

OKLAUNION INDUSTRIAL PARK, LLC

GROUNDWATER MONITORING AND CORRECTIVE ACTION REPORT

OKLAUNION POWER STATION
PROJECT NO. 135110

REVISION 0 JANUARY 31, 2024

CONTENTS

1.0	Annual Report Data				
	1.1	Overview	1-1		
	1.2	Groundwater Monitoring Well Locations and Identification Numbers	1-2		
	1.3	Monitoring Wells Installed or Decommissioned	1-3		
	1.4	Groundwater Quality Data and Static Water Elevation Data with Flow Rate Direction and Discussion	1-3		
	1.5	Statistical Evaluation of 2023 Events	1-4		
	1.6	Alternate Source Demonstrations	1-4		
	1.7	Discussion about Transition Between Monitoring Requirements or Alternate Monitoring Frequency	1-4		
	1.8	Other Information Required	1-4		
	1.9	Description of any Problems Encountered in 2023 and Actions Taken	1-4		
	1.10	A Projection of Key Activities for the Upcoming Year	1-4		
2.0	Refe	erences	2-5		
APP	ENDI	X A - GROUNDWATER MONITORING WELL INSTALLATION W PLAN	ORK)		
APPENDIX B - DRILLING LOGS WELLS AD-23 AND AD-24					
APPENDIX C - FEDERAL CCR FINAL RULE PROGRAM GROUNDWATER SAMPLING AND ANALYSIS PLAN					
APPENDIX D - GROUNDWATER MONITORING SYSTEM CERTIFICATION					
APPENDIX E - STATISTICAL METHOD FOR EVALUATING GROUNDWATER MONITORING DATA CERTIFICATION					

FIGURES

Figure 1-1: Groundwater Monitoring Well Network1-3
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Index and Certification

OKLAUNION INDUSTRIAL PARK, LLC 2023 ANNUAL GROUNDWATER MONITORING AND CORRECTIVE ACTION REPORT

Project No. 135110

Report Index

Chapter Number	Chapter Title	Number of Pages
1.0	Annual Report Data	4
2.0	References	1
Appendix A	Groundwater Monitoring Network Installation Work Plan	202
Appendix B	Drilling Logs - Wells AD-23 and AD-24	6
Appendix B	Federal CCR Final Rule Program Groundwater Sampling and Analysis Plan	85
Appendix D	Groundwater Monitoring System Certification	4
Appendix E	Statistical Method for Evaluating Groundwater Monitoring Data Certification	3

Certification

As a Professional Engineer in the state of Texas, I hereby certify to the best of my knowledge, information, and belief, that the information contained in this document meets the requirements of 40 CFR § 257.90(e). This report is not intended or represented to be suitable for reuse by the OKLAUNION INDUSTRIAL PARK, LLC or others without specific verification or adaptation by the Engineer.



Eric S. Dulle, P.E. (TX Registration No. 128008)

Date: January 31, 2024

Annual Report Data 1.0

1.1 Overview

This Annual Groundwater Monitoring and Corrective Action Report (Report) has been prepared to report the status of groundwater monitoring and corrective action activities for the preceding year (2023) for the inactive CCR Units at the Oklaunion Industrial Park, LLC. (OIP), Oklaunion Power Station (Site) located in Vernon, Texas in Wilbarger County. This Report was prepared to support compliance with the requirements included in the Texas Commission on Environmental Quality (TCEQ) regulations under 30 Texas Administrative Code (TAC) §352.901-991 (Texas coal-combustion residuals [CCR] regulations) that follows the United States Environmental Protection Agency (USEPA) Hazardous and Solid Waste Management System; Disposal of Coal Combustion Residuals from Electric Utilities; Final Rule of 40 Code of Federal Regulations (CFR) Part 257 and 261 of §257.90(e) (collectively referred to herein as the CCR Rule) to document the status of the groundwater monitoring and corrective action program at the CCR units, summarize key actions completed, describe any problems encountered, discuss any actions to resolve the problems, and provide key activities for the upcoming year (2024). The CCR Rule was established to regulate the disposal of CCR produced by electricity generating facilities (USEPA, 2015; USEPA, 2018; USEPA, 2020a; and 2020b). The USEPA's CCR rules require this Report be posted to OIP's operating record and OIP's publicly accessible CCR reporting website for the preceding year no later than January 31, 2024.

This Report is the annual report for the five inactive CCR Units at the site and summarizes activities performed in 2023 related to the CCR Rule groundwater monitoring program at the following CCR Units: Pond 6, Pond 21, Pond 22, Pond 23, and Wastewater and Sludge Pond (WWSP).

Closure activities have not yet started for the closure of the five inactive CCR Units. A Registration Application was submitted to the TCEQ on March 9, 2022 (Registration No. CCR117, Tracking No. 27363596, EPA ID No. TXD982294803; RN101062255; CN605853951) and is awaiting approval. Upon approval of the Registration Application, OIP will commence closure of the CCR Units.

Groundwater was not currently being monitored at this site. It was determined by the previous owners, and in concurrence with the TCEQ, that a viable aquifer was not present and therefore groundwater monitoring was not required. However, groundwater monitoring is set to begin in first quarter of 2024 in accordance with 40 CFR §257.90 of the Federal CCR Final Rule Program Groundwater Sampling and Analysis Plan for Oklaunion Power Station (SAP; Burns & McDonnell, 2024c) included in Appendix C.

Groundwater monitoring is scheduled to begin in the first quarter of 2024 under the detection monitoring program to establish background of the monitoring well network in accordance with 40 CFR §257.94 and as described in the SAP included as Appendix C in this document.

The following activities were completed in 2023:



- Monitoring Wells AD-23 and AD-24 were installed as part of the site groundwater monitoring well network. The *Groundwater Monitoring Network Installation Work Plan* (Work Plan; Burns & McDonnell, 2023) is attached in **Appendix A**. The new monitoring well drilling logs were filed with the TCEQ upon completion of drilling activities and are attached in **Appendix B**.
- A groundwater SAP was developed for the site in accordance with 40 CFR §257.93. This plan can be found in **Appendix C** of this document.
- The groundwater monitoring system certification (Burns & McDonnell, 2024a) was completed in accordance with 40 CFR §257.91(f) and placed in both OIP's operating record and publicly accessible CCR reporting website. This certification can be found in Appendix D of this document.
- The selected statistical method certification (Burns & McDonnell, 2024b) for
 evaluating the groundwater monitoring data was completed in accordance with 40
 CFR §257.93(f)(6) and placed in both OIP's operating record and publicly accessible
 CCR reporting website. This certification can be found in Appendix E of this
 document.

1.2 Groundwater Monitoring Well Locations and Identification Numbers

The figure below depicts the location of the inactive CCR units as well as the groundwater monitoring wells on site. Monitoring Wells AD-06, AD-07, AD-08, AD-14, and AD-15 were part of the existing groundwater monitoring well network but were not sampled by OIP. A copy of this figure is also included in the SAP (**Appendix C**). The existing wells, in addition to the two new groundwater Monitoring Wells AD-23 and AD-24 installed in 2023, comprise the currently established groundwater monitoring well network for the inactive CCR units. The monitoring well network is comprised of three upgradient wells (AD-06, AD-07, and AD-08) and five downgradient wells (AD-13, AD-14, AD-15, AD-23, and AD-24. Further details regarding the monitoring well network is presented in the groundwater monitoring system certification provided in **Appendix D** of this document.





Figure 1-1: Groundwater Monitoring Well Network

1.3 Monitoring Wells Installed or Decommissioned

Two new monitoring wells were installed at the site on October 24, 2023. Monitoring Wells AD-23 and AD-24 were installed as downgradient wells in accordance with the TCEQ-approved Work Plan included in Appendix A. The final Drilling Logs (included in Appendix B) discuss the depth of installation and the lithology of the overburden soils in which they were installed.

1.4 Groundwater Quality Data and Static Water Elevation Data with Flow Rate Direction and Discussion

No ground monitoring was completed within the 2023 calendar year.



Groundwater monitoring is scheduled to begin in the first quarter of 2024 under the detection monitoring program to establish background of the monitoring well network in accordance with 40 CFR §257.94 and as described in the SAP included as **Appendix C** in this document.

1.5 Statistical Evaluation of 2023 Events

This section is not applicable as no groundwater monitoring was completed for the calendar year of 2023.

1.6 Alternate Source Demonstrations

This section is not applicable as no groundwater monitoring was completed for the calendar year of 2023.

1.7 Discussion about Transition Between Monitoring Requirements or Alternate Monitoring Frequency

This section is not applicable as no groundwater monitoring was completed for the calendar year of 2023.

Groundwater monitoring is scheduled to begin in the first quarter of 2024 under the detection monitoring program to establish background of the monitoring well network in accordance with 40 CFR §257.94 and as described in the SAP (**Appendix C**).

1.8 Other Information Required

Not Applicable

1.9 Description of any Problems Encountered in 2023 and Actions Taken

No significant problems were encountered in 2023.

1.10 A Projection of Key Activities for the Upcoming Year

Anticipated key activities planned for the next 2024 annual reporting period include:

- Initiate groundwater sampling under the detection monitoring program to establish background of the monitoring well network as outlined in the SAP (**Appendix C**).
- Preparation of the next 2024 Annual Groundwater Monitoring and Corrective Action Report.
- Initiate closure of the inactive CCR units upon approval of the Permit Application by the TCEQ.



2.0 References

- Burns & McDonnell, 2023. *Groundwater Monitoring Network Installation Work Plan*, Oklaunion Industrial Park, LLC. May 15th .
- Burns & McDonnell, 2024a. *Re: Groundwater Monitoring System Certification for Oklaunion Industrial Park, LLC.* Oklaunion Power Station CCR Surface Impoundments in Vernon, TX. January 22nd.
- Burns & McDonnell, 2024b. *Re: Statistical Method for Evaluating Groundwater Monitoring Data Certification for Oklaunion Industrial Park, LLC*. Oklaunion Power Station CCR Surface Impoundments in Vernon, TX. January 22nd.
- Burns & McDonnell, 2024c. Federal CCR Final Rule Program Groundwater Sampling and Analysis Plan for Oklaunion Power Station. January.
- State of Texas Well Report for Tracking #653832, October, 2023.
- State of Texas Well Report for Tracking #653821, October, 2023.
- Texas Administrative Code (TAC), Title 30, Part 1, Chapter 352, Subchapter H Groundwater Monitoring and Corrective Action, §352.01-991.
- USEPA, 2015. Hazardous and Solid Waste Management System; Disposal of Coal Combustion Residuals from Electric Utilities; Final Rule, 40 CFR Parts 257 and 261, Federal Register, Vol. 80, No. 74, April 17. http://www.gpo.gov/fdsys/pkg/FR-2015-04-17/pdf/2015-00257.pdf.
- USEPA, 2018. Hazardous and Solid Waste Management System: Disposal of Coal Combustion Residuals From Electric Utilities; Amendments to the National Minimum Criteria (Phase One, Part One). 40 CFR Part 257, Federal Registrar, Vol. 83, No. 146, July 30. https://www.federalregister.gov/documents/2018/07/30/2018-16262/hazardous-and-solid-waste-management-system-disposal-of-coal-combustion-residuals-from-electric-utilities.
- USEPA, 2020a. Hazardous and Solid Waste Management System: Disposal of Coal Combustion Residuals From Electric Utilities; A Holistic Approach to Closure Part A: Deadline to Initiate Closure. 40 CFR Part 257, Federal Register, Vol. 85, No. 53516 September 28. https://www.federalregister.gov/documents/2020/08/28/2020-16872/hazardous-and-solid-waste-management-system-disposal-of-coal-combustion-residuals-from-electric.
- USEPA, 2020b. Final Rule A Holistic Approach to Closure Part B: Alternate Liner Demonstration. 40 CFR Part 257, Federal Register, Vol. 85, No. 219 December 14. Federal Register: Hazardous and Solid Waste Management System: Disposal of CCR; A Holistic Approach to Closure Part B: Alternate Demonstration for Unlined Surface Impoundments. https://www.federalregister.gov/documents/2020/12/14/2020-27031/hazardous-and-solid-waste-management-system-disposal-of-ccr-a-holistic-approach-to-closure-part-b







Groundwater Monitoring Network Installation Work Plan



Oklaunion Industrial Park, LLC.

Oklaunion Project No. 135110

5/15/2023

Groundwater Monitoring Network Installation Work Plan

prepared for

Oklaunion Industrial Park, LLC. Vernon, Texas

Project No. 135110

5/15/2023

prepared by

Burns & McDonnell Kansas City, Missouri

TABLE OF CONTENTS

		<u>Page</u>	<u>No.</u>		
1.0	INTRODUCTION1-1				
1.0	1.1	Rationale			
2.0	SITE BACKGROUND2-1				
	2.1	Site Location and Description	2-1		
	2.2	Site Geology/Hydrogeology	2-1		
3.0	sco	OPE OF WORK	3-1		
4.0	MON	NITORING WELL INSTALLATION PLAN	4-1		
	4.1	Pre-Investigation Activities	4-1		
		4.1.1 Site Access and Permitting	4-1		
		4.1.2 Utility Clearance	4-2		
	4.2	Monitoring Well Installation	4-2		
		4.2.1 Drilling Activities	4-3		
		4.2.2 Monitoring Well Construction and Installation			
	4.3	Monitoring Well Development	4-5		
	4.4	Aquifer Testing			
		4.4.1 Well Yield Testing			
		4.4.2 In-Situ Hydraulic Conductivity Testing			
	4.5	Decontamination			
	4.6	Investigation-Derived Waste			
	4.7	Monitoring Well Surveying			
	4.8	Down-Well Camera Inspection	4-7		
5.0	REF	ERENCES	5-1		
APPI APPI	ENDIX ENDIX ENDIX	(A – REGIONAL GENERALIZED GEOLOGIC CROSS-SECTIONS (B – LOCAL GENERALIZED GEOLOGIC CROSS-SECTIONS (C – STANDARD OPERATING PROCEDURES			

LIST OF FIGURES

<u>Figure No.</u>	Title
1-1	Topographic Site Vicinity Map
1-2	Proposed Groundwater Monitoring Wells
4-1	Typical Above-Grade Monitoring Well Construction Diagram

LIST OF ABBREVIATIONS

Abbreviation <u>Term/Phrase/Name</u>

bgs below ground surface

Burns & McDonnell Engineering Company, Inc.

CCR coal combustion residuals

CFR Code of Federal Regulations

HSA hollow-stem auger

TAC Texas Administrative Code

TCEQ Texas Commission on Environmental Quality

TDLR Texas Department of Licensing and Regulation

IDW investigation-derived waste

MW Monitoring Well

NAVD 88 North America Vertical Datum of 1988

OIP / Facility Oklaunion Industrial Park, LLC

Oklaunion / Site Oklaunion Power Station in Vernon, TX

% percent

SOP Standard Operating Procedure

Work Plan Groundwater Monitoring Well Installation Work Plan

WWSP Wastewater and Sludge Storage and Dewatering Pond

1.0 INTRODUCTION

Burns & McDonnell Engineering Company, Inc. (Burns & McDonnel), on behalf of Oklaunion Industrial Park, LLC. (OIP or Facility), has prepared this *Groundwater Monitoring Network Installation Work Plan* (Work Plan) for the installation of additional monitoring wells to the existing groundwater monitoring network at the Oklaunion Power Station (Oklaunion) in Vernon, Texas (Site). A Site location topographic and aerial map is provided as Figures 1-1 and 1-2, respectively.

The purpose of this Work Plan is to outline and define the scope of work and describe proposed field activities and procedures to be used during the installation of the proposed monitoring wells. These additional monitoring wells will be incorporated into the existing groundwater monitoring well network that will serve as a multi-unit monitoring system for five inactive coal combustion residuals (CCR) surface impoundments scheduled for closure. A groundwater monitoring program for the multi-unit system will be developed as a separate submittal.

1.1 Rationale

Based on the available site-specific groundwater data and requirements per the Texas Commission on Environmental Quality (TCEQ) regulations for CCR impoundments including groundwater monitoring and corrective action requirements under 30 Texas Administrative Code (TAC) §352.901-991 (Texas CCR regulations), the uppermost groundwater-bearing unit is a Class 3 groundwater resource in accordance with the Texas Risk Reduction Program (given the concurrence letter from TCEQ dated July 11, 2016) and is also considered the uppermost aquifer in accordance with the Texas CCR regulations. The Texas CCR regulations regarding groundwater and corrective action adopts by reference the United States Environmental Protection Agency *Hazardous and Solid Waste Management System; Disposal of Coal Combustion Residuals from Electric Utilities; Final Rule, 40 Code of Federal Regulations (CFR) Part 257 and 261* (Federal CCR Final Rule), and references to the one implies the other.

Based on review of available site-specific groundwater data and the Texas CCR regulations, there is currently insufficient information available to demonstrate compliance with the Groundwater Monitoring and Corrective Action requirements as required in Section IV of the registration application. The scope of work presented herein is intended to collect sufficient information and prepare required documentation to submit to TCEQ to demonstrate compliance with Texas CCR regulations and to complete Section IV of the registration application for TCEQ.

The general proposed approach would include discussions with the TCEQ to align proposed groundwater work with the review and approval of the submitted registration application including subsequent notice of deficiency emails issued by the TCEQ to Oklaunion on May 5 and September 22, 2022.

2.0 SITE BACKGROUND

2.1 Site Location and Description

The Site is located approximately two miles south of the junction of Texas Farm to Market Road 433 and Texas Farm to Market Road 3430 and approximately four miles southwest of Oklaunion, Wilbarger County, Texas. It is owned and operated by OIP. There are five inactive CCR surface impoundments scheduled for closure that include Ponds 6, 21, 22, 23, and the Wastewater and Sludge storage and dewatering pond (WWSP). A site location map showing the general location of the facility on a 7.5-minute topographic map is presented in Figure 1-1. An aerial map showing the location of the units at the facility is shown in Figure 1-2. The inactive Oklaunion Ponds that were used for storing CCR and other materials from the coal combustion process at OIP included two approximately 5-acre ponds for bottom ash storage and dewatering (Pond 21 and Pond 22), an approximately 13-acre pond for fly ash storage and dewatering (Pond 23), an approximately 22 acre WWSP, and the approximately 68-acre Pond 6 used for the disposal of both fly ash and bottom ash.

2.2 Site Geology/Hydrogeology

The Site geology and hydrogeology presented below is based on review of the following previous investigations/reports:

- Groundwater Monitoring System Installation Report (Terracon, 2011)
- Report 1 Groundwater Monitoring Network for CCR Compliance (Terracon, 2016)

The OIP area is underlain by the Permian age Clearfork Group, which is the major geologic formation outcropping in the vicinity of the Site. The Clearfork Group consists of mudstone, siltstone, sandstone, dolomite, limestone, and gypsum. The group is comprised mostly of a mudstone that is commonly silty and is a brownish red with minor gray color content. Calcareous nodules are abundant in the lower part and vertebrate fossils are locally common. Some inter-bedded, bluish-gray siltstone units, 1 to 3 feet in thickness, are found throughout the group. The group is locally dolomitic in the upper part of the unit. The sandstone in the group is found to be reddish-brown, very fine grained to fine grained, locally conglomeratic, cross-bedded, lenticular, and thin-bedded as channel fill. Dolomite ranges from 2 inches to 1 foot in thickness in the upper section of the Clear Fork Group. A gray limestone is found in thin discontinuous beds in the lower part. A white satin spar and alabaster gypsum are found as thin lenses and veins in the uppermost part of the group. The Clear Fork Group has a thickness of 1,200 to 1,400 feet.

Groundwater occurs through a slow infiltration rate ranging at various depths across the Site. Based on field observations of continuous sampling and drill cuttings, the thin silt seams and the bedding plans of the claystone/mudstone appear to provide preferential pathways for groundwater. Based on review of existing Site monitoring well drill logs, the unconsolidated overburden material is comprised predominately of silty clay soils with slight gravelly zones and occasional silt lenses that overly claystone/mudstone of the Clearfork Group. The screened interval for a majority of the existing monitoring wells targets the base of unconsolidated silty clay overburden immediately above the underlying bedrock. Generalized geologic cross-sections of the region (Price, 1979) in the vicinity of the Site are provided in Appendix A. Based on review of existing monitoring well drill logs, local generalized geologic cross-sections were prepared and provided in Appendix B.

3.0 SCOPE OF WORK

The following field activities will be completed to support the establishment of a groundwater monitoring network to meet Texas CCR regulation requirements:

- Advance two (2) soil borings to be completed with installation of two monitoring wells.
- Develop monitoring wells.
- Perform down-well camera inspection to evaluate current condition of existing monitoring well AD-14 and AD-15.
- Perform aquifer testing of new and existing monitoring wells; and
- Conduct surveying of newly installed and existing monitoring wells.

