in the project work documents or by the Project Manager. At a minimum the following information is required upon the label: Site name, sample ID, parameter(s) to be tested, sample date and time, sampler’s initials, chemical preservative, if used.

7.5.2. Groundwater Sample Collection Forms

Groundwater Sample Collection Forms (Exhibit B) are used by the Sampling Technician to document the official raw field information for each sample that will be chemically analyzed. All blanks shall be filled in (N/A if not applicable). The original must be submitted as soon as possible to the Project Manager. Copies must be sent to the Task Leader (if appropriate).

7.5.3. Chain of Custody Records

Chain-of-Custody Records (Exhibit C) will be used to record the custody and transfer of samples in accordance with guideline TG-1.2-23, "Chain of Custody." These forms shall be filled in completely (N/A if not applicable). Tamper-proof Seals (Exhibit A) shall be placed on either sample bottles or shipping coolers. The seal number shall be recorded on the Chain of Custody Form. The original form must accompany the samples to the analytical laboratory to be completed and returned to Golder in the analytical data report. A copy of the Chain of Custody Record documenting the transfer of samples from the field must be submitted to the Project Manager.

7.5.4. Field Report Forms

Field Report Forms (Exhibit D) or project field notebooks shall be used by the Sampling Technician to record daily activities. Data shall be recorded on the Field Report Form in chronological format. The time of each recorded event shall be included. The original Field Report Form must be submitted as soon as possible to the Project Manager. Copies must be given to the Task Leader.

7.5.5. Sample Integrity Data Sheet

Sample Interity Data Sheets (Exhibit E) shall be used by the Sampling Technician to record raw field information for each sample that will be chemically analyzed. This data sheet can be used as a supplement to but not in lieu of a groundwater sample collection form. The original must be submitted as soon as possible to the Project Manager. Copies must be given to the Task Leader.

7.6. Field Change Request

Variation from established guideline requirements may be necessary due to unique circumstances encountered on individual projects. All variations from established guidelines shall be documented on Field Change Request (Exhibit F) and reviewed by the Project Manager.

In lieu of requirements in the sampling plan or other project documentation, the Project Manager may authorize individual staff to initiate variations as necessary. If practical, the request for variation must be reviewed by the Project Manager or their designee prior to implementation. All completed Field Change Requests will be maintained in project records.

8.0 REFERENCED GUIDELINES

Golder Associates Inc. Quality Procedure QP-1, "Calibration and Maintenance of Measuring and Test Equipment."

Golder Associates Inc. Technical Guideline TG-1.2-23, "Chain of Custody."

Golder Associates Inc. Technical Guideline TG-1.4-6, "Water Level Measurement."

9.0 ADDITIONAL GUIDELINES AND PROCEDURES

Wood, W.W. (1976), "Guidelines for Collection and Field Analysis of Ground-Water Samples for Selected Unstable Constituents," Techniques of Water-Resources Investigations of the United States Geological Survey, Book 1, Collection of Water Data by Direct Measurement, Chapter D2.

U.S. EPA, 1986, Test Methods for Evaluating Solid Waste - (SW-846), 3rd Edition (Final Update III, December 1996), U.S. EPA/Office of Solid Waste, Washington, D.C.

40 CFR 136, U.S. EPA, Guidelines Establishing Test Procedures for the Analysis of Pollutants. Title 40 Part 136 of the Code of Federal Regulations.

U.S. EPA, 1986, RCRA Ground-Water Monitoring Technical Enforcement Guidance Document, U.S. EPA/Office of Solid Waste, Washington D.C.

40 CFR 141, U.S. EPA, National Primary Drinking Water Regulations, Title 40, Part 141 of the Code of Federal Regulations.

Various EPA Region and State Standard Operating Procedures

Golder Associates Technical Guideline TG-2.3-3, “Headspace Analysis Using the Organic Vapor Analyzer”

TABLE 1

TABLE 1

SAMPLE CONTAINER CODES, TYPES, VOLUMES, PREPARATION, SPECIAL HANDLING, PRESERVATION, HOLDING TIMES

Page 1 of 2

Analysis	Cont. Code	Containers, Water	Handling and Preservation	Holding Time
Volatile Organics	V	2, 40ml glass vial teflon lined septum	Store 4±2°C; handle upwind from euip. Fumes, no headspace permitted; Pres with HCl to pH <2 for volatile aromatics	7 days 14 days (HCl pres.)
Base/Neutral and Acid Extractable Organics	SV	2, 1 liter amber glass, teflon lined cap	Store 4±2°C; handle upwind from equip. fumes; no contact with plastics, gloves	7 days until extraction 40 days thereafter
Organiochlroine Pesticides and PCBs	P	2, 1 liter amber glass, teflon lined cap	Store 4±2°C; handle upwind from equip. fumes; no contact with plastics, gloves	7 days until extraction 40 days thereafter
Herbicides	H	2, 1 liter amber glass, teflon lined cap	Store 4±2°C; handle upwind from equip. fumes; no contact with plastic, gloves	7 days until extraction 40 days thereafter
Total Fuel Hydrocarbons (Fuel Fingerprint)	TH	1, 125 ml amber glass, teflon lined septum	Store 4±2°C; handle upwind from equip. fumes, no headspace permitted; pres with HCl to pH <2	14 days
Total Petroleum Hydrocarbons or Oil and Grease	OG	1, 1 liter glass, teflon lined cap	Store 4±2°C; handle upwind from equip. fumes, no contact with gloves or plastics; pres with HCl to pH <2	28 days
Cyanide (total)	CN	1,1 liter plastic	Store 4±2°C; pres with NaOH to pH >12	14 days
Suflide (total)	S	1, 1 liter plastic	Store 4±2°C; pres with ZnOAC/NaOH to pH >12	7 days
Chloride, Sulfate, pH Conductivity and Total Dissolved Solids	MA	1,1 liter plastic	Store 4±2°C.	28 days (Chloride, sulfate and conductivity) Analyze on-site (pH) 7 days (TDS)

TABLE 1

SAMPLE CONTAINER CODES, TYPES, VOLUMES, PREPARATION, SPECIAL HANDLING, PRESERVATION, HOLDING TIMES,

Page 2 of 2

Analysis	Cont. Code	Containers, Water	Handling and Preservation	Holding Time
Major Cations and Metals (Except Mercury)	TM	1,1 liter plastic	0.45 um filter, pres with HNO_3 to pH <2	6 months
Mercury	HG	1, 500 ml plastic	0.45 um filter, pres with HNO_3 to pH <2	28 days
Gamma Emitting Radionuclides	GR	2, 1 liter plastic	0.45 um filter, pres with HNO_3 to pH <2	6 months (record exact date/time of sampling for calculation of half-life decay)
Alpha Emitting Radionuclides	AR	2, 1 liter plastic	0.45 um filter, pres with HNO_3 to pH <2	6 months (record exact date/time of sampling for calculation of half-life decay)
Beta Emitting Radionuclides	BR	2, 1 liter plastic	0.45 um filter, pres with HNO_3 to pH <2	6 months (record exact date/time of sampling for calculation of half-life decay)
Total Phosphorus, Ammonia-N, Nitrate/nitrite-N, COD and TOC	TP	1, 1 liter plastic	Store 4±2°C; pres with H_2SO_4 to pH <2, store in dark	28 days
Orthophosphate	OP	1, 1 liter plastic	0.45 um filter, store 4±2°C	48 hours

EXHIBIT A

Golder Associates

Location ____________________
Job No. __________ Date __________
Boring No. ______ Sample No. ______
Depth __________ Blows __________
Description ____________________
____
____
____
Driller __________ Engr. __________