4.0 MONITORING WELL INSTALLATION PLAN

The objective of this Work Plan is to install two additional groundwater monitoring wells at the Site to support compliance with groundwater monitoring system requirements per 40 CFR §257.91 for the five inactive CCR surface impoundments by establishing a CCR multi-unit system for groundwater monitoring. Proposed field activities include continuous soil sampling for logging purposes using direct-push drilling techniques, hollow-stem auger (HSA) drilling for well installation, development of monitoring wells, in-situ hydraulic conductivity testing, fluid level measurements, decontamination, management of investigation-derived waste (IDW), and surveying of monitoring wells.

Drilling of soil borings and well installation activities will be conducted by a Texas-certified well driller, and work will be required to be performed in accordance with the 30 TAC 352.911(d) and TAC Title 16, Part 4, Chapter 76 regulations for Water Well Drillers and Water Well Pump Installers regarding subsurface drilling/probing, soil boring abandonments, and monitoring well construction and installation.

Proposed monitoring well locations are presented on Figure 1-2. The standard operating procedures (SOPs) for the field activities to be performed and field documentation are provided in this Work Plan as Appendices C and D, respectively. All data will be documented on field-data sheets (Appendix D) and/or site logbook as detailed in SOP 701 Field Documentation (Appendix C). A general approach to field activities is presented below. A groundwater monitoring program for the established groundwater monitoring network will be developed as a separate submittal to comply with the groundwater monitoring requirements in 40 CFR 257.93 and will serve as guidance for personnel performing the groundwater monitoring.

4.1 Pre-Investigation Activities

Pre-investigation activities include obtaining on-Site access, satisfying permit requirements, and performing utility clearance.

4.1.1 Site Access and Permitting

Site access will be obtained and coordinated with OIP prior to initiation of field work.

Planned monitoring wells are located within the Oklaunion property boundary. No access agreements or permits are anticipated for the planned monitoring wells located on Oklaunion property.

4.1.2 Utility Clearance

Prior to initiation of field activities, utility clearance will be required. Utilities will be located with the aid of Oklaunion personnel and Texas One-Call (811 local or 1-800-344-8377), a public utility locating service and a private utility locating service. A 48-hour (excluding Saturday, Sunday, and legal holidays) notification is required for Texas One-Call prior to commencing intrusive activities. Oklaunion will be responsible for locating all on-Site utilities owned by Oklaunion and may require use of a private locating service.

Subsurface activities will not be conducted within five feet of any marked underground utilities. Vehicles and the direct-push rig will maintain minimum distances from overhead utilities in accordance with Occupational Safety and Health Administration regulations to reduce the possibility of arcing. Depending on the presence of underground or overhead utilities, it may be necessary to offset proposed soil boring and monitoring well locations. Utility clearance will follow the procedures presented in *SOP 501 Utility Clearance*, presented in Appendix C.

4.2 Monitoring Well Installation

To address the groundwater monitoring requirements per 40 CFR §257.91, two (2) new monitoring wells are proposed for installation to implement a CCR multi-unit groundwater monitoring system/program at Oklaunion. New monitoring wells will be installed in the vicinity of the inactive CCR Pond 6 with the proposed locations illustrated in Figure 1-2. These locations are approximate with final locations determined based on conditions encountered in the field. Generalized geologic cross-sections that include the existing and proposed monitoring wells are provided in Appendix B. The proposed CCR multi-unit groundwater monitoring well network will comprise of the following:

- Two (2) proposed downgradient-gradient monitoring wells (MW):
 - AD-23 located along the western downgradient waste boundary of the inactive CCR
 Pond 6; and
 - AD-24 located adjacent to existing AD-13 along the southern downgradient waste boundary of the inactive CCR Pond 6.
- Three (3) existing downgradient-gradient monitoring wells AD-13, AD-14, and AD-15 located directly near the southern boundary of the inactive CCR Pond 6.
- Three (3) existing up-gradient monitoring wells AD-07, AD-06, and AD-08:

- o AD-06 located along the northern boundary between inactive CCR Ponds 21 and 22.
- o AD-07– located along the northern boundary of the inactive CCR Pond 24; and
- o AD-08 located near the northeastern Oklaunion property boundary.

Collectively, this network of wells meets the groundwater monitoring system performance standard per 40 CFR §257.91 by including a minimum of one (1) upgradient and three (3) downgradient monitoring wells, and by representing the quality of background groundwater and the downgradient quality of groundwater passing the waste boundary of the CCR multi-unit system.

4.2.1 Drilling Activities

The proposed two (2) monitoring wells will be drilled and installed in separate borings by a Texas-certified well driller that follows TAC Title 16, Part 4, Chapter 76 regulations for Water Well Drillers and Water Well Pump Installers and in accordance with TCEQ rules and regulations and 30 TAC 352.911(d). The monitoring well boring will be advanced first with continuous core sampling using direct-push drilling techniques for soil logging purposes using the procedure presented in SOP 121 Collection of Subsurface Soil Samples Using Direct-Push, presented in Appendix C. During direct-push probing, continuous soil samples will be collected with a Macro-Core (or similar) sampling device. The soil will be visually inspected by a geologist in the field, and a description of the soils encountered will be recorded on a drilling log in accordance with the Unified Soil Classification System using the procedure presented in SOP 521 Field Classification and Description of Soil and Bedrock, provided in Appendix C. The description of soils encountered will be recorded on a Drilling Log Form (or similar) provided in Appendix D. The depth to groundwater, if encountered, will be noted in the field logbook and respective drill logs (if encountered during drilling). Collection of soil samples for laboratory testing/analysis is not planned.

The targeted depth for drilling is into the uppermost water-bearing zone comprised of unconsolidated silty clay overburden that overlies claystone. If shallow refusal is encountered above the suspected uppermost water-bearing zone during drilling, the boring will be abandoned (backfilled with bentonite) and a second drilling attempt will be made at an off-set location.

Following completion of continuous soil sampling into the water table using direct-push drilling techniques, additional blind drilling with HSAs will be performed by the driller to enlarge/ream the direct-push borehole to a minimum 6-inch diameter borehole to allow for monitoring well installation.

4.2.2 Monitoring Well Construction and Installation

Monitoring wells will be installed using HSA drilling techniques in accordance with SOP 551 Installation and Development of Monitoring Wells and Piezometers (Appendix C) at the two proposed monitoring wells to support groundwater monitoring for collection of groundwater samples and gauging groundwater elevations.

Monitoring wells will be installed through HSAs inside a minimum 6-inch diameter borehole. Monitoring wells will consist of 2-inch diameter, Schedule 40, polyvinyl chloride casing/screens. Well screens will be 10-foot long and consist of 0.010-inch machine-slotted screen and threaded end caps. Glues or solvents will not be used in the construction of the monitoring wells.

A well filter pack consisting of clean, uniform, 20/40-grade, silica sand will be placed from the bottom of the well screen and extend approximately 2-feet above the top of the well screen. A minimum 3-foot-thick bentonite chip seal will be placed immediately above the filter pack and placed in 1-foot hydrated lifts. The annular seal will be placed above the bentonite seal to within approximately 3-ft below ground surface (bgs) using high solids bentonite slurry. A locking, expandable, water-tight plug will be installed on the top of the well casing.

Monitoring wells will have above-grade surface completions. The top of the well riser will be cut to approximately 3-feet above ground surface and will be level. A locking steel protective casing at the surface will be installed over the well casing and extend approximately 3-feet bgs and above the top of well casing (approx. 3-feet above ground) to readily access the well. The annular space between the protective casing and borehole wall will be filled with concrete to ground surface. An approximate 3-foot square or 3-foot diameter circular concrete well pad will be centered on the well and protective casing and will be sloped away from the monitoring well to facilitate water runoff. Bollards will not be required for surface completions at grade. A Texas Department of Licensing and Regulation (TDLR) Well Report will be completed for each new monitoring well and submitted to TDLR and TCEQ, a copy of which is provided in Appendix D.

Typical above-grade monitoring well schematic is provided in Figure 4-1 for proposed monitoring wells. A well construction diagram will be generated upon completion of each installed monitoring well. A water level indicator will be used to confirm water levels after drilling and well installation have been completed.

4.3 Monitoring Well Development

Fluid level measurements will be collected from all newly installed monitoring wells prior to well developments.

Well development will be performed on newly installed Monitoring Wells AD-23 and AD-24 prior to aquifer testing (see Section 4.4). Development will be used to remove fine-grained material from the well and the filter pack near the screen. Development will be accomplished by surging and pumping the monitoring wells using a submersible pump (or bailer) in accordance with SOP 551 in Appendix C. Data collected from well developments will be recorded on a Well Development Form (Appendix D) and in the field logbook.

4.4 Aquifer Testing

Aquifer testing will be performed on both the existing and newly installed monitoring wells that are part of the multi-unit monitoring system and will consist of doing both well yield and in-situ hydraulic conductivity testing. Aquifer testing will be performed following well development (for newly installed wells).

4.4.1 Well Yield Testing

The TCEQ has published a *Groundwater Classification* guidance document (RG-366/TRRP-8; TCEQ, 2010) that provides a recommended process for completing groundwater classification. According to the TCEQ guidance, a groundwater-bearing unit is defined as a saturated geologic formation, group of formations, or part of a formation that has a hydraulic conductivity equal to or greater than 1x10⁻⁵ centimeter per second. The guidance has also established a sustainable daily rate of withdrawal from a properly completed well of more than 150 gallons per day.

Using this guidance, field testing at monitoring wells will be used to determine "significant yield" of the water bearing zones beneath the Site. Well yield can be determined at monitoring wells by direct field-testing procedures consisting of data collection using discharge methods. For this scope of work, field testing for well yield will consist of cyclic discharge procedures outlined below:

- 1. Initial Water Level: measure static water level in well.
- 2. Water Level Bail-Down: Use bailer, pump, or other device to effectively evacuate all water from the well. Contain all discharge water and measure total volume (V₁). Measure static water level in well immediately upon completion of water removal.

- 3. Time for Water Level Recovery: Monitor the water level in well during recovery and measure elapsed time (t₁) from completion of water removal until static water level in well recovers to the same specific level, up to, but no greater than 90 percent (%) of height to initial static water level.
- 4. Repeat Bail-Down and Recovery: Repeat Steps 2 and 3 above twice. This procedure requires a minimum of three bail-down/recovery cycles. However, fewer bail-down/recovery cycles may be performed if well recovery/yield is very slow/low). Record total volume of water (V₁...V_n) removed from well during each successive bail-down and the elapsed time (t₁...t_n) from completion of water removal until water level in well recovers to the same specified level used in prior cycle(s) [i.e., up to, but not greater than 90% of height to initial static water level].

The maximum well yield corresponds to the total bailed water volume ($\sum Vn$; sum of bailed water volume [V] for n number of tests) divided by the combined recovery time ($\sum tn$; sum of recovery time [t] for n number of tests) measured during at least three bail-down/recovery cycles (or fewer cycles at low recovery/yield wells) and presented in units of gallons per day. Additional specific details on testing and analysis are provided in the TCEQ Groundwater Classification guidance (TCEQ, 2010), a copy of which is included in Appendix C.

4.4.2 In-Situ Hydraulic Conductivity Testing

In-situ hydraulic conductivity testing ("slug test") will not occur at a monitoring well until water levels equilibrate to near static conditions (approximately 90% of water level recorded prior to well development [where performed]). Slug testing data collection will be collected concurrently during the well yield testing (see Section 4.4.1) by measuring the recovery of the water level (slug-out testing method) using a water level meter and will conform to the procedures presented in SOP 555 In-Situ Hydraulic Conductivity Slug Testing (Appendix C). If well recovery is very rapid/fast, an electronic data logging device may be used in the well for slug testing. Data collected from slug testing will be recorded on a Slug Test Form (Appendix D) or in the field logbook. Slug test data will be evaluated using computer software to calculate estimated hydraulic conductivity values.

4.5 Decontamination

Probing/drilling equipment and tools and other non-disposable sampling equipment that is used for subsurface soil sampling will be decontaminated prior to drilling operations and between boring and monitoring well locations, using the procedure presented in *SOP 504 Decontamination* (Appendix C). These decontamination procedures will also be used for any slug testing equipment used at monitoring wells for in-situ hydraulic conductivity testing.

4.6 Investigation-Derived Waste

Excess soil resulting from the probing/drilling operations generated during the monitoring well installation activities will be disposed of in one of the inactive CCR surface impoundments at the direction of Oklaunion personnel.

Liquid IDW generated during the monitoring well installation activities is anticipated to consist primarily of decontamination water and purge groundwater from well development. Liquid IDW will be temporarily containerized in a 55-gallon United Nations-approved steel drum or portable poly tank and disposed of in one of the active wastewater impoundments at the direction of Oklaunion personnel.

IDW will be managed using the procedure presented in SOP 601 Investigative Derived Waste Storage, Sampling, and Disposal, presented in Appendix C.

4.7 Monitoring Well Surveying

The existing and newly installed monitoring wells proposed to be included in the CCR multi-unit groundwater monitoring well network will be surveyed for both vertical and horizontal control. Surveying will be performed by a Texas-licensed Professional Land Surveyor. The monitoring well locations will be surveyed horizontally to the nearest 0.1 foot and tied into the Texas State Plane coordinate system with latitude and longitude coordinates also provided. The ground surface and top of well pad of the monitoring well locations will be measured to the nearest 0.1 foot relative to mean sea level and reported using North America Vertical Datum of 1988 (NAVD 88). The top of the monitoring well riser pipe will be surveyed to the nearest 0.01 foot relative to mean sea level and reported using NAVD 88.

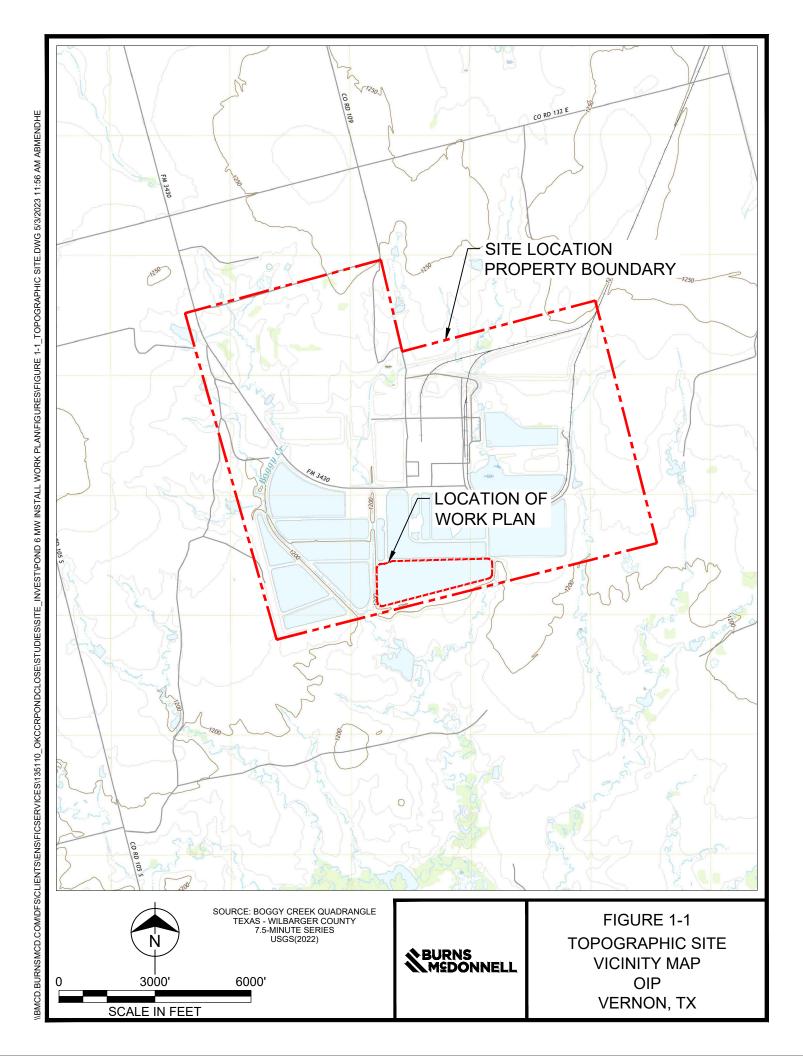
4.8 Down-Well Camera Inspection

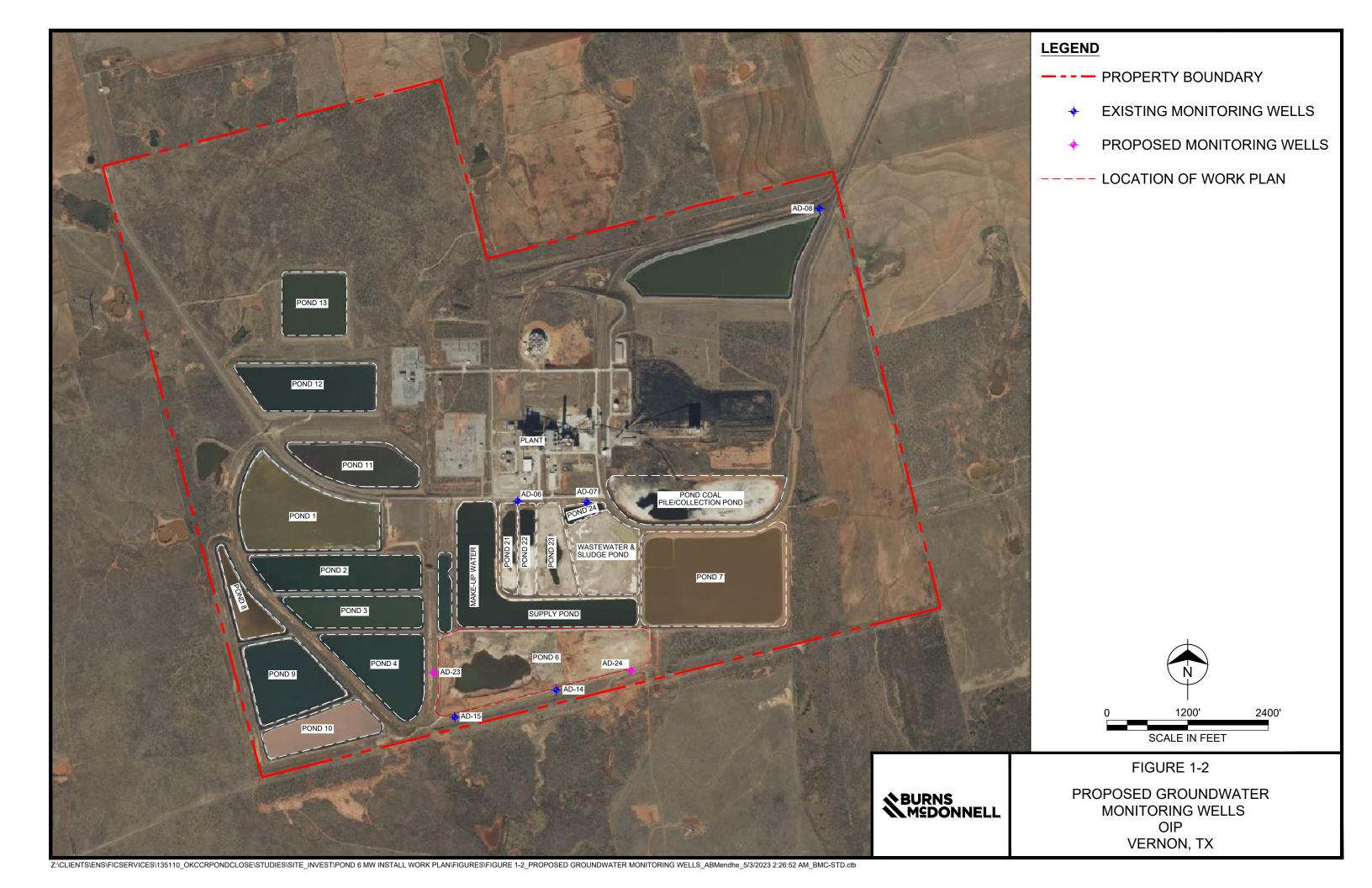
A down-well camera will be deployed in existing monitoring wells AD-14 and AD-15 to access the integrity of the well. The video from the down-well camera will be recorded and saved. Results of the video will be reviewed with OIP and a path forward, if necessary, discussed. If these inspections suggest that the wells are damaged, the wells may be repaired or abandoned and replaced with newly installed wells located in the immediate vicinity of the existing well.