Sample Label

Golder Associates
Seal Number
2455

Golder Associates

Sent By: ______________
Date: ______________

Tamper Proof Seal

SAMPLE LABELS

EXHIBIT B

WATER SAMPLE FIELD INFORMATION FORM

Site:

Location:

Project Number:

Sampling Team:

Sample Point ID: **(well)**

Purging Device: **Teflon Bailer & Nylon Rope**

Depth to water before purging (ft-bmp) Date: Time:

Sounded well depth (ft-bmp) PID reading (ppm)

As-built well depth (ft-bmp)

Casing diameter (in)

Casing volume (gal)

Casing Volume Calculation

2"	4"	6"	8"
0.163 gal/ft	0.653 gal/ft	1.47 gal/ft	2.61 gal/ft

Volume purged (gal) Time Start: Time Finish:

Depth to water after purging (ft-bmp) Purge Calc:

Remarks:

WELL INSPECTION (Circle Y or N)

Is well location correct on map?	Y or N	Is the well locked?	Y or N
Is well located in a dry area?	Y or N	Is the lock in good condition?	Y or N
Is well readily accessible?	Y or N	Is the well vented?	Y or N
Is well legibly labeled?	Y or N	Does casing have weep hole?	Y or N
Is well protected with posts?	Y or N	Does well have dedicated bailer?	Y or N
Is casing free of kinks/bends?	Y or N	Does well have dedicated pump?	Y or N
Is protective casing secure?	Y or N	Is equip. in good condition?	Y or N

Remarks:

FIELD MEASUREMENTS

						Units	Calibration Notes
Time	1)	2)	3)	4)	5)		
Temp.	1)	2)	3)	4)	5)	**ºC**	**Calibration time:**
pH	1)	2)	3)	4)	5)	**std. units**	**Serial#:**
Sp. Cond	1)	2)	3)	4)	5)	**mS/cm**	
Turbidity	1)	2)	3)	4)	5)	**ntu**	
D.O.	1)	2)	3)	4)	5)	**mg/l**	
Redox	1)	2)	3)	4)	5)	**mV**	
DTW	1)	2)	3)	4)	5)	**ft-bmp**	
Volume	1)	2)	3)	4)	5)	**gallons**	

Sample Collection Notes:

Weather conditions at time of sampling:

Sample characteristics:

Sample date / time: Method of sample collection: **Teflon Bailer & Nylon Rope**

Analytical Parameters:

Signature: Company: **Golder Associates Inc.** Date:

NJ Certification #03027

LOW FLOW GROUNDWATER PURGE/SAMPLE FIELD INFORMATION FORM

Golder Associates

Site ______________________

Location: ______________________

Project Number: ______________________

MONITORING WELL ID: ______________________

Depth to Water Prior to Purging [ft-bmp]: ______________________

Well Casing Diameter [in]: ______________________

Start Time (purging): ______________________

Purging Device: ______________________

Pump intake setting: ______________________

Well Screen Interval: ______________________

As-Built Construction Well Depth [ft-bmp]: ______________________

Sounded Well Depth [ft-bmp]: ______________________

Weather Conditions: ______________________

Meter/Type/Serial #: ______________________

Meter Calibrated @: ______________________

Sampling Date/Time: ______________________

Sampler(s): ______________________

Sampling Device: ______________________

Sampling Purge Rate: ______________________

Sample Characteristics: ______________________

PID Measurement of Well Headspace (ppm): ______________________

Analytical Parameters: ______________________

Fe+2 result (field measurement):______________PPM

Time [hh:mm]	**Temperature** [^{o}C]	**pH** [std]	**Specific Conductance** **Circle One** [S/m] or [mS/cm]	**Turbidity** [ntu]	**Dissolved Oxygen** [mg/l]	**Redox Potential** **Note - Indicate if (+) or (-)** [mV]	**Depth To Water** [ft-bmp]	**Volume Purged** [liters]	**Approximate Purge Rate** [ml/min]	**Observations** (PID readings, sample characteristics, equipment problems, etc.)

Comments:

Signature:

GROUNDWATER SAMPLE COLLECTION FORM

Golder Associates

Project Ref: ____________________________ **Project No. :**________________

WEATHER CONDITIONS

Temperature ________________ Weather ______________________________

SAMPLE INFORMATION

Sample Location ______________________ Sample No. ________________

Sample Date ____________ Time __________ Sample By__________________

Sample Method ______________________ Sample Type__________________

Water Level Before Purging: ______________________

Well Volume: ______________________

Volume Water Removed Before Sampling: ______________________

Water Level Before Sampling: ______________________

Water Level After Sampling: ______________________

Appearance of Sample: ______________________

FIELD MEASUREMENTS

Parameter	Units	Measurement	Measurement	Measurement	Measurement	Sample
Time	hhmm					
Volume Discharge	gals					
pH	Standard					
Spec. Cond.	___S/CM					
Turbidity	NTU					
Temperature	°___					
Dissolved Oxygen	mg/l					
Redox Potential	+/- mV					

LABORATORY CONTAINERS

Sub-Sample	Analysis Requested	Type and Size of Sample Container	Filtered (Yes or No)	Type of Preservative
1				
2				
3				
4				
5				
6				
7				
8				

REMARKS: ____

NA = Not applicable

SAMPLING METHODS:

Bailer:	PVC/PE	Peristaltic Pump	Air-Lift Pump
	Stainless Steel	Submersible Pump	Other___________
	Teflon	Hand Pump	

EXHIBIT C

CHAIN OF CUSTODY RECORD

PROJ. NO.	SITE/LOCATION
SAMPLERS: *(Signature)*	

STA. NO.	DATE	TIME	SAMPLE TYPE	MEDIA	SAMPLE IDENTIFICATION	NO. OF CON-TAINERS	AMOUNT/ PRESERVATIVE						SEAL NO.	SEAL INTACT? (Y or N)	REMARKS (with initials)

Relinquished by: *(Signature/Firm)*	Date/Time	Received by: *(Signature/Firm)*	Relinquished by: *(Signature/Firm)*	Date/Time	Received by: *(Signature/Firm)*
Relinquished by: *(Signature/Firm)*	Date/Time	Received by: *(Signature/Firm)*	Relinquished by: *(Signature/Firm)*	Date/Time	Received by: *(Signature/Firm)*
Relinquished by: *(Signature/Firm)*	Date/Time	Received by: *(Signature/Firm)*	Date/Time	Remarks (attachments if necessary)	

EXHIBIT D

GOLDER ASSOCIATES

DATE	JOB NO
PROJECT	
LOCATION	
CONTRACTOR	OWNER
WEATHER	TEMP °at AM °at PM
PRESENT AT SITE	

TO

THE FOLLOWING WAS NOTED.

COPIES TO

FIELD REPORT

SIGNED

EXHIBIT E

SAMPLE INTEGRITY DATA SHEET

Plant/Site ____________________ Project No. ____________

Site Location ____________________ Sample ID ____________

Sampling Location ____________________________________

____

Technical Procedure Reference(s) ______________________

Type of Sampler ______________________________________

Date ____________________ Time ____________________

Media ____________________ Station ____________________

Sample Type: grab time composite space composite

Sample Acquisition Measurements (depth, volume of static well water and purged water, etc.)

____

____

____

Sample Description ____________________________________

____

____

Field Measurements on Sample (pH, conductivity, etc.) ____________

____

____

____

Aliquot Amount	Container	Preservation/Amount

Sampler (signature) ____________________ Date ____________

Supervisor (signature) ____________________ Date ____________

Golder Associates Inc.

EXHIBIT F

FIELD CHANGE REQUEST

Golder Associates

Job/Task Number: ____

Procedure Reference: ____

Other Affected Documents: ____

Requested Change: ____

Reason for Change: ____

Change Requested by: ____ Date ____

Reviewed by: ____ Date ____
Project Manager

Comments: ____

GOLDER

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