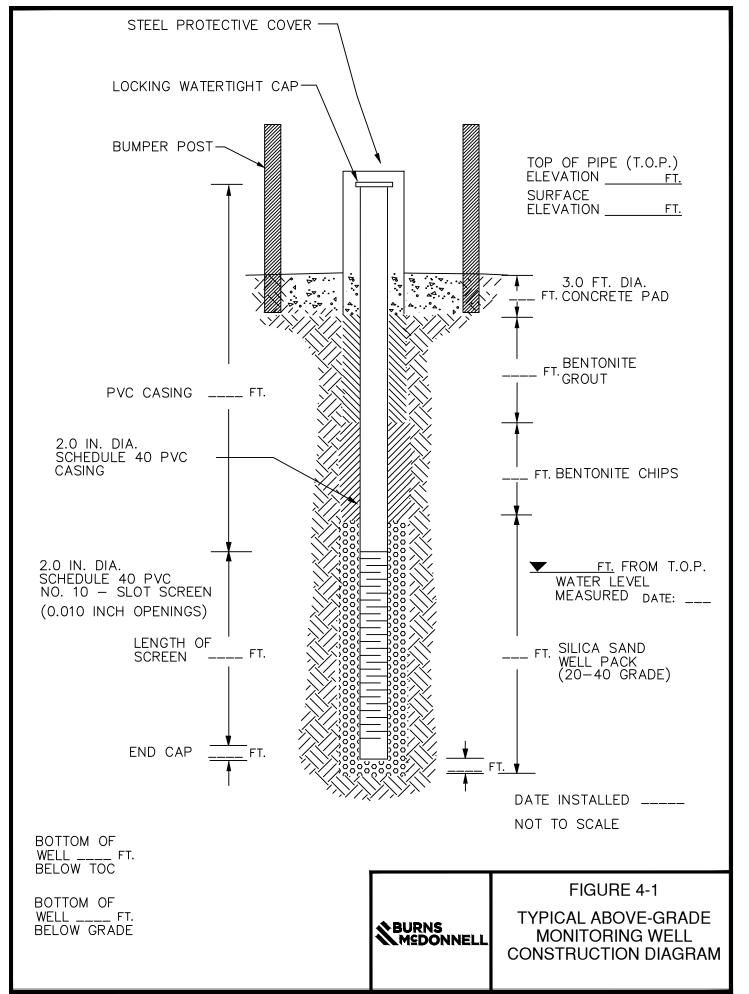
5.0 REFERENCES

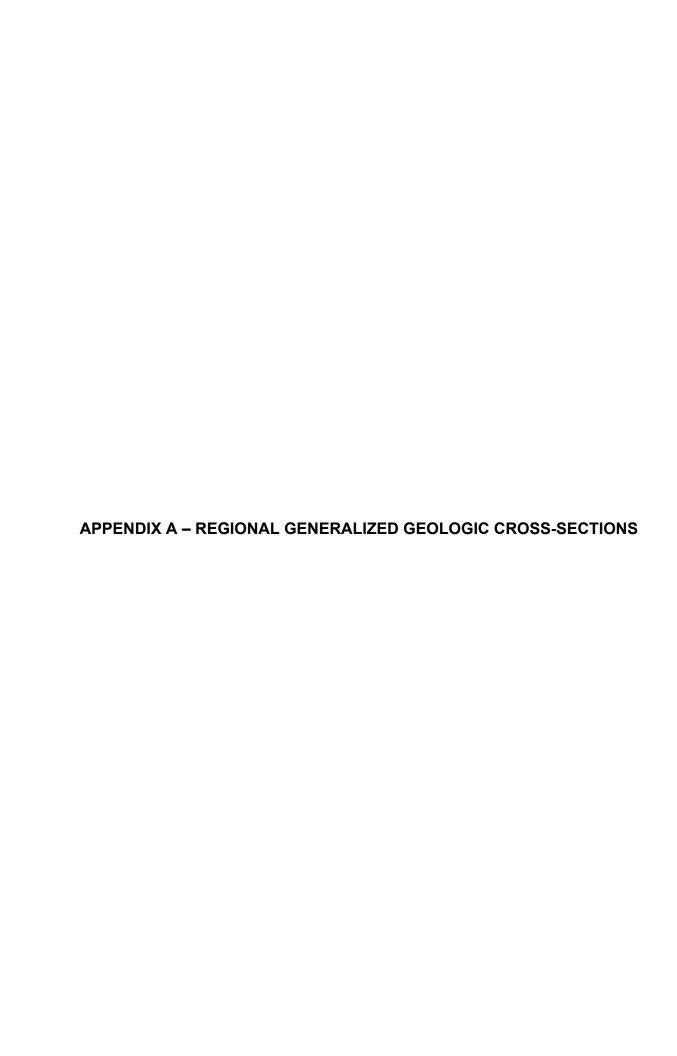
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- Terracon, 2016, Report 1 Groundwater Monitoring Network for CCR Compliance, American Electric Power, Oklaunion Power Station, Pond 6, November 2016.
- Terracon, 2011, Oklaunion AEP Groundwater Monitoring System Installation Report, revised January 2011.
- Texas Administrative Code (TAC), Title 16 Economic Regulation, Part 4 Texas Department of Licensing and Regulation, Chapter 76 Water Well Drillers and Water Well Pump Installers.
- TAC, Title 30 Environmental Quality, Part 1 Texas Commission of Environmental Quality, Chapter 352 Coal Combustion Residuals Waste Management.
- TAC, Title 30, Part 1, Chapter 352, Subchapter H Groundwater Monitoring and Corrective Action, §352.901-991.
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- Texas Department of Water Resources, Price, Robert D. 1979, Report 240, Occurrence, Quality, and Quantity of Ground Water in Wilbarger County, Texas.
- USEPA, 2015, Hazardous and Solid Waste Management System; Disposal of Coal Combustion Residuals from Electric Utilities; Final Rule, 40 CFR Parts 257 and 261, Federal Register, Vol. 80, No. 74, April 17, 2015, http://www.gpo.gov/fdsys/pkg/FR-2015-04-17/pdf/2015-00257.pdf.

FIGURES











TEXAS DEPARTMENT OF WATER RESOURCES

REPORT 240

OCCURRENCE, QUALITY, AND QUANTITY OF GROUND WATER IN WILBARGER COUNTY, TEXAS

Ву

Robert D. Price, Geologist Texas Department of Water Resources

TEXAS DEPARTMENT OF WATER RESOURCES

Harvey Davis, Executive Director

TEXAS WATER DEVELOPMENT BOARD

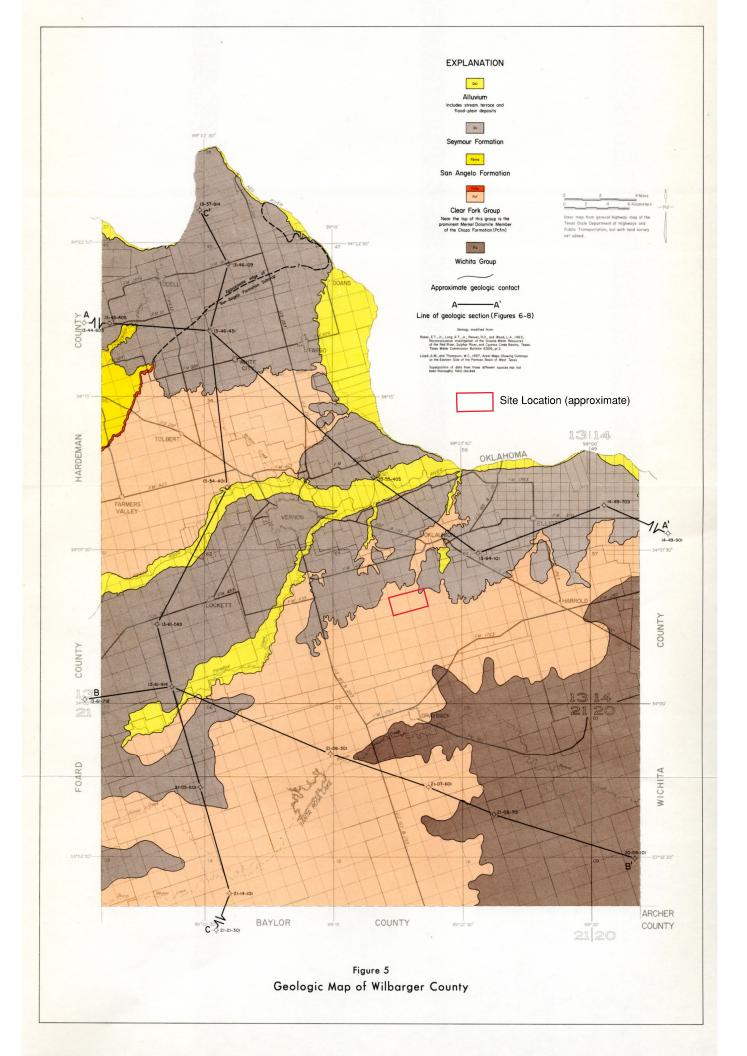
A. L. Black, Chairman Milton Potts George W. McCleskey John H. Garrett, Vice Chairman Glen E. Roney W. O. Bankston

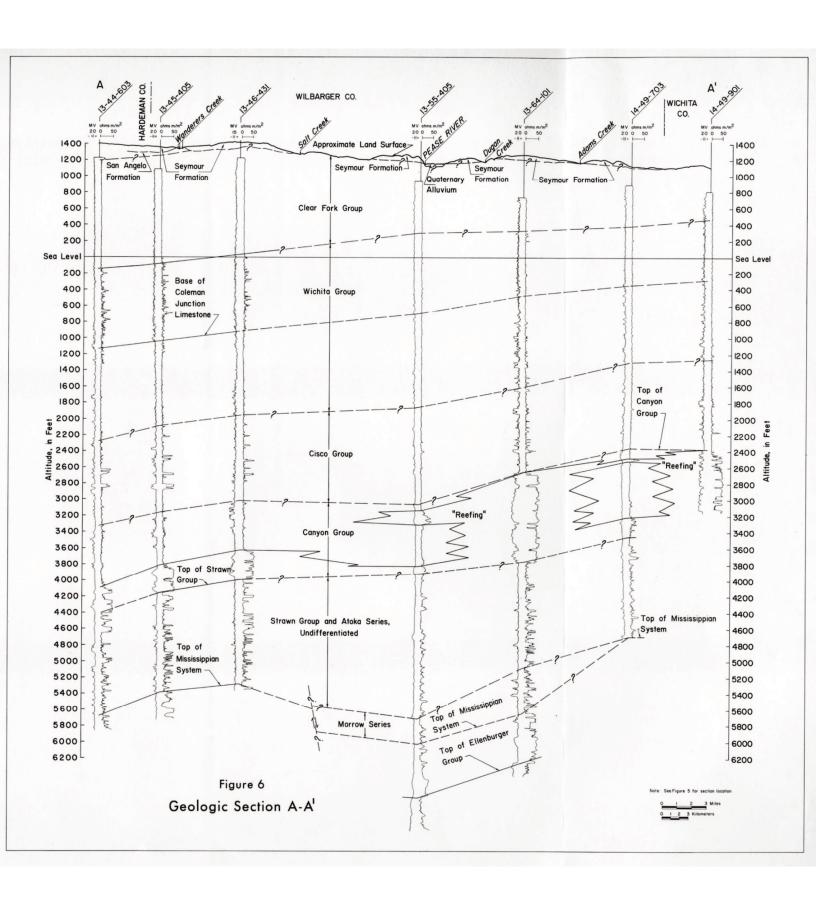
TEXAS WATER COMMISSION

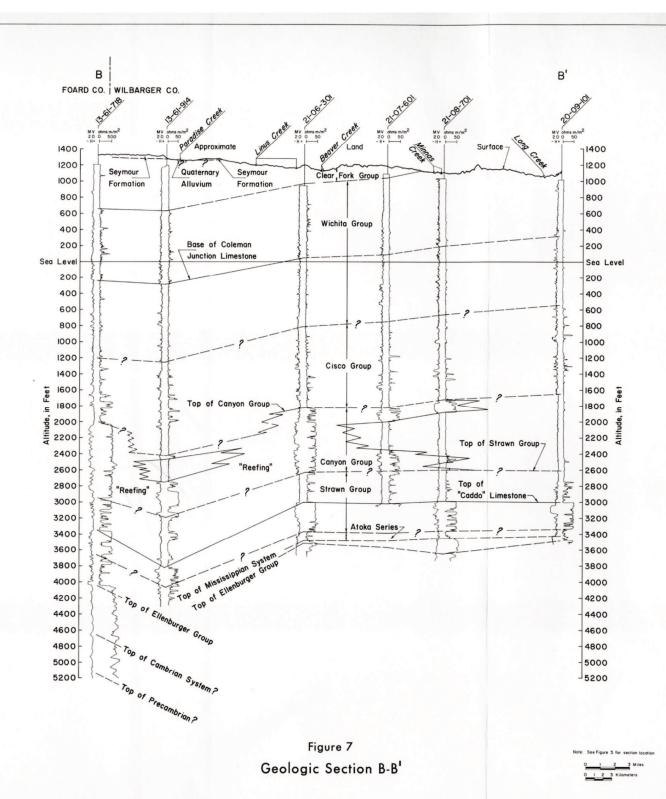
Felix McDonald, Chairman Dorsey B. Hardeman, Commissioner Joe R. Carroll, Commissioner

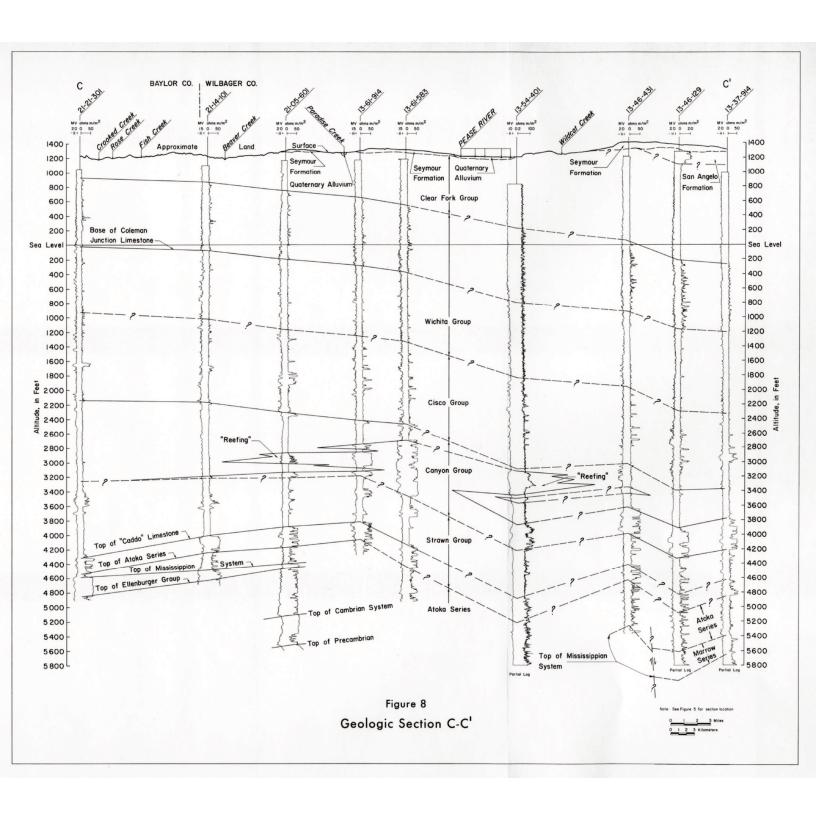
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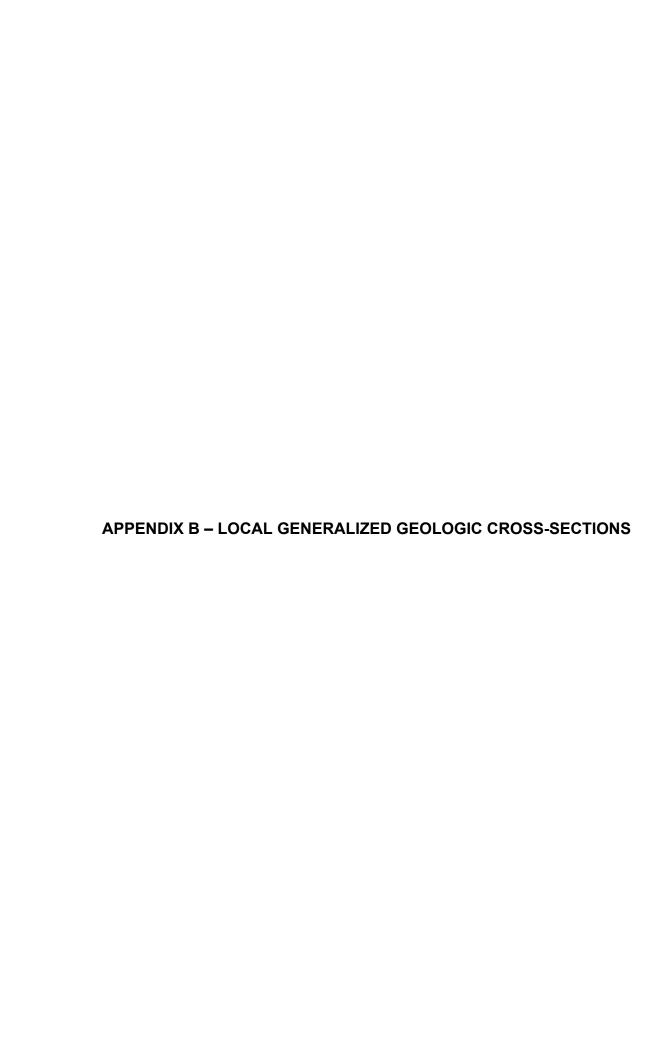
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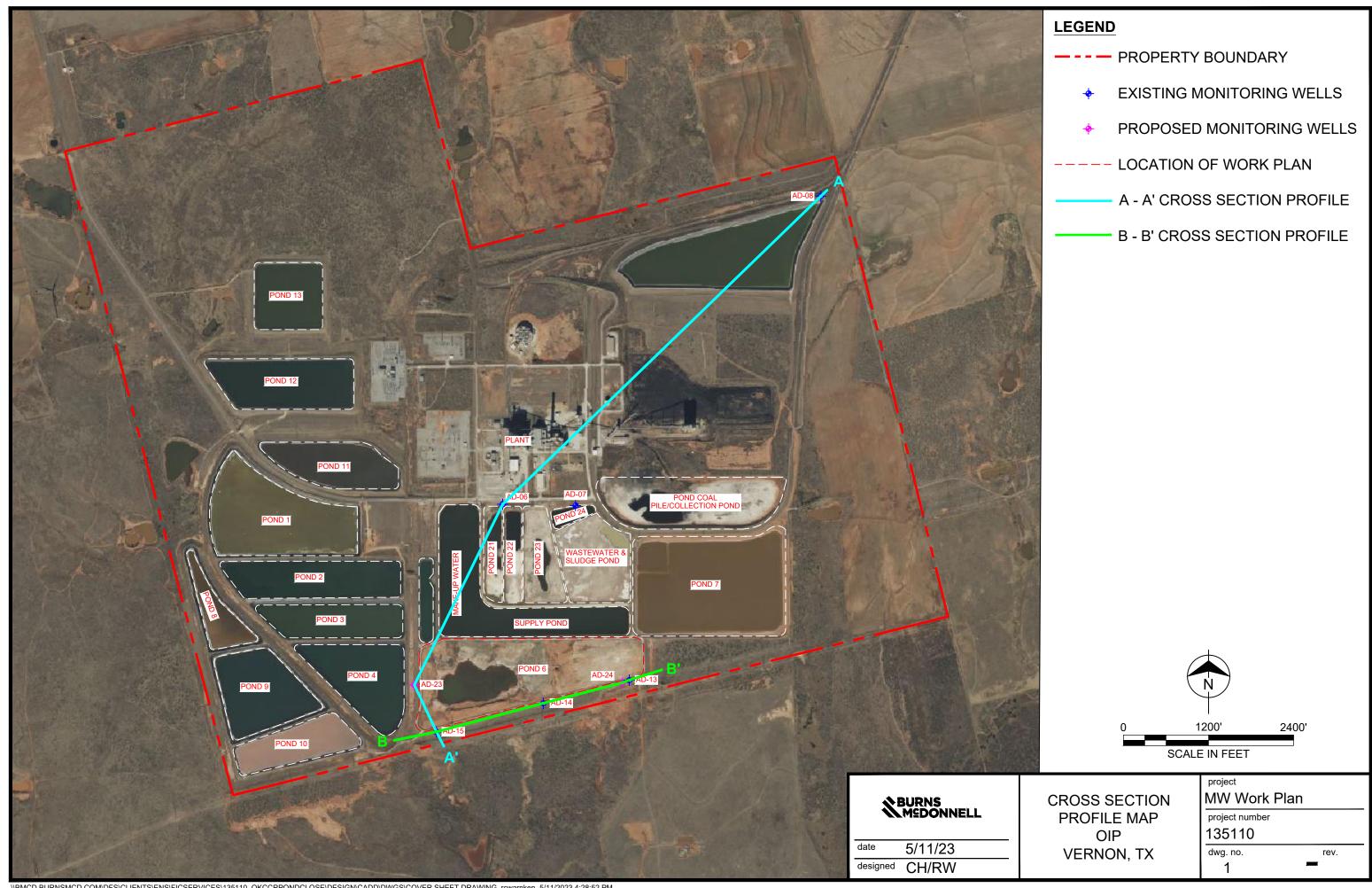


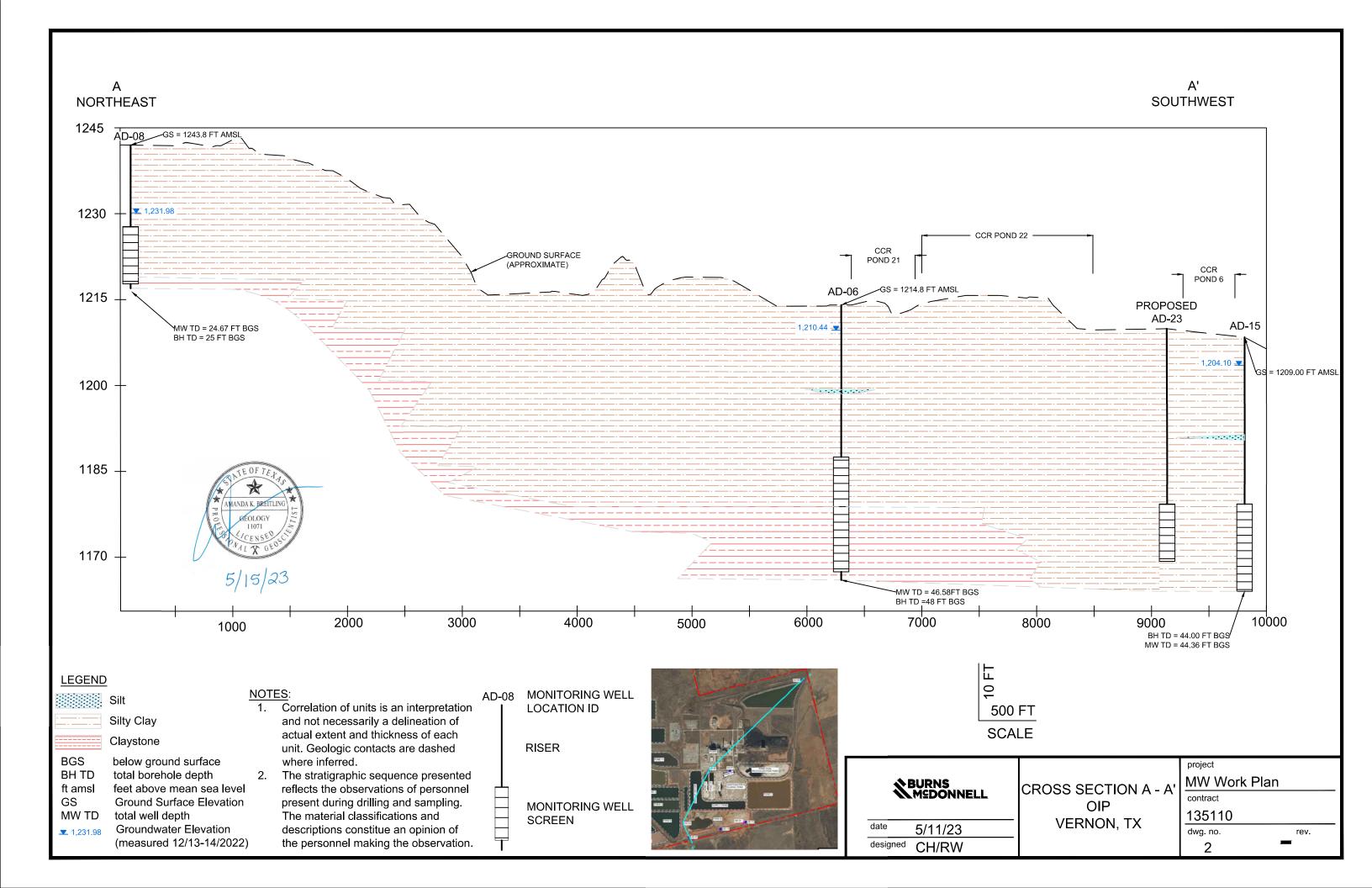


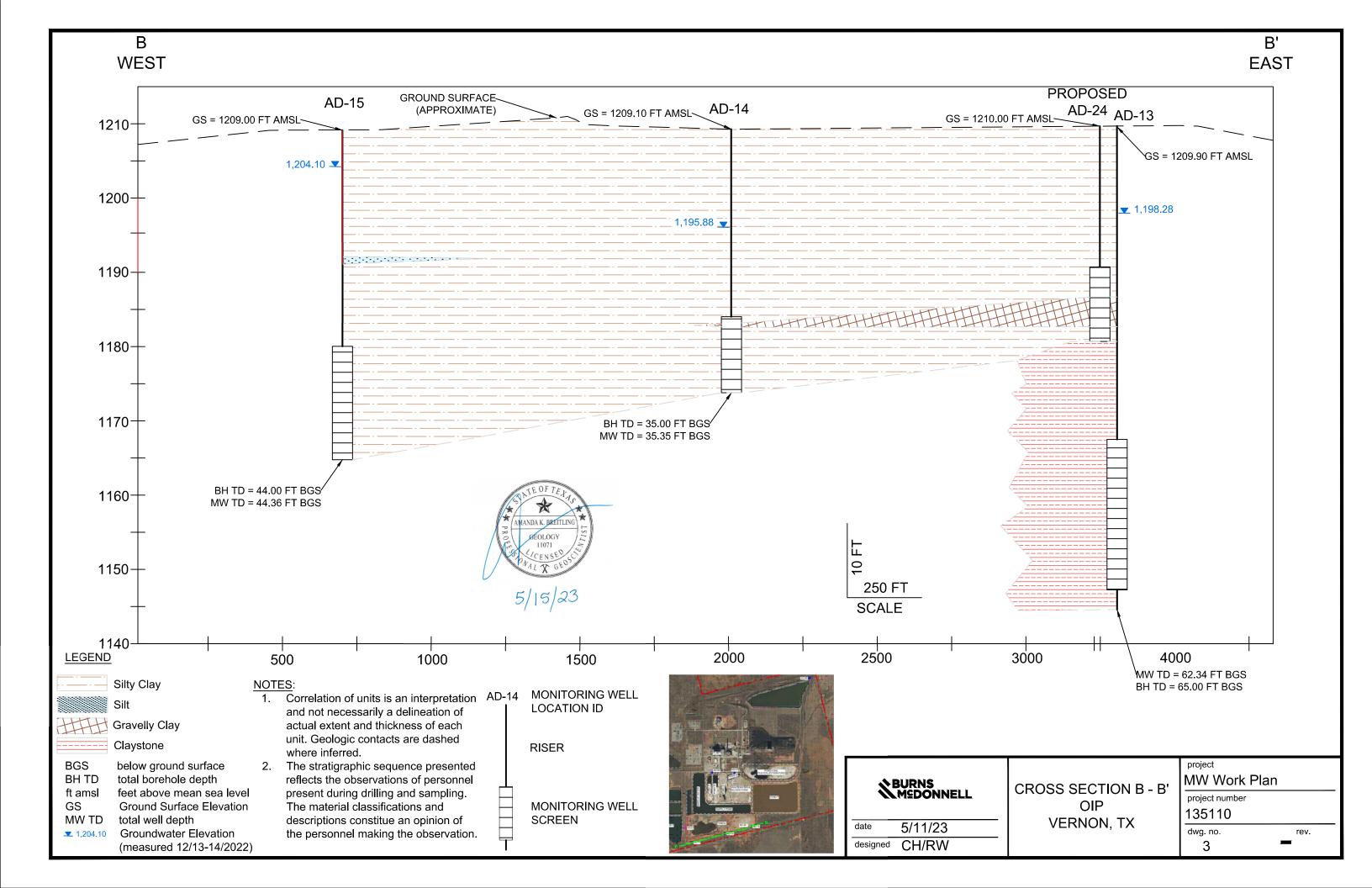












APPENDIX C - STANDARD OPERATING PROCEDURES

SOP 121 – Collection of Subsurface Soil Samples Direct-Push

SOP 501 – Utility Clearance

SOP 504 – Decontamination

SOP 521 – Field Classification and Description of Soil and Bedrock

SOP 551 – Installation and Development of Monitoring Wells and Piezometers

SOP 555 - In-Situ Hydraulic Conductivity (Slug) Testing

SOP 601 – Investigative Derived Waste Storage, Sampling, and Disposal

SOP 701 – Field Documentation

TCEQ Groundwater Classification Guidance Document - Method 2a: Well Yield by Cyclic Discharge

SOP 121 Collection of Subsurface Soil Samples Using Direct-Push

Revision 01 04/06/2018

Approved by:			
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John Hesemann, PE, Remediation Technical Service Area Leader, Environmental Services Division		Date	
Biennial Review:			
Revision/Review	Date	Responsible Party	Description of Change
Revision 01	04/06/2018	Hildebrandt, Martha	Minor grammar and reference updates.

TABLE OF CONTENTS

		<u>Page No.</u>
1.0	Purpose and Applicability	3
2.0	Summary of Method	3
3.0	Definitions	3
4.0	Safety and Health	4
5.0	Cautions	4
6.0	Personnel Qualifications	4
7.0	Equipment and Supplies	5
8.0	Procedures	5
9.0	Data and Records Management	7
10.0	Quality Assurance/Quality Control10.1 Field Duplicate Samples10.2 MS/MSDs10.3 ERBs10.4 Temperature Blanks	8 8 9
11.0	References	9
12.0	Attachments	9

1.0 PURPOSE AND APPLICABILITY

The purpose of Standard Operating Procedure (SOP) 121 Collection of Subsurface Soil Samples Using Direct-Push is to establish a uniform procedure for the collection of subsurface soil samples using a direct-push drill rig. This SOP covers the process for the collection of subsurface soil samples using direct-push; sample rationale and scope including locations, depths, required sample amounts, sample preservatives, etc. are detailed in the Project-Specific Work Plan. As Burns & McDonnell Engineering Company, Inc. (Burns & McDonnell) does not self-perform borehole drilling but instead subcontracts these services, this SOP is for the oversight and direction of the drilling subcontractor with Burns & McDonnell personnel responsible for the geologic logging and environmental sample collection. The advancement of boreholes is regulated in most states. It is the responsibility of both the Project Manager and the on-site field personnel to ascertain that state regulations are met, that the direct-push operator is properly licensed for work in that state, and that required paperwork is completed by the responsible person (typically the direct-push operator) and submitted to the proper state agency. SOP 121 Collection of Subsurface Soil Samples Using Direct-Push has been prepared in accordance with the Guidance for the Preparing of Standard Operating Procedures (USEPA, 2007) and the Burns & McDonnell Policy Manual (Burns & McDonnell, 2018).

2.0 SUMMARY OF METHOD

Subsurface soil samples collected from a direct-push rig will be collected from specific locations and depths per the Project-Specific Work Plan. Samples can be collected via sampling tool with a liner. The specific size of sampler to be used will be detailed in the Project-Specific Work Plan. Subsurface soil samples for volatile organic compound (VOC) analysis will be placed directly into the sample containers. Samples for other compounds can be directly placed into the sample container, or, if required by the Project-Specific Work Plan, homogenized (mixed) prior to placement in the sample containers.

3.0 DEFINITIONS

- **Direct-Push Machine** A direct-push machine "pushes" tools and sensors into the ground using a relatively small amount of static (vehicle) weight combined with percussion as the energy for advancing the tool string. Because the tools are "pushed," excess soil (i.e., cuttings) is not removed as in typical drilling methods.
- **Homogenization** Combining and mixing of soil to produce a uniform distribution of soil particles and other constituents throughout a composite soil.

- Project-Specific Accident Prevention Plan/Site Safety and Health Plan (Project-Specific APP/SSHP) – A plan or plans that address occupational safety and health hazards associated with site operations.
- Project-Specific Work Plan The plan(s) that details the rationale, scope, and techniques to be used
 at the site to achieve the project objectives. Project-Specific Work Plans can include work plans, field
 sampling plans, quality assurance project plans, technical memorandums, and other documentation of
 proposed work.

4.0 SAFETY AND HEALTH

Field activities as detailed in this SOP will be performed in accordance with applicable safety related documents/requirements, which may include, but are not limited to: Project-Specific APP/SSHP, the Burns & McDonnell Safety and Health Program (Burns & McDonnell, 2017), and site / client-specific requirements. Prior to any field work involving intrusive subsurface activities, utility clearance will be required per SOP 501 Utility Clearance. Care should be taken when doing any intrusive activity that could contact underground utilities. Potential health and safety issues with direct-push rigs include mechanical and hydraulic systems that result in loud repetitive noises and the potential for physical injury. Personal protective equipment (PPE) including hard hats, safety glasses, steel toed boots, gloves, and hearing protection should be worn as appropriate and as detailed in the Project-Specific APP/SSHP. PPE requirements should be assessed daily and on a per task basis.

5.0 CAUTIONS

Samples should not be homogenized if the sample is to be analyzed for a constituent that is easily volatilized. Care should be taken to limit the amount of non-soil components (rocks, sticks, roots) within the sample. If sampling for munition constituents, any projectiles or munition debris found should be removed from the sample. The description and amount of any non-soil components that are removed should be noted in the field logbook. Depths should be measured from the original surface.

6.0 PERSONNEL QUALIFICATIONS

Burns & McDonnell personnel conducting on-site environmental activities will have completed the 40-hour Occupational Safety and Health Administration (OSHA) Hazardous Waste Operations and Emergency Response (HAZWOPER) course and annual 8-hour HAZWOPER refresher courses. At a minimum, one person on site will be certified in first aid and cardiopulmonary resuscitation (CPR), and, if

multiple people are on site, at least one person will have completed the 8-hour HAZWOPER Supervisor Training course. If Burns & McDonnell subcontractors are on site then, at a minimum, one Burns & McDonnell person will have completed the OSHA 30-hour Construction Industry Outreach Training course.

7.0 EQUIPMENT AND SUPPLIES

Equipment to be used during surface soil sampling may include:

- Direct-push rig
- Sampler with liner (liner should be acetate unless otherwise indicated in the Project-Specific Work Plan)
- Mixing bowl(s) and spoon(s)
- Sample containers and sample preservatives per the Project-Specific Work Plan
- PPE and safety equipment per the Project-Specific APP/SSHP

Equipment and utensils that will be in direct contact with the sample material should be constructed of non-reactive materials and free of coatings or platings. Equipment to be used for location, logging/characterization, field measurements, decontamination, and sample labeling, packing and shipping can be found in the SOPs for those activities.

Prior to the start of field activities, the Field Site Manager and/or the Project Manager should determine that 1) necessary permits, right of entries, and utilities clearances have been obtained; 2) the Project-Specific APP/SSHP has been reviewed by Burns & McDonnell personnel participating in the work and subcontractors who will be onsite; 3) appropriate PPE has been obtained for Burns & McDonnell personnel and will be available onsite; 4) equipment and meters are available, in working order, and complete with needed components; 5) applicable safety data sheets are on site and available to the field team; and 6) sample containers provided by the laboratory are the correct size and type, are preserved, if required, per the Project-Specific Work Plan, and are sufficient in number for the planned field activities.

8.0 PROCEDURES

Subsurface soil samples collected using a direct-push rig will be collected using the following steps:

1. Using a sampling tool with a liner inserted, push the tool to the specified depth. Extract the sampling tool from the borehole and remove the sampling tool from the rod.

- 2. Open the sampling device and remove the filled liner. Either cut the liner longitudinally from top to bottom, or extrude the sample onto clean plastic. Do not allow the sample to contact other potentially contaminated material. If sufficient sample volume is present, shave the outside of the core to remove potentially smeared soil.
- 3. Describe the lithology of the sample in accordance with *SOP 521 Field Classification and Description of Soil and Bedrock* as required by the Project-Specific Work Plan. Record this information in the field logbook or on the appropriate boring log.
- 4. Collect discrete subsurface soil samples at the intervals specified in the Project-Specific Work Plan. Remove rocks and/or debris as appropriate. Clean, disposable gloves will be worn and changed after the collection of each discrete subsurface soil sample. Transfer the soil directly to the sample container unless directed by the Project-Specific Work Plan.
- 5. Do not homogenize samples for VOC analysis. For VOC samples collected by methods other than SW-846 Method 5035A, place the soil sample directly in sample containers taking care to minimalize head space, label, and place immediately on ice. For samples collected by SW-846 Method 5035A for VOC analysis, collect the soil sample per SOP 191 Collection of Soil or Sediment Samples Using an En Core® or Terra Core® Sampler. Unless specified otherwise in the Project-Specific Work Plan, soil samples for VOC analyses will be collected from the interval displaying the highest photoionization detector reading or exhibiting visual signs of contamination.
- 6. If the Project-Specific Work Plan directs homogenization of the soil sample, place the remaining sample volume from the desired interval into a decontaminated or disposable sample bowl and thoroughly homogenize the soil by mixing with a spoon or by hand while wearing clean gloves.
- 7. Place the soil in appropriate sample containers, label the containers, and place immediately in a cooler with ice. In general, sample containers will be filled in order from most volatile to least volatile constituents to be analyzed. Specific sample order, sample containers, and sample preservatives will be detailed in the Project-Specific Work Plan.
- 8. Enter the appropriate information on the chain of custody (COC) and in the field logbook in accordance with *SOP 701 Field Documentation*.
- 9. Pack the samples for shipping as specified in the Project-Specific Work Plan and SOP 592 Sample Packaging and Shipping.

- 10. Decontaminate non-disposable sampling equipment prior to the start of the sampling event and between samples as specified in *SOP 504 Decontamination*.
- 11. Unless specified otherwise in the Project-Specific Work Plan, fill and abandon the sample hole as required by backfilling with granular bentonite to approximately 2 feet from ground surface. For the interval above the groundwater table, hydrate the bentonite every foot using potable water. The top 2 feet of the borehole will be backfilled to match the surrounding environment.
- 12. Per the Project-Specific Work Plan, either mark the sample location with a lath or flag for later location or measure the location of the sample to two fixed, known locations.
- 13. Manage investigative derived waste as specified in the Project-Specific Work Plan and SOP 601 Investigative Derived Waste Storage, Sampling, and Disposal.

9.0 DATA AND RECORDS MANAGEMENT

Environmental field activities will be documented, as detailed in *SOP 701 Field Documentation*. Boring logs will be completed, as detailed in *SOP 521 Field Classification and Description of Soil and Bedrock*. Field documentation will be completed as activities are conducted and will be relayed to the Field Site Manager or Project Manager at a minimum weekly or on a more frequent basis if so stated in the Project-Specific Work Plan.

10.0 QUALITY ASSURANCE/QUALITY CONTROL

Prior to the start of any field activity, Burns & McDonnell personnel will have read and understood the Project-Specific Work Plan as well as this SOP. Field personnel will be trained for a minimum of 40 hours prior to their working alone on environmental field activities. Field documentation will be completed as activities are conducted and will be relayed to the Field Site Manager or Project Manager at a minimum weekly or on a more frequent basis if so stated in the Project-Specific Work Plan. Quality control (QC) samples will be collected in the field to aid in the determination of the validity of the analytical results. The type, number, and location of QC samples to be collected will be detailed in the Project-Specific Work Plan. Typical QC samples for subsurface soil samples include:

- Field duplicates
- Matrix spike/matrix spike duplicates (MS/MSDs)
- Equipment rinsate blanks (ERBs)
- Temperature blanks

10.1 Field Duplicate Samples

Field duplicate samples will be obtained at the same time and analyzed for the same set of parameters as the investigative sample they are intended to replicate. Field duplicates are used to assess precision, including variability associated with both the laboratory analysis and the sample collection process. For soil samples that are collected from a core, the core will be halved lengthwise and the original and the field duplicate will be collected from each of the facing halves. For samples that are homogenized, the sample within the bowl will be halved and the original sample will be collected from one half and the duplicate from the other half. The original and duplicate samples will be placed in separate, but identical, containers and preserved in the same manner. Both the original and the duplicate will be sent to the primary laboratory or on-site laboratory, as applicable, and analyzed for the same analytical parameters. Field samples will be identified with unique sample identification numbers. Field duplicates will be numbered to be blind to the laboratory. Sample locations where field duplicate samples are collected will be documented in the field logbook. Field duplicates are typically taken on 10 percent of the original samples collected.

10.2 MS/MSDs

MS/MSDs will be analyzed for the same constituents as the original sample. MS/MSD samples provide information on matrix interference encountered during extraction, digestion, and analysis (i.e., suppression or enhancement of instrument signals). MS samples are principally used to evaluate accuracy by measuring recovery of the spiked compounds. When the MS sample is used together with an associated MSD sample, information is obtained on analytical precision. Soil samples will be collected in triplicate volume at certain locations also, unless previous arrangements have been made with the analytical laboratory regarding sample volume requirements. Soil MS/MSD samples for VOCs analyses will always be collected in triplicate; the samples will be identified as the original, MS, and MSD and will be collected in the same manner as the duplicate samples. The COC will be completed to notify the laboratory that a MS/MSD should be completed in addition to the original sample.

MS/MSDs are typically taken on 5 percent of the original samples collected; however, some projects may require a site-specific MS/MSD for each batch analyzed at the laboratory. For analytical methods with short holding times (i.e., fewer than 7 days), it may be necessary to collect MS/MSDs at a frequency of greater than 5 percent. The analytical laboratory should be consulted regarding their MS/MSD batching needs when requesting sample analysis for short holding time methods.

10.3 ERBs

ERBs will be prepared for non-dedicated sampling equipment used to collect soil samples for chemical analyses. For direct-push soil sampling, ERBs are typically taken from the shoe of the sampler. ERBs are used to evaluate potential cross-contamination between samples caused by residual contamination on the sampling equipment. To prepare an ERB, the portion of the equipment that could potentially touch a sample will be decontaminated per *SOP 504 Decontamination* and then rinsed with analyte-free water. The water from the post-decontamination rinse (i.e., rinsate) will be placed directly into specified aqueous sample containers, labeled as the ERB, placed into a cooler with ice, and analyzed for the same parameters as the original soil sample. The type of water and batch number, if using laboratory grade water, used to prepare the ERB will be noted in the field logbook. ERBs are typically not required for disposable equipment that is not reused. ERBs are typically taken a minimum of one per sample type per sample event.

10.4 Temperature Blanks

Temperature blanks consist of small containers filled with water that are included in each cooler. The temperature of each blank will be measured by laboratory personnel upon arrival at the laboratory to determine if method-specific preservative requirements (i.e., ≤ 4 °C) were met. Temperature blanks are often prepared by the laboratory and included with the sample container order shipment to Burns & McDonnell.

11.0 REFERENCES

Burns & McDonnell Engineering, Co, Inc. (Burns & McDonnell), 2015. Policy Manual,

- Chapter 8, Employee Safety & Health, April 2017.
- Chapter 10, Quality Control Manual, January 2017.

United States Environmental Protection Agency (USEPA), 2007. *Guidance for Preparing Standard Operating Procedures*. EPA/600/B-07/001. April

12.0 ATTACHMENTS

None.

SOP 501 Utility Clearance

Revision 0 01/06/2017

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Alatha L. Hildebardt			01/17/2017	
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Biennial Review:				
Revision/Review	Date	Responsible Party	Description of Change	

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TABLE OF CONTENTS

	<u>Page</u>	<u>e No.</u>
1.0	Purpose and Applicability	3
2.0	Summary of Method	3
3.0	Definitions	3
4.0	Health and Safety	3
5.0	Cautions	4
6.0	Personnel Qualifications	4
7.0	Equipment and Supplies	4
8.0	Procedures	4
9.0	Data and Records Management	5
10.0	Quality Assurance/Quality Control	5
11.0	References	5
12.0	Attachments	6

1.0 PURPOSE AND APPLICABILITY

The purpose of *Standard Operating Procedure (SOP) 501 Utility Clearance* is to establish a uniform procedure for field personnel to use for utility clearance prior to intrusive work at an environmental site. This SOP covers the *process* for the utility clearance; specifics of the utility clearance including property ownership and potential utilities are detailed in the Project-Specific Work Plan and the Project-Specific Accident Prevention Plan/Site Safety and Health Plan (Project-Specific APP/SSHP). *SOP 501 Utility Clearance* has been prepared in accordance with the *Guidance for the Preparing of Standard Operating Procedures* (USEPA, 2007) and the Burns & McDonnell Engineering Company, Inc. (Burns & McDonnell) *Policy Manual* (Burns & McDonnell, 2015).

2.0 SUMMARY OF METHOD

Prior to any field work involving intrusive activities, utility clearance will be required. Subcontractor or Burns & McDonnell personnel will locate utilities with the aid of state-mandated utility location services, private utility location services, as-built drawings, client personnel, and/or individual property owners. Typically utility locates are the responsibility of the subcontractor conducting the intrusive activities; however, in some cases, such as hand augering, the intrusive activities are being conducted by Burns & McDonnell, in which case, Burns & McDonnell is responsible for the utility clearance prior to the start of the intrusive activities.

3.0 DEFINITIONS

- Project-Specific Accident Prevention Plan/Site Safety and Health Plan (Project-Specific APP/SSHP) – A plan or plans that address occupational safety and health hazards associated with site operations.
- Project-Specific Work Plan The plan that details the rationale, scope, and techniques to be used at
 the site to achieve the project objectives. Project-Specific Work Plans can include work plans, field
 sampling plans, quality assurance project plans, technical memorandums, and other documentation of
 proposed work.

4.0 HEALTH AND SAFETY

Utility clearance is required prior to conducting any intrusive activity at a site. Hitting a utility can result in property destruction, injury, or even death. Work may be stopped at <u>any</u> time by <u>any</u> team personnel due to utility concerns. At some locations, client requirements will include additional precautions for utility clearance such as using an air knife, hydro vacuum, and/or soil vacuum.

Field activities as detailed in this SOP will be performed in accordance with applicable safety related documents/requirements which may include, but are not limited to: Project-Specific APP/SSHP, the Burns & McDonnell Corporate *Safety and Health Program* (Burns & McDonnell 2015), and site / client-specific requirements.

5.0 CAUTIONS

See Section 4.0

6.0 PERSONNEL QUALIFICATIONS

Burns & McDonnell personnel conducting on-site environmental activities will have completed the 40-hour Occupational Safety and Health Administration (OSHA) Hazardous Waste Operations and Emergency Response Standard (HAZWOPER) course and annual 8-hour HAZWOPER refresher courses. At a minimum, one person on site will be certified in first aid and cardiopulmonary resuscitation (CPR) and, if multiple people are on site, at least one person will have completed the 8-hour HAZWOPER Supervisor Training course. If Burns & McDonnell subcontractors are on site then, at a minimum, one Burns & McDonnell person will have completed the OSHA 30-hour Construction Industry Outreach Training course.

7.0 EQUIPMENT AND SUPPLIES

Equipment and supplies are the responsibility of the subcontractor or utility location service.

8.0 PROCEDURES

Utility clearance activities start during the project planning process. Information on the location of utilities should be requested from the client and locations and potential locations of utilities should be avoided when planning sample locations.

A minimum of two full business days' notification is required for most state one-calls prior to commencing intrusive activities. Utility clearance activities, including the ticket number, request date and end date, utilities notified, and the names and companies of persons granting utility clearance will be documented on the ticket and in the field logbook. If a subcontractor is performing the utility clearance, a copy of the utility clearance ticket will be requested for documentation purposes. The Field Site Manager should track the effective date of the utility clearance and check that the utility clearance has been renewed prior to the ticket expiring.

Specific utility clearance procedures will be detailed in the Project-Specific Work Plan and the Project-Specific APP/SSHP. At a minimum, drilling rigs/equipment will be positioned such that they are no closer than the lesser of the height of the mast/tallest part of the equipment or 20 feet of overhead lines with voltages 0-50 kV; for other voltages refer to 29 CFR 1926.550 (a) (15) and 29 CFR 1910.333 (i) (1). Other vehicles will remain a minimum lateral distance of 30 feet from overhead utilities to reduce the possibility of arcing. Intrusive activities will be no closer than 10 feet from buried utilities. Specific procedures for any activities that are closer than 10 feet will be detailed in the Project-Specific Work Plan and in the Project-Specific APP/SSHP.

Due to the presence of underground or overhead utilities, it may be necessary to offset boring locations. This will be done with the approval of the Field Site Manager and documented in the field logbook. Notification of the relocation of boring locations due to utility or other interference will be reported to the Project Manager by the Field Site Manager immediately.

9.0 DATA AND RECORDS MANAGEMENT

A copy of the utility clearance ticket number will be kept in the project file and notes regarding utility location activities will be maintained in the field logbook as described in *SOP 701 Field Documentation*. Field documentation will be completed as activities are conducted and will be relayed to the Field Site Manager or Project Manager at a minimum weekly or on a more frequent basis if so stated in the Project-Specific Work Plan. The client will be notified if data collected in the field screening indicates unmarked or unknown underground lines are present so that they can update their records.

10.0 QUALITY ASSURANCE/QUALITY CONTROL

Prior to the start of any field activity, Burns & McDonnell personnel will have read and understood the Project-Specific Work Plan as well as this SOP. Field personnel will be trained for a minimum of 40 hours prior to their working solo on environmental field activities.

11.0 REFERENCES

Burns & McDonnell Engineering, Co, Inc. (Burns & McDonnell), 2015. Policy Manual,

- Chapter 10, Quality Control Manual, January.
- Chapter 8, Safety and Health Manual, February.

United States Environmental Protection Agency (USEPA), 2007. *Guidance for Preparing Standard Operating Procedures*. EPA/600/B-07/001. April

12.0 ATTACHMENTS

None.

SOP 504 Decontamination

Revision 000 01/06/2017

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Revision/Review	Date	Responsible Party	Description of Change
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TABLE OF CONTENTS

	<u>Pa</u>	<u>ige No.</u>	
1.0	Purpose and Applicability	3	
2.0	Summary of Method		
3.0	Definitions		
4.0	Health and Safety		
5.0	Cautions	4	
6.0	Personnel Qualifications		
7.0	Equipment and Supplies	5	
8.0	Procedures	5	
	8.1 Decontamination of Non-Dedicated Bladder Pumps		
	8.2 Decontamination of Other Sample-Contacting Equipment		
	8.3 Decontamination of Meters and Probes		
	8.4 Decontamination of Non-Sample-Contacting Equipment	8	
9.0	Data and Records Management	8	
10.0	Quality Assurance/Quality Control	9	
11.0	References		
12 N	Attachments	٥	

1.0 PURPOSE AND APPLICABILITY

The purpose of *Standard Operating Procedure (SOP) 504 Decontamination* is to establish a uniform procedure for field personnel in the decontamination of environmental equipment. Proper equipment decontamination is essential in ensuring the quality and integrity of samples collected during a given sampling event. This SOP covers the *process* for the equipment decontamination; specifics of decontamination including decontamination fluids and rinses, location of decontamination places and pad, and extra washes and rinses to be used are detailed in the Project-Specific Work Plans. *SOP 504 Decontamination* has been prepared in accordance with the *Guidance for the Preparing of Standard Operating Procedures* (USEPA, 2007) and the Burns & McDonnell Engineering Company, Inc. (Burns & McDonnell) *Policy Manual* (Burns & McDonnell, 2015).

2.0 SUMMARY OF METHOD

Decontamination is the process of removing contamination from equipment prior and post sampling. Removing contaminants from equipment minimizes the likelihood of sample cross contamination, reduces transfer of contaminants to clean areas, and prevents the mixing of incompatible substances. Decontamination is typically includes both physical (scrubbing) and chemical (soap and acid or solvent rinses). It is important that decontamination is performed using materials and equipment that can effectively remove anticipated contaminants of concern while not damaging the equipment. After decontamination, equipment should be handled only by personnel wearing clean gloves and moved out of the decontamination area to prevent re-contamination.

3.0 DEFINITIONS

- **Distilled Water** Water that has had many of its impurities removed through distillation. Distillation involves boiling the water and then condensing the steam into a clean container.
- Laboratory Grade Detergent A detergent formulated specifically for use in laboratories to be clean rinsing and phosphate free. Standard brands include Alconox® and Liquinox®.
- Potable Water Treated municipal water or well water used and approved for drinking.
- Project-Specific Accident Prevention Plan/Site Safety and Health Plan (Project-Specific APP/SSHP) – A plan or plans that address occupational safety and health hazards associated with site operations.

Project-Specific Work Plan – The plan that details the rationale, scope, and techniques to be used at
the Site to achieve the project objectives. Project-Specific Work Plans can include work plans, field
sampling plans, quality assurance project plans, technical memorandums, and other documentation of
proposed work.

4.0 HEALTH AND SAFETY

Field activities as detailed in this SOP will be performed in accordance with applicable safety related documents/requirements which may include, but are not limited to: Site Safety and Health Plans, the Burns & McDonnell Corporate *Safety and Health Program* (Burns & McDonnell, 2015), and site / client-specific requirements. Personal protective equipment (PPE) including safety glasses and gloves should be worn as appropriate and as detailed in the Project-Specific APP/SSHP. Rinses such as acids and solvents should be handled with care during transportation to and from the site and stored properly while on site. A Safety Data Sheet should be on site for all chemical rinses.

5.0 CAUTIONS

High concentrations of contaminants or the requirement of very low detection levels may require decontamination procedures that are more stringent than that described in this SOP. This should be considered during work plan development but also recognized if encountered in the field.

Prior to field mobilization, the expected types of contamination should be evaluated to determine if the field cleaning and decontamination activities will generate rinsates and other wastewaters that might be considered Resource Conservation and Recovery Act (RCRA) hazardous waste thus require special handling and disposal procedures.

Care should be taken to remove all visible potential contamination from sample equipment to prevent cross contamination which could result in false positive analytical results.

6.0 PERSONNEL QUALIFICATIONS

Burns & McDonnell personnel conducting on-site environmental activities will have completed the 40-hour Occupational Safety and Health Administration (OSHA) Hazardous Waste Operations and Emergency Response Standard (HAZWOPER) course and annual 8-hour HAZWOPER refresher courses. At a minimum, one person on site will be certified in first aid and cardiopulmonary resuscitation (CPR) and, if multiple people are on site, at least one person will have completed the 8-hour HAZWOPER Supervisor Training course. If Burns & McDonnell subcontractors are on site then, at a minimum, one

Burns & McDonnell person will have completed the OSHA 30-hour Construction Industry Outreach Training course.

7.0 EQUIPMENT AND SUPPLIES

Typical decontamination equipment and supplies include the following items:

- Potable water
- Distilled water
- Non-phosphate laboratory-grade detergent
- Wash bottles
- Buckets
- Scrub brushes
- Plastic sheeting
- Garbage bags
- PPE and safety equipment per the Project-Specific APP/SSHP

Additional rinsates including methanol, isopropyl, and hexane, may be required dependent upon the chemicals of concern.

Prior to the start of field activities, the Field Site Manager and/or the Project Manager should determine that 1) necessary permits, and right of entries have been obtained; 2) the Project-Specific APP/SSHP has been reviewed by Burns & McDonnell personnel participating in the work and subcontractors who will be on site; 3) appropriate PPE has been obtained for Burns & McDonnell personnel and will be available on site; and 4) equipment and meters are available, in working order, and complete with needed components.

8.0 PROCEDURES

8.1 Decontamination of Non-Dedicated Bladder Pumps

Non-dedicated bladder pumps will be decontaminated according to the following procedure:

1. Leave or attach approximately 4 feet of air supply and water discharge tubing to the pump. Place the pump inside a 5-foot section of 2-inch inside diameter polyvinyl chloride (PVC) pipe that has one end capped.

- Attach the air supply tube to the controller, which is attached to the compressed air source, and
 direct the discharge tube back into the pipe to recirculate the wash water. Fill the PVC pipe with
 distilled or potable water, adding approximately one-half teaspoon of non-phosphate, laboratorygrade detergent.
- 3. Turn on the pump and circulate the wash water for approximately one minute.
- 4. Direct the discharge into a bucket and pump the detergent water from the PVC pipe.
- 5. Pump 3 to 5 liters of distilled water through the pump, adding water to the pipe as needed, to rinse the detergent from the pump.
- 6. Retain decontamination fluids per SOP 601 Investigative Derived Waste Storage, Sampling, and Disposal.

8.2 Decontamination of Other Sample-Contacting Equipment

Non-disposable and other non-dedicated equipment which contacts the sample will be decontaminated prior to the collection of each sample and at the close of each day. This equipment includes, but is not limited to, sampling knives and spoons, mixing bowls, split-sampling barrels, direct-push shoes and subs, and reusable containers.

Sampling equipment will be decontaminated according to the following procedure:

- 1. Fill a nonmetallic wash tub or bucket to a depth of approximately 6 inches with potable water. Mix a detergent solution in the tub. The solution shall consist of approximately 1 tablespoon of non-phosphate laboratory-grade detergent (e.g. Liquinox) per gallon of water.
- 2. Scrub sampling equipment with a stiff-bristled brush and detergent solution to physically remove visible gross contamination.
- 3. Transfer the equipment to another wash tub partially filled with distilled water and rinse.
- 4. Rinse the sampling equipment again with fresh distilled water.
- 5. Place the equipment on clean plastic and allow it to air dry.
- 6. Store the equipment covered with plastic or aluminum foil upon the completion of decontamination.

7. Retain decontamination fluids per *SOP 601 Investigative Derived Waste Storage, Sampling, and Disposal.*

8.3 Decontamination of Meters and Probes

Meter probes, water level indicator and oil/water interface probe, will be decontaminated prior to use at each sample location and at the close of each day. Water indicator probes and tapes will be decontaminated per the following procedure.

- 1. As the tape is being reeled onto the instrument, the tape will be wiped with paper towels that have been sprayed or dampened with a detergent solution. The solution shall consist of approximately 1 tablespoon of non-phosphate laboratory-grade detergent (e.g. Liquinox) per gallon of water.
- 2. Decontaminate the probe portion of the instrument by spraying with the detergent solution then rinsing with water. If sediment is present on the probe, then ensure the sediment is removed by the cleaning followed by a distilled water rinse.

If nonaqueous phase liquids are encountered or if the measured media is severely impacted, then decontaminate water level indicators and oil/water interface probes by:

- 1. Fill a nonmetallic wash tub or bucket to a depth of about 6 inches with potable water. Mix a detergent solution in the tub. The solution shall consist of approximately 1 tablespoon of non-phosphate laboratory-grade detergent (e.g. Liquinox) per gallon of water.
- 2. Clean the portions of the meters and probes that had contact with site media with the detergent solution.
- 3. Rinse the portions of the meters and probes with distilled water.
- 4. Place the equipment on clean plastic and allow it to air dry.
- 5. Store the equipment in the provided case or covered with plastic or aluminum foil.
- 6. Retain decontamination fluids per SOP 601 Investigative Derived Waste Storage, Sampling, and Disposal.

Instruments such as pH meters, conductivity meters, and other instruments that do not come into contact with the material that will be collected for analysis may be decontaminated by thoroughly rinsing the instrument probes.

8.4 Decontamination of Non-Sample-Contacting Equipment

Down-hole sampling tools such as drill string, augers, and direct-push rods, as well as drill rigs and direct-push trucks/vans, will be decontaminated prior to the start of work on site, between each borehole, and prior to leaving the site. Decontamination of subcontractor-owned equipment is typically the responsibility of the subcontractor. Decontamination should be according to the following procedure:

- 1. Construct a three-sided decontamination pad using planks as a frame and plastic sheeting as the bottom. The pad should be constructed on a slight slope with the open side facing uphill.
- 2. Back the drill rig or direct-push rig into the decontamination pad or place equipment in a rack off the ground inside the pad.
- 3. Use pressurized, potable water to completely remove visible soil and contamination from surfaces. Include the inside of drill string, augers, and direct-push rods. If necessary, use a stiff-bristled brush to remove soil and contamination. Dependent upon the contaminant present, the Project-Specific Work Plan may require the use of hot, pressurized water with laboratory grade detergent. The use of a detergent wash will require a rinse with potable water.
- 4. Place the equipment on clean plastic and allow to air dry.
- 5. Store equipment and cover with plastic after decontamination.
- 6. Retain decontamination fluids as described in SOP 601 Investigative Derived Waste Storage, Sampling, and Disposal.

9.0 DATA AND RECORDS MANAGEMENT

A documentation of field activities will be maintained in the field logbook as described in *SOP 701 Field Documentation*. Field documentation will be completed as activities are conducted and will be relayed to the Field Site Manager or Project Manager at a minimum weekly or on a more frequent basis if so stated in the Project-Specific Work Plan.

10.0 QUALITY ASSURANCE/QUALITY CONTROL

Equipment rinstate blanks (ERBs) are often collected from non-disposable, sample-contacting equipment to determine if cross contamination is occurring. Procedures for the collection of ERBs can be found in the SOPs for the specific sampling method.

Prior to the start of any field activity, Burns & McDonnell personnel will have read and understood the Project-Specific Plans as well as this SOP. Field personnel will be trained for a minimum of 40 hours prior to their working solo on environmental field activities.

11.0 REFERENCES

Burns & McDonnell Engineering, Co, Inc. (Burns & McDonnell), 2015. Policy Manual,

- Chapter 10, Quality Control Manual, January.
- Chapter 8, Safety and Health Manual, February.

United States Environmental Protection Agency (USEPA), 2007. *Guidance for Preparing Standard Operating Procedures*. EPA/600/B-07/001. April

12.0 ATTACHMENTS

None.

SOP 521 Field Classification and Description of Soil and Bedrock

Revision 0 01/06/2017

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Revision/Review	Date	Responsible Party	Description of Change

TABLE OF CONTENTS

	<u>Pa</u>	ge No.		
1.0	Purpose and Applicability	3		
2.0	Summary of Method	3		
3.0	Definitions			
4.0	Health and Safety	4		
5.0	Cautions	4		
6.0	Personnel Qualifications4			
7.0	Equipment and Supplies	5		
3.0	Procedures 8.1 Borehole Logging 8.2 Excavation Logging 8.3 Characterization of Soils (Unconsolidated Material) 8.4 Characterization of Rock (Consolidated Material) 8.5 Preparation of Bedrock Core for Storage	6 9 9		
9.0	Data and Records Management	11		
10.0	Quality Assurance/Quality Control	12		
11.0	References 12			
12.0	Attachments12			

1.0 PURPOSE AND APPLICABILITY

The purpose of *Standard Operating Procedure (SOP) 521 Field Classification and Description of Soil and Bedrock* is to establish a uniform procedure for the description and classification of soil and bedrock during sampling and site characterization, for documenting excavations and borings, and for the preparation of bedrock core for storage at environmental sites. This SOP covers the *process* for the soil and bedrock characterization; rationale and scope including locations, depths, number of measurements, etc. are detailed in the Project-Specific Work Plan. *SOP 521 Field Classification and Description of Soil and Bedrock* has been prepared in accordance with the *Guidance for the Preparing of Standard Operating Procedures* (USEPA, 2007) and the Burns & McDonnell Engineering Company, Inc. (Burns & McDonnell) *Policy Manual* (Burns & McDonnell, 2015).

2.0 SUMMARY OF METHOD

Field classification of soil and bedrock consists of characterizing soil and bedrock samples and cuttings by standard methods resulting in consistent descriptions of the subsurface materials. Soils are classified by the Unified Soil Classification System (ASTM, 2011) for both major and minor components. Soil should also be described for color, moisture, plasticity, size, grading, consistency/density and depositional type, as appropriate (see attachment TS-GT-3-1). Bedrock should be classified by rock type then described by color, hardness, texture, weathering, and other significant features. Soil and bedrock samples will be logged by an experienced on-site geologist, geotechnical engineer, or other trained scientist or engineer. Soil and bedrock logging will be documented as appropriate in boring logs, excavation logs, and field logbooks.

3.0 DEFINITIONS

- Drilling Log Burns & McDonnell Forms WCI-OP3-1/3-2, WCD-2-1/2-2; MRK Forms 55/55-2
 (United States Army Corps of Engineers [USACE] projects); or other forms as specified in the Project-Specific Work Plan used to document soil and bedrock descriptions and classifications.
- Drill Rig Mechanically driven equipment used to advance a borehole for the collection of soil or bedrock samples for geologic or geotechnical characterization or chemical analysis.
- Project-Specific Accident Prevention Plan/Site Safety and Health Plan (Project-Specific APP/SSHP) – A plan or plans that address occupational safety and health hazards associated with site operations.

Project-Specific Work Plan – The plan that details the rationale, scope, and techniques to be used at
the site to achieve the project objectives. Project-Specific Work Plans can include work plans, field
sampling plans, quality assurance project plans, technical memorandums, and other documentation of
proposed work.

4.0 HEALTH AND SAFETY

Field activities as detailed in this SOP will be performed in accordance with applicable safety related documents/requirements which may include, but are not limited to: Project-Specific APP/SSHP, the Burns & McDonnell *Corporate Safety and Health Program* (Burns & McDonnell, 2015), and site / client-specific requirements. For any intrusive activities, *SOP 501 Utility Clearance* should be followed. Potential health and safety issues with drill rigs include mechanical and hydraulic systems that result in loud repetitive noises and the potential for physical injury. Personal protective equipment (PPE) including hard hats, safety glasses, steel toed boots, and hearing protection should be worn as appropriate and as detailed in the Project-Specific APP/SSHP.

5.0 CAUTIONS

Because field identification of soil is a learned skill, results may vary due to experience, weather conditions, and type of sampling. Soil and bedrock should be logged in a clear and concise manner. The logger should take care to follow the same order for descriptions throughout the logging process with the main constituent of the soil or rock as the first word of the description. Ensure that the color chart being used is appropriate for the media logged and that both the color name and color notation are included. Note, where possible, when fractures or partings are caused by drilling and are not naturally occurring. The logger should take care that the material being logged is native material and not slough from an upper portion of the boring. Note where soil or rock core has not been recovered. If the logger is unsure where in the interval the recovered portion should be assigned, this also should be documented on the log. Document on the log if the soil or bedrock was characterized based upon cuttings. Photos of soil or bedrock cores should include a scale and labeling of date, boring, and interval.

6.0 PERSONNEL QUALIFICATIONS

Burns & McDonnell personnel conducting on-site environmental activities will have completed the 40-hour Occupational Safety and Health Administration (OSHA) Hazardous Waste Operations and Emergency Response Standard (HAZWOPER) course and annual 8-hour HAZWOPER refresher courses. At a minimum, one person on site will be certified in first aid and cardiopulmonary resuscitation (CPR)

and, if multiple people are on site, at least one person will have completed the 8-hour HAZWOPER Supervisor Training course. If Burns & McDonnell subcontractors are on site then, at a minimum, one Burns & McDonnell person will have completed the OSHA 30-hour Construction Industry Outreach Training course.

7.0 EQUIPMENT AND SUPPLIES

Equipment to be used during soil and bedrock logging typically includes:

- Munsell color chart (soil or rock, as appropriate)
- Boring logs including
 - WCD-2-1/2-2 Burns & McDonnell forms for environmental borings
 - WCI-OP3-1/3-2 Burns & McDonnell forms for geotechnical borings
 - MRK Forms 55/55-2 USACE forms typically used on Department of Defense Sites
- Folding ruler (engineer scale) or tape measure (engineer scale)
- Utility knife
- Indelible marking pen
- Hand lens
- Camera
- Paper towels
- Plastic sheeting
- Hand sprayer or wash bottle
- Dilute hydrochloric acid solution (10%)
- Aluminum foil and/or plastic wrap
- Rock Hammer
- Chisel
- Handsaw
- Core boxes
- Wooden blocks or spacers
- Laths, stakes, and or flags
- Drilling or excavation forms/field logbooks
- PPE and safety equipment per the Project-Specific APP/SSHP

Equipment to be used for decontamination and documentation can be found in the SOPs for those activities.

Prior to the start of field activities, the Field Site Manager and/or the Project Manager should determine that 1) necessary permits, right of entries, and utilities clearances have been obtained; 2) the Project-Specific APP/SSHP has been reviewed by Burns & McDonnell personnel participating in the work and subcontractors who will be on site; 3) appropriate PPE has been obtained for Burns & McDonnell personnel and will be available on site; 4) sample equipment and meters are available, in working order, and complete with needed components; and 5) core boxes or storage containers are the correct size and type; and are sufficient in number for the planned field activities.

8.0 PROCEDURES

8.1 Borehole Logging

The procedures and requirements listed below will be followed for borehole logging in the field. Where a specific location on a form is noted and the forms differ, the first description will be for Burns & McDonnell's WCD-2-1/2-2 or WCI-OP3-1/3-2 forms and the second for USACE's MRK 55/55-2 forms. MRK 55/55-2 forms should meet the requirements put forth in the USACE guidance document entitled *Engineering and Design - Monitor Well Design, Installation, and Documentation at Hazardous, Toxic, and Radioactive Waste Sites*, EM 1110-1-4000 (USACE, 1998).

- 1. Boreholes will be logged at the drilling site as the holes are drilled. A geologic log should be prepared for each borehole in the field by a qualified geologist, scientist, or engineer; however, a single geologic log maybe prepared for nested wells that are located in close proximity to each other, if so directed by the Project-Specific Work Plan. The logs will be hand printed, neatly and legibly, using an appropriate scale and will be based upon the unconsolidated and consolidated material samples and cuttings collected.
- 2. The drilling logs must be filled out as completely as possible where appropriate and as the applicable data are available. The information in the header of the first page of the borehole log including the size and type of sampler or coring bit and barrel will be completed for each borehole. "NA" will be written on the forms for entries that are not applicable (e.g., "NA" is written in the <u>Bedrock</u> <u>Footage/Depth to Bedrock</u> section if bedrock is not encountered in the borehole).
- 3. The scale of the log shall be one inch equals one foot unless otherwise noted in the Project-Specific Work Plan.

- 4. Stratigraphic or lithologic changes encountered within the boring will be shown in the <u>Description</u> column as a solid line. Gradational changes in stratigraphy and lithology will be shown as a dashed line in the <u>Description</u> column.
- 5. The bottom of the borehole will be represented on the form as a solid double line with the notation "Bottom of Hole." Note in the *Description* column if the bottom of the borehole was at drill rig refusal or at top of bedrock.
- 6. Results of air monitoring will be reported in the <u>PID/Field Screening Results</u> column. Any evidence of contamination will be noted in the <u>Remarks</u> column including color, odor, or staining.
- 7. During the course of drilling, water levels and times of measurement should be taken as often as possible and noted in the *Remarks* column. The absence of water following drilling of the borehole shall also be indicated in the *Remarks* column. The depth to water will be recorded in the *Remarks* column and also *Box 15* on the MRK forms including the time when the first water zone is encountered. Depth to water measurements will be recorded in *Remarks* column and also *Boxes 16* and 17 on the MRK forms after the completion of drilling and again after additional time has elapsed and groundwater has reached static conditions.
- 8. As the borehole is advanced, the depth of the borehole will be periodically measured with a weighted tape to the nearest 0.1 foot and recorded in the *Remarks* Column. The weighted tape will be constructed of materials that will not introduce contaminants into the borehole and will be decontaminated between boreholes. Borehole depths and time of measurement should be taken as often as practical and recorded on the drilling log. Significant times to record depth include the beginning and end of each day, the time prior to equipment placement in the borehole, and when any equipment is removed from the borehole.
- 9. The total length of the core or soil sample (recovery) will be measured with a tape measure or folding ruler to the nearest 0.1 foot and recorded in <u>Recovery/Column E</u>. Intervals of bedrock or soil cores including both intact and lost intervals will also be recorded in <u>Recovery/Column E</u>.
- 10. Record a visual description of bedrock core in the *Classification* column, include lithology, jointing, fractures, vugs, fossiliferous zones, etc.
- 11. If required by the Project-Specific Work Plan, the rock quality designation (RQD) should be calculated per *ASTM D6032 08 Standard Test Method for Determining Rock Quality Designation* (*RQD*) of Rock Core (ASTM, 2008) and recorded in either the <u>Field Strength</u> column (WCI-OP3-1/3-2) or the *Remarks* column (WCD-2-1/2-2 and MRK 55/55-2).

- 12. Changes in type of sampler or coring bit and barrel sizes should be noted in the *Remarks* column at the depth the change occurred.
- 13. The source of the water used for coring or monitoring well installation will be recorded in the *Remarks* column.
- 14. Drill fluid volume, loss or gain, brand, and product name will be recorded in the remarks section in the *Remarks* column.
- 15. If compressed air is used during the drilling process, the type of air filter will be recorded in the *Remarks* column.
- 16. The depth and type of any temporary casing used during the well installation procedure will be recorded in the *Remarks* column.
- 17. Depth intervals of borehole instability that are encountered during drilling will be recorded in the *Remarks* column.
- 18. Difficulties during drilling (e.g., changes in drilling speed, rates, downhole torque, or drill rig chatter) and any special sampling problems also will be noted in the *Remarks* column, including descriptions of problem resolutions.
- 19. The depth interval over which samples are collected for chemical analysis will be noted and recorded in the <u>Sample Designation/Analytical Sample No.</u> column.
- 20. A description (i.e. boring number) will be provided for the boring at the top of each page.
- 21. If monitoring wells or piezometers are installed, a detailed installation diagram should be included as either on the last page of the boring log, a construction diagram form, or within the field logbook per *SOP 551 Installation and Development of Monitoring Wells and Piezometers*.
- 22. Each boring log will be legibly signed by the preparer after proofreading the log for completeness.

Monitoring well/piezometer installation procedures are detailed in SOP 551 Installation and Development of Monitoring Wells and Piezometers. Abandonment procedures are detailed in SOP 553 Abandonment of Monitoring Wells and Piezometers, and SOP 554 Borehole Advancement and Abandonment.

Decontamination procedures are in SOP 504 Decontamination. Additional documentation procedures are in SOP 701 Field Documentation.

8.2 Excavation Logging

Excavations for site characterization and sample collection should be documented into the field logbook or onto a Project-Specific form. Log the excavation per the following procedures

- 1. Include the date, start and completion times of the excavation, type of excavation equipment used, and name of the excavator operator.
- 2. Note any debris or non-native materials removed from the excavation. Include a description and amount of non-native material.
- 3. Measure and record the length, width, and depth of the excavation. If the excavation is irregular in shape, include a plan map in your logbook with sufficient measurements to draw the excavation to scale at a later date. Include a north arrow.
- 4. If the excavation is a trench, draw one of the side of the trench in the log book. Include sufficient measurements to draw the trench side to scale at a later date. Classify the soil and bedrock per Sections 8.3 and 8.4 below. Include the direction the observer is looking (i.e. looking northeast.)
- 5. If the excavation is not a trench, repeat Step 4 for each side of the excavation. Information on the bottom of the excavation should be included on the plan view.
- 6. If groundwater is present within the excavation, note the depth to groundwater and, if known, where the groundwater is entering the excavation.
- 7. Record results of headspace air monitoring and any evidence of contamination including color, odor, or staining.
- 8. Document date, time, and method of backfilling the excavation. Include the material and amount of material used to backfill the excavation.

8.3 Characterization of Soils (Unconsolidated Material)

Unconsolidated material will be logged using the Unified Soil Classification System (ASTM, 2011). Items in this section are recorded in <u>Description</u> column of the Burns & McDonnell forms or in <u>Column</u> \underline{C} of the MRK forms.

The primary and secondary constituents of the soil (ie, clay, silt, sand, gravel, etc.) will be logged.
 The primary constituent will be the first word of the description and will have all letters capitalized.

- Secondary constituents will be preceded by an estimation of amount in either percentages or descriptive (trace >0 to 10%, some 11% to 35%, with 36% to 50%, and 50%)
- The standardized color of the unconsolidated material will be logged using the Munsell Soil Color Chart.
- The moisture content, in relative terms (i.e., dry, moist, wet/saturated), will be noted. If the sample is saturated (i.e., encountered groundwater), the groundwater level will be recorded to the nearest 0.1 foot as noted above.
- The angularity, grain size, and grading of soil classified as coarse will be logged.
- The consistency of materials classified as fine (e.g., ML or CH) and the density of materials classified as coarse (e.g., SW or GM) will be noted.
- Bedding characteristics, evidence of bioturbation, root holes, and fractures will be noted and logged.
- When known, the depositional type (i.e., alluvium, residual, till) will be noted.

8.4 Characterization of Rock (Consolidated Material)

Items in this section are recorded in <u>Description</u> column of the Burns & McDonnell forms or in <u>Column</u> C of the MRK forms.

- The primary rock type (i.e., limestone, sandstone, shale) will be logged. The primary constituent will be the first word of the description and will have all letters capitalized. The primary consistent will be followed by secondary constituent, if present (i.e. SHALE, sandy).
- The formation name, if known, will be logged.
- The relative hardness of the consolidated material will be measured and logged.
- The texture and grain angularity of the consolidated material will be examined with a hand lens,
 and the results of the field analysis will be logged.
- The standardized color of the consolidated material will be logged using a Munsell Rock Color Chart.
- The consolidated material will be inspected for apparent weathering. The results of the inspection will be logged.
- The moisture content, in relative terms (i.e., dry, moist, wet/saturated), will be noted. If the sample is saturated (i.e., encountered groundwater), the groundwater level will be recorded to the nearest 0.1 foot as noted above.

- Evidence of bedding, bedding planes, fractures, and joints will be noted and logged. The approximate angle of the dip of bedding, fracture, and joint planes will be noted.
- Other significant features (e.g., fossils, crystals, pits, solution cavities) will be noted.
- The reaction of the consolidated material to hydrochloric acid, if any, will be recorded.

8.5 Preparation of Bedrock Core for Storage

Upon completion of characterization of each core run, bedrock core should be placed into core boxes for long term storage.

- 1. Rinse the core with water to remove drilling fluids and grit from the drilling process.
- 2. Place the core in a core box. Core should be placed so that the top of the core is the upper left core when looking at the box in landscape and the bottom is in the lower right corner.
- 3. If the core is fragile, wrap in aluminum or plastic wrap. Label the wrap surrounding the core. If the core is fragmented and cannot be wrapped, simply place it in the correct interval of the core box.
- 4. Record the top and bottom depth, position of core loss or no recovery zones (if known), and identification of fractures on the boring log. Fractures caused by coring, removing core from the core barrel, or breakage to fit the core into the box should be distinguished from fractures interpreted as insitu.
- 5. Label the top and end of the core boxes. Record the borehole number, depth interval of the core, and other appropriate information. Wooden blocks may be used as spacers inside core boxes to mark the ends of core runs and positions of core loss or no recovery zones. Label the wooden blocks with the depth intervals they represent.
- 6. Photograph the core prior to sealing the box. The photograph should be of high-enough resolution to see details on the core. Ensure that a scale and notations on the boring, interval represented, project number, and date are clearly visible in the photograph.

9.0 DATA AND RECORDS MANAGEMENT

Soil and bedrock characterizations are typically documented in boring logs or field logbooks. Boring logs may vary dependent on the client or the type of boring being done. On environmental projects, soil and bedrock classifications and descriptions are typically documented on Burns & McDonnell's WCD-2-1/2-2 forms and for geotechnical projects on WCD-2-1/2-2 forms. Soil and bedrock boreholes for US Army Corps of Engineers projects are typically documented on MRK 55/55-2 forms. Excavations are

typically documented within the field logbooks but maybe documented on borehole or excavation forms. Surface soil characterization is documented in the field logbooks. Environmental field activities will be documented as detailed in *SOP 701 Field Documentation*.

10.0 QUALITY ASSURANCE/QUALITY CONTROL

Prior to the start of any field activity, Burns & McDonnell personnel will have read and understood the Project-Specific Work Plan as well as this SOP. Field personnel will be trained for a minimum of 40 hours prior to their working solo on environmental field activities. Field documentation will be completed as activities are conducted and will be relayed to the Field Site Manager or Project Manager at a minimum weekly or on a more frequent basis if so stated in the Project-Specific Plans.

11.0 REFERENCES

ASTM, D6032-08, Standard Test Method for Determining Rock Quality Designation (RQD) of Rock Core, ASTM International, West Conshohocken, PA, 2008, www.astm.org

ASTM, D2487-11, Standard Practice for Classification of Soils for Engineering Purposes (Unified Soil Classification System), ASTM International, West Conshohocken, PA, 2011, www.astm.org

Burns & McDonnell Engineering, Co, Inc. (Burns & McDonnell), 2015. Policy Manual,

- Chapter 10, Quality Control Manual, January.
- Chapter 8, Safety and Health Manual, February.

United States Army Corps of Engineers (USACE), 1998. Engineering and Design - Monitor Well Design, Installation, and Documentation at Hazardous, Toxic, and Radioactive Waste Sites, EM 1110 1 4000, November 1, 1998.

United States Environmental Protection Agency (USEPA), 2007. *Guidance for Preparing Standard Operating Procedures*. EPA/600/B-07/001. April

12.0 ATTACHMENTS

The following forms are included with this SOP:

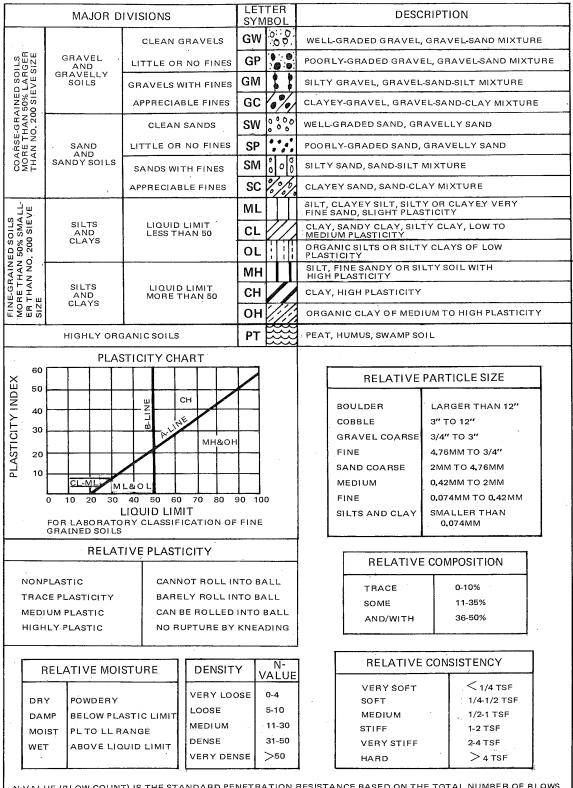
- Burns & McDonnell's TS-GT-3-1 form
- Burns & McDonnell's WCD-2-1/2-2 forms
- Burns & McDonnell's WCI-OP3-1/3-2 forms

• US Army Corps of Engineers' MRK Forms 55/55-2.



Attachments

Unified Soil Classification System



N-VALUE (BLOW COUNT) IS THE STANDARD PENETRATION RESISTANCE BASED ON THE TOTAL NUMBER OF BLOWS, USING A 140-LB HAMMER WITH 30-INCH FREE FALL, REQUIRED TO DRIVE A SPLIT-SPOON THE LAST TWO OF THREE 6-INCH DRIVE INCREMENTS. (EXAMPLE: 4/7/9, N = 7+9=16)

Drilling Log

Project Name	Project Name Project Number							Boring Number						
Ground Elevation		Location							Page			******		
Air Monitoring Equipment									Total Footage					
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Drilling Rig						e of npler								
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Form WCI-OP3-

Drilling Log, continued

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SOP 551 Installation and Development of Monitoring Wells and Piezometers

Revision 0 01/06/2017

Approved by:									
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Annual Review:									
Revision/Review	Date	Responsible Party	Description of Change						

TABLE OF CONTENTS

		<u>Page No.</u>
1.0	Purpose and Applicability	3
2.0	Summary of Method	3
3.0	Definitions	4
4.0	Health and Safety	5
5.0	Cautions	5
6.0	Personnel Qualifications	6
7.0	Equipment and Supplies	6
8.0	Procedures	7
	8.1 Monitoring Well Construction Requirements	
	8.2 Borehole Advancement	9
	8.3 Monitoring Well Installation	10
	8.4 Development of Monitoring Wells and Piezometers	13
9.0	Data and Records Management	14
10.0	Quality Assurance/Quality Control	15
11.0	References	15
12.0	Attachments	15

1.0 PURPOSE AND APPLICABILITY

The purpose of Standard Operating Procedure (SOP) 551 Installation and Development of Monitoring Wells and Piezometers is to establish a uniform procedure for the installation and development of monitoring wells and piezometers using traditional-style drill rigs. This SOP covers the process for the installation and development of monitoring wells and piezometers; rationale and scope including locations, depths, drilling methods, development criteria, etc. are detailed in the Project-Specific Work Plan. As Burns & McDonnell Engineering Company, Inc. (Burns & McDonnell) does not self-perform well installation but instead subcontracts drilling services, this SOP is for the oversight and direction of the drilling subcontractor with Burns & McDonnell personnel responsible for geologic logging, field measurements, and well development activities. The installation and development of monitoring wells and piezometers is regulated in most states. It is the responsibility of both the Project Manager and the onsite field personnel to ascertain that state regulations are met, that the driller is properly licensed for work in that state, and that required paperwork is completed by the responsible person (typically the driller) and submitted to the proper state agency. SOP 551 Installation and Development of Monitoring Wells and Piezometers has been prepared in accordance with the Guidance for the Preparing of Standard Operating Procedures (USEPA, 2007) and the Burns & McDonnell Policy Manual (Burns & McDonnell, 2015).

2.0 SUMMARY OF METHOD

Monitoring wells and piezometers are installed at project sites to monitor hydrogeologic and contaminant parameters. Monitoring wells and piezometers are typically constructed in the same manner but are intended for different uses: monitoring wells are for the monitoring of groundwater quality while piezometers are for monitoring hydrogeologic parameters such as water levels. Throughout this SOP, the term "monitoring well" is interchangeable with "piezometer."

Monitoring well installation includes advancing a borehole into the unconsolidated and/or consolidated materials that underlie a site, building a monitoring well within the borehole, and developing the monitoring well. Various drilling methods including hollow-stem augers, solid-stem augers, air rotary, rotary wash, sonic, cable tool, and other methods can be used to advance the borehole. The specific drilling method should be chosen based upon the site geology, desired depth, desired borehole diameter, logging and testing requirements, and potential site contaminants and should be specified in the Project-Specific Work Plan. If soil or bedrock is to be sampled, logged, or tested, the Project-Specific Work Plan should reference the appropriate SOP.

Upon completion of the borehole and any required sampling, testing, and/or logging, the monitoring well is installed. Monitoring wells should be installed per the specific construction details included in the Project-Specific Work Plan including location, approximate depth, diameter, weight and material of riser and screen, screen slot size, length of screen, and placement of the screen in relationship to the groundwater table. Monitoring wells are typically completed with either flush mount or above grade completions dependent upon the site and the client's requirements.

Monitoring wells are developed after installation to remove the any soil or rock fines that are left within the filter pack and well during installation and to improve the conductivity between the well and the formation. Well development is typically conducted by gently surging the screened interval then purging groundwater in cycles until the monitoring well meets the development criteria set forth in the Project-Specific Work Plan. The monitoring well is then allowed to stabilize prior to the collection of hydrogeologic measurements or samples.

3.0 DEFINITIONS

For this SOP the following definitions will apply:

- Annular Space The space between two cylindrical objects one of which surrounds the other for
 example the space between the well casing and the borehole.
- Bentonite Any type of commercial sodium bentonitic clay used in the construction or plugging of wells.
- **Bentonite Cement Grout** A cement grout generally containing one 94 pound bag of Portland cement mixed with 7 gallons of clean water and 2 pounds of bentonite.
- **Borehole** Any hole drilled into the subsurface for the purpose of identifying lithology, collecting soil samples, and/or installing groundwater wells.
- Casing/Riser An impervious durable pipe placed in a well to keep the well from caving and help seal the well from the surface and upper sources of water and contaminants. Typically composed of polyvinyl chloride (PVC) but can also be composed of steel or stainless steel.
- Cuttings Pieces of fill, soil, or rock displaced from the borehole during drilling or development.
- **Filter Pack** Granular filter material (sand, gravel, etc.) placed in the annular space between the well screen and the borehole to increase the effective diameter of the well and prevent fine-grained material from entering the well.

- Grout The material placed between the borehole wall and the casing to keep surface water out of
 the well and to restrict movement of water in the annular space between the borehole and the riser.
 Materials commonly used include bentonite and bentonite cement.
- Monitoring Well A well that provides for the collection of representative groundwater samples, the
 detection and collection of representative light and dense non-aqueous phase organic liquids, and the
 measurement of fluid levels.
- Piezometer A well that provides for the measurement of fluid levels and other hydrogeologic properties.
- Project-Specific Accident Prevention Plan/Site Safety and Health Plan (Project-Specific APP/SSHP) – A plan or plans that address occupational safety and health hazards associated with site operations.
- Project-Specific Work Plan The plan that details the rationale, scope, and techniques to be used at
 the site to achieve the project objectives. Project-Specific Work Plans can include work plans, field
 sampling plans, quality assurance project plans, technical memorandums, and other documentation of
 proposed work.
- **Tremie** A tubular device or pipe used to place grout, bentonite, or filter pack in the annular space.
- Well Screen A commercially available, factory-perforated, wire wound, continuous wrap, or slotted casing segment used in a well to maximize the entry of water from the producing zone and to minimize the entrance of sand.

4.0 HEALTH AND SAFETY

Field activities as detailed in this SOP will be performed in accordance with applicable safety related documents/requirements which may include, but are not limited to: Project-Specific APP/SSHP, the Burns & McDonnell Corporate Safety and Health Program (Burns & McDonnell, 2015), and site/client-specific requirements. For any intrusive activities, *SOP 501 Utility Clearance* should be followed. Potential health and safety issues with drill rigs include mechanical and hydraulic systems that result in loud repetitive noises and the potential for physical injury. Personal protective equipment (PPE) including hard hats, safety glasses, steel toed boots, and hearing protection should be worn as appropriate and as detailed in the Project-Specific APP/SSHP.

5.0 CAUTIONS

Installation of a monitoring well or piezometer is a complex procedure that has the potential to result in non-optimum results due to a variety of circumstances that may occur due to natural conditions or due to

inattention to detail in the field. Since long term monitoring occurs at many sites, most monitoring wells should be built to meet an expected life span of 20+ years. Cautions have been included in the procedures below; however not all situations that may arise can be covered in an SOP or the Project-Specific Work Plan. The on-site personnel should be aware of situations that may result in a compromised well, correct them as they arise, and stay in communication with their Project Manager and regulator as needed.

6.0 PERSONNEL QUALIFICATIONS

Burns & McDonnell personnel conducting on-site environmental activities will have completed the 40-hour Occupational Safety and Health Administration (OSHA) Hazardous Waste Operations and Emergency Response Standard (HAZWOPER) course and annual 8-hour HAZWOPER refresher courses. At a minimum, one person on site will be certified in first aid and cardiopulmonary resuscitation (CPR) and, if multiple people are on site, at least one person will have completed the 8-hour HAZWOPER Supervisor Training course. If Burns & McDonnell subcontractors are on site then, at a minimum, one Burns & McDonnell person will have completed the OSHA 30-hour Construction Industry Outreach Training course.

7.0 EQUIPMENT AND SUPPLIES

Equipment used during the oversight and direction of monitoring well installation and development may include the following:

- Indelible marking pen
- Locks keyed to other site monitoring wells
- Fiberglass or steel tape with weight
- Field logbook and appropriate field forms
- PPE and safety equipment per the Project-Specific APP/SSHP

Equipment to be used for the collection of fluid levels, logging of soil and bedrock, water quality measurements, decontamination, and documentation can be found in the SOPs for those activities.

Prior to the start of field activities, the Field Site Manager and/or the Project Manager should determine that 1) necessary permits, right of entries, and utilities clearances have been obtained; 2) the Project-Specific APP/SSHP has been reviewed by Burns & McDonnell personnel participating in the work and subcontractors who will be on site; 3) appropriate PPE has been obtained for Burns & McDonnell

personnel and will be available on site; and 4) equipment and meters are available, in working order, and complete with needed components.

8.0 PROCEDURES

Each monitoring well installed and developed during field investigations will be constructed according to the requirements and procedures below and the appropriate state regulations. Clients may have additional requirements or requests for monitoring wells to meet safety and aesthetic requirements. Additionally monitoring wells placed at sites overseen by the United States Army Corps of Engineers (USACE) should meet the USACE guidance document entitled *Engineering and Design - Monitor Well Design*, *Installation, and Documentation at Hazardous, Toxic, and Radioactive Waste Sites*, EM 1110 1 4000 (USACE, 1998).

8.1 Monitoring Well Construction Requirements

The following installation and construction requirements will be used:

- Riser and screen will be packaged in containers that bear the manufacturer's markings.
- Monitoring well/piezometer screen and riser pipe will be flush-threaded. The joints will be
 constructed so as to form a watertight seal. Screen bottoms will be sealed with a flush-threaded
 cap or slip-on cap secured with stainless-steel, self-tapping screws.
- Requirements for PVC riser and screen include:
 - Monitoring wells/piezometers will be constructed with National Sanitation Foundation (NSF) potable water grade, flush-threaded PVC riser and screen that conforms to American Society of Testing and Materials (ASTM)-D 1785 standards.
 - PVC riser and screen for 2-inch diameter monitoring wells will typically be schedule 40 for shallow wells but should be upgraded to schedule 80 for wells greater than 100 feet in depth.
 Riser and screen specifics will be included in the Project-Specific Work Plan.
 - No glues or solvents shall be used in the construction of PVC monitoring wells/piezometers.
- Specifications for steel or stainless steel riser and casings will be included in the Project-Specific Work Plan.

- Well screen shall be factory slotted and sized to be compatible with the filter pack and aquifer
 materials. Screen size will be specified in the Project-Specific Work Plan or will be determined
 by a geologist based upon the size and gradation of the material to be screened. Field slotted or
 cut screens will not be used.
- A minimum annulus of 2 inches will be maintained between the outside of the well casing and the borehole wall.
- Centralizers will be used to maintain concentricity and alignment of the well in the borehole. Centralizers will not be installed in the filter pack or bentonite seal. Centralizers will not be used on wells installed through hollow stem augers or in wells less than 30 feet deep.
- The filter pack will consist of clean, inert, non-carbonate, uniform sand. Filter pack size will be specified in the Project-Specific Work Plan or will be determined by a geologist based upon the size and gradation of the material to be screened.
- The annular seal shall consist of coarse-granular, chipped or pelletized bentonite; a high-solids bentonite grout slurry; or a bentonite cement grout. Grout will be mixed per the manufacturer's instructions and so to meet all state requirements. If bentonite pellets or chips are used, adequate time will be allowed for hydration (typically >4 hours) prior to installation of the of an upper annular seal or the surface seal.
- Monitoring wells will be completed either as an above-grade or a flush with grade well. In either case, the well will be completed in such a way so that there is enough room at the top of the well riser to the bottom of the protective cover to install a locking, protective cap on the riser.
- Monitoring well pads will consists of a concrete pad installed around the monitoring well/piezometer. The borehole will be enlarged so that the concrete pad will extend away from the well casing at the surface and taper down to the size of the borehole within 2 to 3 feet. The pad should be constructed so that the deeper portion is below the frost line for the project location. The top of the concrete pad will slope gently away from the protective cover, but be constructed nearly flush with the surrounding surface.
- Monitoring wells completed above grade will have a steel protective cover installed. The protective cover should be installed so that at least two feet of the casing is within the concrete

pad and such that the cover can open easily over the capped riser. A weep hole should be drilled into the protective cover approximately 1 inch above the top of the pad and the annular space between the protective cover and the riser should be filled with coarse sand or pea gravel.

- Monitoring wells completed as flush grade completion should use a watertight well cap for the well riser pipe in addition to a watertight road box to prevent surface water from entering the well. The well casing should extend approximately 3 inches above the sealant in the bottom of the well box. Flush-grade completion within traffic areas may require more substantive well boxes and concrete completions. The surface completion should provide positive drainage away from the well box to prevent ponding around the well. In traffic areas and sidewalks, this positive drainage slope away from the box should be minimized to prevent physical hazards. The surface seal around the box should be a minimum of 12 inches around the perimeter of the box.
- Guard posts will consist of 3-inch diameter steel posts or tee-bar driven steel posts placed around the concrete pad. These posts will be positioned one foot outside the pad and equally spaced and will be placed so to be protective of the well from vehicular traffic and other hazards. The posts will extend above the protective casing and 2 feet below ground surface. The protective casing and posts will be painted in high visibility colors in remote areas and brown in populated areas.
- At locations where a monitoring well/piezometer is needed but groundwater is not apparent during drilling, the borehole may be left open to determine if groundwater is seeping into the borehole. The borehole will be bermed and covered during this period to reduce the potential for entry of surface water runoff or contamination. After 24 hours (unless specified otherwise in the Project-Specific Work Plan), the on-site personnel will consult with the Project Manager to determine if the borehole should be advanced further or abandoned.

8.2 Borehole Advancement

Boreholes may be advanced by a variety of techniques including hollow or solid stem augers, air rotary, rotary wash, cable tool, sonic, dual-tube percussion, or other drilling techniques. The specific drilling method should be chosen based upon the site geology, desired depth, desired borehole diameter, logging and testing requirements, and potential site contaminants and should be specified in the Project-Specific Work Plan. If soil or bedrock is to be sampled, the Project-Specific Work Plan should include the rationale and scope for the sampling including the number of samples to be collect, depth, analytical parameters, and method of collection with the referenced SOPs. Soil and bedrock should be logged from

either the samples collected or from cuttings in accordance with *SOP 521 Soil and Bedrock Logging*. Other types of testing that may be required including packer tests and downhole geophysical logging should be specified in the Project-Specific Work Plan with the referenced SOPs.

Temporary casing may be required in some boreholes to maintain the stability of the borehole or to prevent contaminants from an upper zone to enter a lower zone. The need for temporary casing should be determined on a site-specific basis and detailed in the Project-Specific Work Plan.

For many boreholes, the initial borehole advanced for sample collection or logging purposes is insufficient in diameter for the installation of a monitoring well. In these cases the borehole is then reamed to the final desired diameter. Care should be taken during this step to remove as many cutting from the borehole as possible without damaging the integrity of the borehole side.

8.3 Monitoring Well Installation

Monitoring well installation specifics including screen size, length, and placement; filter pack size and placement, secondary filter pack use and placement, grout type, placement method and thickness; and well completion type will be detailed in the Project-Specific Work Plan. After installation of the riser, a locking sealed cap should be placed on the riser if the well is left unattended for any significant amount of time.

- 1. Inspect well materials to determine if they meet the project specifications and are clean and free of foreign matter prior to use. Wash screens and casings with laboratory grade detergent and potable water mixture then rinse with deionized water and allow to air dry. Store washed materials in clean plastic sheeting until installation. Washing is not necessary if well material is in the manufacturer's original packaging and the packaging is intact. Keep materials in the manufacturer's original packaging until time of use.
- Assemble the screen and riser. Attach centralizers as needed. Measure the length of screen and
 riser components and placement of the centralizers. Record the information in the field logbook
 or on the appropriate field form. Calculate and note the approximate amount of filter pack that
 will be needed.
- 3. Lower well screen and casing into the borehole. Record to the nearest 0.1 foot the depth of the top and bottom of the well screen from the grade/ground surface. If the terrain is very uneven, drive a bolt or spike in the ground to serve as a reference until the well is completed.

- 4. With the casing string suspended near the bottom of the boring, pour the filter pack material slowly into the annular space to prevent bridging. For deep wells and wells where the screen is set significantly below the water table, the filter pack should be emplaced via a tremie pipe. Use of a tremie should be specified in the Project-Specific Work Plan in these cases. If installing through hollow stem augers or a temporary casing, slowly raise the augers or casing as the filter pack is emplaced. Use a fiberglass or steel tape with a weight attached to the end to determine the top of the filter pack. Measure the depth to the top of the filter pack to within 0.1 foot. Compare the estimated amount of filter pack needed to that used to determine if bridging has occurred.
- 5. Unless specified otherwise, swab the well screen with a surge block and remove water from the well. Allow the filter sand pack to settle and measure the depth to the top of the filter pack again. Add additional filter material, if necessary. If over one foot of filter pack is added, repeat the process. Filter packs should be emplaced to the level above the well screen detailed in the Project-Specific Work Plan. This is typically 3 to 5 feet above the top of the screen but can be less if the well is shallow or a secondary filter pack is to be installed. Record the brand and size of the filter pack, the amount emplaced, and the final depth to top of filter pack in the field logbook or on the appropriate field form.
- 6. If a secondary filter pack is required, install per the same process as that used for the primary filter pack. Record the brand and size of the secondary filter pack, the amount emplaced, and the final depth to top of the secondary filter pack in the field logbook or on the appropriate field form.
- 7. Install the grout seal from the top of the filter pack to approximately 3 feet below ground surface. The grout seal is typically either bentonite in chip, pellet, or slurry form or a bentonite cement. Bentonite cement grout should only be placed upon a bentonite layer or on a secondary filter pack. In no circumstances should cuttings be used as a seal. If installing through hollow stem augers or a temporary casing, slowly raise the augers or casing as the filter pack is emplaced. Take and record depth measurements on a frequent basis during the installation of the grout seal. Based upon the grout specified in the Project-Specific Work Plan install the grout by:
 - a. Bentonite chips or pellets Pour bentonite chips or pellets slowly down the annulus to prevent bridging. Measure the depth to the top of the bentonite seal to within 0.1 feet with the weighted tape. If the seal is above the water table, pour several gallons of potable water down the annulus to hydrate the bentonite seal for every foot of pellets or chips emplaced. If the

bentonite layer is being placed between the primary filter pack and a bentonite cement seal, then the bentonite seal should be a minimum of three feet in thickness and allowed to hydrate for a minimum of three to four hours.

- b. Bentonite slurry Calculate and mix the amount of bentonite slurry needed. Bentonite slurry should consist of a commercial bentonite powder approved for environmental use, mixed per the manufacturer's instructions. Bentonite slurry should be emplaced using a tremie pipe. The pipe should be placed so that the end is submerged within the grout and raised slowly as the grout is emplaced into the annular space.
- c. Bentonite cement Calculate and mix the amount of bentonite cement grout needed. The bentonite cement grout should consist of at least five pounds of bentonite powder per 94 pound sack of cement. A commercial grade bentonite powder approved for environmental use, should be mixed per the manufacturer's instructions. Bentonite cement grout should be emplaced using a tremie pipe. The pipe should be placed so that the end is submerged within the grout and raised slowly as the grout is emplaced into the annular space. It should be noted that bentonite cement grout will give off heat during the hydration and curing process. Care should be taken to ensure that the PVC riser is not compromised by the heat.

Record the brand and size (if using bentonite pellets or granular bentonite), the amount of grout emplaced, and the final depth to top of grout in the field logbook or on the appropriate field form.

- 8. Allow the grout to settle before installing the protective cover and concrete pad. If the top of grout falls below the depth needed for the pad installation (typically 3 feet below ground surface), then additional grout should be added. Note the amount of grout added and the final depth to top of grout in the field logbook or on the appropriate field form.
- 9. Prior to installing the protective cover and concrete pad, trim the rise stickup to approximately the final elevation needed. Measure and record the amount of riser removed. Cut a notch or place a mark on the top of the well casing as a reference point for top of casing (TOC) elevation and depth to water measurements and place a lockable sealable cap such as a J-plug on the riser.
- 10. Install the protective casing/flush mount cover, well pad, and protective bollards, as needed, per the specifications in Section 8.1. Ensure the protective cover is locked for above ground

completions or a lockable J-plug with lock is installed for flush mount completions. Document the installation in the field logbook or on the appropriate field form.

As the well or piezometer is installed, a construction diagram should be sketched. It is preferable to place the diagram on either a well construction diagram or on the final page of the boring log but it can also be documented in the field logbook. The field personnel should take care to record date and time of activities; materials used including brands, amounts, and size; depths and methods of placement; and other pertinent information.

8.4 Development of Monitoring Wells and Piezometers

Monitoring wells and piezometers will be developed to remove fine particles and sediment from the screen and filter pack. The method will consist of swabbing with a surge block or similar apparatus, followed by pumping and/or bailing. Swabbing consists of raising and lowering a surge block within the casing and screened interval. Caution should be exercised when swabbing within the screened interval so as not to damage the screen or the filter pack. Sediment and volume of water removed will be monitored and recorded regularly until development is complete. The development of a monitoring well should be initiated not sooner than 24 hours, nor longer than seven days after the final grouting of the monitoring well. For work performed for the USACE, the time before development begins should be more than 48 hours (USACE, 1994). Field measurements collected as part of well development should be recorded in either the field logbook or on a standardized well development form. Development will continue until the well or piezometer is properly developed based on attainment of the specified standard for turbidity units and stabilization of the pH, conductivity, and temperature. The required parameter standard criteria are detailed in the Project-Specific Work Plan.

The development sequence is as follows:

- 1. Record water level and total depth of the well. Calculate the volume of standing water.
- 2. Collect a water sample. If the water is fairly clear, measure and record pH, conductivity, temperature, and turbidity.
- 3. Gently swab the well with a surge block for 10 to 15 minutes, starting at the bottom and working upward in intervals.

- 4. Bail and/or pump the well to remove any sediment in the well. Record the amount of water and sediment removed. If required by the Project-Specific Work Plan, containerize the removed water and sediment per the protocol and SOP specified in the Plan.
- 5. Re-measure and record the water level and the total depth of the well.
- 6. Repeat Steps 2-5 until the water bailed or pumped meets the required turbidity standard set forth in the Project-Specific Work Plan; the pH, conductivity, and temperature stabilize to the criteria in the Project-Specific Work Plan (typically <10 percent variation between 3 or more readings taken one well volume apart); and no sediment is left within the well casing. At a minimum, three to five times the volume of any water introduced during drilling and installation shall be removed. Monitoring wells or piezometers that purge dry during development should be purged dry a minimum of three times. Once purged dry, the water level should be allowed to recover to at least 95 percent of the static water level prior to purging a second or third time.

If after a reasonable effort has been made, stabilization of the monitored groundwater parameters (pH, temperature, conductivity, and turbidity) cannot be achieved, the Field Site Manager will discuss the matter with the Project Manager. The Project Manager, with consultation of the client, will determine whether to end development, continue development, or change development methods. It is noted that it is usually possible to reach the stabilization criterion during development, but various conditions may cause ongoing turbidity problems.

After development is complete, the monitoring well should be allowed to stabilize prior to sampling. The stabilization period is dependent upon the production of the aquifer screened and the contaminant being sampled for. The minimum amount of time is 24 hours. Longer periods may be required by the USACE and other clients.

9.0 DATA AND RECORDS MANAGEMENT

All data will be documented on standardized boring logs, well completion forms, well development forms, field-data sheets, and/or site log books as specified in the Project Specific Work Plan and as detailed in *SOP 701 Field Documentation*. Photos of the well locations both prior to the well installation and upon completion of the well installation and photos of the final appearance of groundwater upon completion of development are a good field practice; care should be taken to be aware of any client restrictions on photographs. Field documentation will be completed as activities are conducted and will be

relayed to the Field Site Manager or Project Manager at a minimum weekly or on a more frequent basis if so stated in the Project-Specific Work Plan.

10.0 QUALITY ASSURANCE/QUALITY CONTROL

Prior to the start of any field activity, Burns & McDonnell personnel will have read and understood the Project-Specific Work Plan as well as this SOP. Field personnel will be trained for a minimum of 40 hours prior to their working solo on environmental field activities.

11.0 REFERENCES

Burns & McDonnell Engineering, Co, Inc. (Burns & McDonnell), 2015. Policy Manual,

- Chapter 10, Quality Control Manual, January.
- Chapter 8, Safety and Health Manual, February.

United States Army Corps of Engineers (USACE), 1998. Engineering and Design - Monitor Well Design, Installation, and Documentation at Hazardous, Toxic, and Radioactive Waste Sites, EM 1110 1 4000, November 1, 1998.

United States Environmental Protection Agency (USEPA), 2007. *Guidance for Preparing Standard Operating Procedures*. EPA/600/B-07/001. April

12.0 ATTACHMENTS

None.

SOP 555 In-Situ Hydraulic ConductivitySlug Testing

Revision 0 06/02/2017

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Biennial Review:				
Revision/Review	Date	Responsible Party		Description of Change

TABLE OF CONTENTS

	<u>Page</u>	<u> No.</u>
1.0	Purpose and Applicability	3
2.0	Summary of Method	3
3.0	Definitions	3
4.0	Health and Safety	4
5.0	Cautions	4
6.0	Personnel Qualitifications	4
7.0	Equipment and Supplies	5
8.0	Procedures	5
9.0	Data and Records Management	8
10.0	Quality Assurance/Quality Control	8
11.0	References	8

1.0 PURPOSE AND APPLICABILITY

The purpose of *Standard Operating Procedure (SOP) 555 In-Situ Hydraulic Conductivity-Slug Testing* is to establish a uniform procedure for the collection of field hydraulic conductivity measurements using slug testing techniques. This SOP covers the *process* for the collection of hydraulic head recovery measurements in a well or piezometer after a near instantaneous change in the hydraulic head at a particular well or piezometer is initiated. This is accomplished by creating a sudden change using a "slug" to affect the water level and measuring the recovery response using a transducer or water level indicator: scope including locations, static water levels, and well/piezometer construction, are detailed in the Project-Specific Work Plan. *SOP 555 In-Situ Hydraulic Conductivity-Slug Testing* has been prepared in accordance with the *Guidance for the Preparing of Standard Operating Procedures* (USEPA, 2007) and the Burns & McDonnell Engineering Company, Inc. (Burns & McDonnell) *Policy Manual* (Burns & McDonnell, 2015).

2.0 SUMMARY OF METHOD

A slug test is performed to determine the hydraulic conductivity of a water bearing zone. Slug tests are most useful to collect order of magnitude hydraulic conductivity data in lieu of performing an aquifer pumping test. This method is economical and particularly useful in formations where lower hydraulic conductivity materials limit the usefulness of pump tests. A slug test is typically performed in two stages. The first consists a "slug-in" phase where a mechanical slug of known volume is placed below the static water level in a well to cause water level rise. Water levels are then recorded using a pressure transducer to measure water level response. The second consists of a "slug-out" phase where the mechanical slug is removed causing a water level decline. Water levels are again recorded using a pressure transducer. This SOP specifically addresses the use of a mechanical (solid object) slug for water displacement. Alternative methods may also be used to displace the hydraulic head in the well.

3.0 DEFINITIONS

- **Hydraulic conductivity** A measure of a material's capacity to transmit water.
- **Slug test** The removal or introduction of a solid object or equivalent volume of water causing an abrupt increase (or decrease) in the water level of a well (Butler, 1997).

- Project-Specific Accident Prevention Plan/Site Safety and Health Plan (Project-Specific APP/SSHP) – A plan or plans that address occupational safety and health hazards associated with site operations.
- Project-Specific Work Plan The plan that details the rationale, scope, and techniques to be used at
 the site to achieve the project objectives. Project-Specific Work Plans can include work plans, field
 sampling plans, quality assurance project plans, technical memorandums, and other documentation of
 proposed work.

4.0 HEALTH AND SAFETY

Field activities as detailed in this SOP will be performed in accordance with applicable safety related documents/requirements which may include, but are not limited to: Project-Specific APP/SSHP, the Burns & McDonnell Corporate Safety and Health Program (Burns & McDonnell, 2015), and site / client-specific requirements. Personal protective equipment (PPE) including hard hats, safety glasses, steel toed boots, and hearing protection should be worn as appropriate and as detailed in the Project-Specific APP/SSHP.

5.0 CAUTIONS

A slug test is intended to collected order of magnitude hydraulic conductivity data from a specific screened interval at a discrete spatial location within an aquifer. The well should be adequately developed, fully recovered, and at static conditions prior to initiating the testing. Care needs to be taken when the data is collected to take into account the known and unknown conditions present within the well, its annulus, and the portion of the aquifer penetrated. It is recommended that multiple tests be performed at the well if possible to get a representative hydraulic conductivity value but this is not always possible due to lower hydraulic conductivity conditions or limited yield to the well. It is recommended that the data set is reviewed by a hydrogeologist to determine the validity of the test and selection of appropriate analytical solutions.

6.0 PERSONNEL QUALITIFICATIONS

Interpretation of test data should be conducted by or overseen by experienced personnel. Burns & McDonnell personnel conducting on-site environmental activities will have completed the 40-hour Occupational Safety and Health Administration (OSHA) Hazardous Waste Operations and Emergency Response Standard (HAZWOPER) course and annual 8-hour HAZWOPER refresher courses. At a

minimum, one person on site will be certified in first aid and cardiopulmonary resuscitation (CPR) and, if multiple people are on site, at least one person will have completed the 8-hour HAZWOPER Supervisor Training course. If Burns & McDonnell subcontractors are on site then, at a minimum, one Burns & McDonnell person will have completed the OSHA 30-hour Construction Industry Outreach Training course.

7.0 EQUIPMENT AND SUPPLIES

Equipment to be used during slug testing may include:

- Pressure transducer(s)
- Mechanical slug (constructed from non-reactive materials)
- Suitable rope or chain for lowering and retrieving slug
- Water level meter
- Data logger
- Field log book or field form
- Marking pen
- PPE and safety equipment per the Project-Specific APP/SSHP

Equipment to be used for documentation, location, and decontamination can be found in the SOPs for those activities.

Prior to the start of field activities, the Field Site Manager and/or the Project Manager should determine that 1) necessary permits and right of entries have been obtained; 2) the Project-Specific APP/SSHP has been reviewed by Burns & McDonnell personnel participating in the work and subcontractors who will be on site; 3) appropriate PPE has been obtained for Burns & McDonnell personnel and will be available on site; and 4) equipment and meters are available, in working order, and complete with needed components.

8.0 PROCEDURES

Slug testing should be conducted in accordance with *SOP 555* and equipment manufacturer's operational manuals and procedures. Slug testing will be conducted per the following steps:

8.1 Slug-In Test

1. Record test information in the Field Log Book. Information should include, at a minimum, well number and construction specifications, date, time, initial water level, and slug volume.

- Enter test setup information into the transducer system, per the manufacturer's specifications.
 Allow the water level to stabilize following transducer installation and record the initial water level using the water level meter.
- 3. Position the slug above the initial static water level.
- 4. Start the transducer data collection.
- 5. Rapidly insert the slug. This method assumes an instantaneous change in volume, so it is important to add the slug as quickly as possible. This event is assigned time "zero."
- 6. Water levels in the slug test well will be collected according to the following schedule:

Cumulative Time	Measurement Interval
From zero to 30 seconds	Every 0.5 second
From 30 to 60 seconds	Every 1 second
From one to five minutes	Every 5 seconds
From five to ten minutes	Every 15 seconds
From ten to sixty minutes	Every 1 minute

- 7. If water level transducers are used to obtain water level data, perform and record manual gauging of the slug test wells using an electric water level indicator at regular intervals to provide confirmation of transducer measurements. Should a well not recover to within 90% of static water level then alternative time intervals of five minutes for 20 minutes and ten minutes for the subsequent 40 minutes will be collected over the next sixty minute span.
- 8. Continue recording depth-time measurements until the water level returns to equilibrium (within 0.1 foot of the initial static water level).

8.2 Slug-Out Test

- 1. Record test information in the Field Log Book. Information should include, at a minimum, well number and construction specifications, date, time, initial water level and slug volume.
- 2. Following the slug-in test, allow the water level to stabilize.

- 3. Record the initial water level. Determine the static water level in the test well by manually measuring the depth to water.
- 4. Start (or continue) the transducer data collection
- 5. Rapidly remove the slug to above the initial static water level. This method assumes an instantaneous change in volume, so it is important to remove the slug as quickly as possible. This event is assigned time "zero."
- 6. Water levels in the slug test well will be collected according to the following schedule:

Cumulative Time	Measurement Interval
From zero to 30 seconds	Every 0.5 second
From 30 to 60 seconds	Every 1 second
From one to five minutes	Every 5 seconds
From five to ten minutes	Every 15 seconds
From ten to sixty minutes	Every 1 minute

- 7. If water level transducers are used to obtain water level data, manual gauging of the slug test wells using an electric water level indicator should be performed and recorded at regular intervals to provide confirmation of transducer measurements. Should a well not recover to within 90% of static water level, then alternative time intervals of five minutes for 20 minutes and ten minutes for the subsequent 40 minutes will be collected over the next 60 minute span.
- 8. Continue recording depth-time measurements until the water level returns to equilibrium (within 0.1 foot of the initial static water level).
- 9. Decontaminate non-disposable equipment between boreholes as specified in *SOP 504 Decontamination*.
- 10. Enter the appropriate information in the field logbook in accordance with *SOP 701 Field Documentation*.

Data collected during the hydraulic conductivity testing will be evaluated as per methodologies described in the Project-Specific Work Plan.

9.0 DATA AND RECORDS MANAGEMENT

Environmental field activities will be documented as detailed in *SOP 701 Field Documentation*. Field documentation will be completed as activities are conducted and will be relayed to the Field Site Manager or Project Manager at a minimum weekly or on a more frequent basis if so stated in the Project-Specific Work Plan. Conductivity logs should be stored in the project files in either hard or electronic format.

10.0 QUALITY ASSURANCE/QUALITY CONTROL

Prior to the start of any field activity, Burns & McDonnell personnel will have read and understood the Project-Specific Work Plan as well as this SOP. Field personnel will be trained for a minimum of 40 hours prior to their working solo on environmental field activities. Field documentation will be completed as activities are conducted and will be relayed to the Field Site Manager or Project Manager at a minimum weekly or on a more frequent basis if so stated in the Project-Specific Work Plan. Quality control (QC) testing shall be performed on data collection methodology and data documentation.

11.0 REFERENCES

Butler, James J., 1997, The Design, Performance, and Analysis of Slug Tests, CRC Press LLC. Burns & McDonnell Engineering, Co, Inc. (Burns & McDonnell), 2015. *Policy Manual*,

- Chapter 10, Quality Control Manual, January.
- Chapter 8, Safety and Health Manual, February.

United States Environmental Protection Agency (USEPA), 2007. *Guidance for Preparing Standard Operating Procedures*. EPA/600/B-07/001. April

SOP 601 Investigative Derived Waste Storage, Sampling, and Disposal

Revision 0 01/06/2017

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TABLE OF CONTENTS

	<u>Pa</u>	<u>ige No.</u>
1.0	Purpose and Applicability	3
2.0	Summary of Method	3
3.0	Definitions	3
4.0	Health and Safety	4
5.0	Cautions	4
6.0	Personnel Qualifications	5
7.0	Equipment and Supplies	5
8.0	Procedures	
	8.1 Containerization, Labeling, and Storage of IDW	
	8.1.2 Solid IDW	
	8.2 IDW Sampling	
	8.2.1 Liquid IDW Drum Sampling Procedures	
	8.2.2 Soil IDW Drum Sampling Procedures	
	8.3.1 Liquid IDW Disposal Procedures	
	8.3.2 Solid IDW Disposal Procedures	
9.0	Data and Records Management	13
10.0	Quality Assurance/Quality Control	14
11.0	References	14
12.0	Attachments	14

1.0 PURPOSE AND APPLICABILITY

The purpose of Standard Operating Procedure (SOP) 601 Investigative Derived Waste Storage, Sampling, and Disposal is to establish a uniform procedure for the storage, sampling, and disposal of investigative derived waste (IDW). Waste management procedures for IDW are based on the requirements specified in Title 40 of the Code of Federal Regulations (CFR), Part 262 (40 CFR 262) Standards Applicable to Generators of Hazardous Waste and professional judgment. Waste management procedures should also include consideration of state regulations. State-specific requirements and regulations should be addressed in the Project-Specific Work Plan.

This SOP covers the <u>process</u> for the storage, sampling, and disposal of IDW; specifics of characterization, and disposal should be included in the Project-Specific Work Plan. SOP 601 Investigative Derived Waste Storage, Sampling, and Disposal has been prepared in accordance with the United States Environmental Protection Agency (USEPA) Guidance for the Preparing of Standard Operating Procedures (USEPA, 2007) and the Burns & McDonnell Engineering Company, Inc. (Burns & McDonnell) Policy Manual (Burns & McDonnell, 2015).

2.0 SUMMARY OF METHOD

During field investigations, various activities such as sampling and decontamination will produce liquid and solid IDW. IDW can include excess sample, soil cuttings, drilling muds, purged groundwater, decontamination fluids (water and other fluids), disposable sampling equipment, disposable personal protective equipment (PPE), and other materials produced during environmental investigation or remediation. Equipment, materials, and supplies needed for containerizing IDW will be selected based on waste characteristics or constituents. Important elements for effective IDW management include: 1) leave a site in no worse condition than existed prior to the investigation; 2) remove IDW that poses an immediate threat to human health or the environment; 3) leave IDW on site that does not require off-site disposal or long-term above-ground containerization; 4) comply with all Federal and State regulations, and; 5) minimize the quantity of IDW generated.

3.0 DEFINITIONS

Hazardous Waste - Any substance listed in 40 CFR Subpart D (260.30 et seq.) or otherwise
characterized as ignitable, corrosive, reactive, or toxic as specified in Subpart C (261.20 et seq.) that
would be subject to manifest and packaging requirements specified in 40 CFR 262. Hazardous waste
is defined and regulated by the USEPA.

- **Hazardous Material** A substance or material in a quantity or form, which may pose an unreasonable risk to health, safety, and/or property when transported in commerce. Hazardous material is defined and regulated by the US Department of Transportation (DOT) (49 CFR 173.2 and 172.101) and International Air Transport Association (IATA) (Section 4.2).
- Sample Physical evidence collected from a facility or the environment which is representative of
 conditions at the point and time at which the sample is collected.
- Project-Specific Accident Prevention Plan/Site Safety and Health Plan (Project-Specific APP/SSHP) – A plan or plans that address occupational safety and health hazards associated with site operations.
- Project-Specific Work Plan The plan that details the rationale, scope, and techniques to be used at
 the site to achieve the project objectives. Project-Specific Work Plans can include work plans, field
 sampling plans, quality assurance project plans, technical memorandums, and other documentation of
 proposed work.

Additional definitions may apply based upon state-specific regulations and guidances.

4.0 HEALTH AND SAFETY

Field activities as detailed in this SOP will be performed in accordance with applicable safety related documents/requirements which may include, but are not limited to: Project-Specific APP/SSHP, the Burns & McDonnell Corporate *Safety and Health Program* (Burns & McDonnell, 2015), and site / client-specific requirements. PPE as listed in the Project-Specific APP/SSHP should be worn when transferring IDW to or from a container or collecting an IDW sample.

5.0 CAUTIONS

Care must be taken when handling IDW to prevent spills. Appropriate containers for IDW storage and transport should be identified and used (see Section 8.0). Care should be exercised when selecting IDW staging areas so that containerized IDW is reasonably secure while awaiting disposal. Care should be taken when filling and storing containers to ensure that weather such as freezing or heating or other events such as flooding will not compromise IDW storage.

State and local regulations and guidances should be consulted during preparation of the Project-Specific Work Plan.

6.0 PERSONNEL QUALIFICATIONS

Burns & McDonnell personnel conducting on-site environmental activities will have completed the 40-hour Occupational Safety and Health Administration (OSHA) Hazardous Waste Operations and Emergency Response Standard (HAZWOPER) course and annual 8-hour HAZWOPER refresher courses. At a minimum, one person on site will be certified in first aid and cardiopulmonary resuscitation (CPR) and, if multiple people are on site, at least one person will have completed the 8-hour HAZWOPER Supervisor Training course. If Burns & McDonnell subcontractors are on site then, at a minimum, one Burns & McDonnell person will have completed the OSHA 30-hour Construction Industry Outreach Training course.

7.0 EQUIPMENT AND SUPPLIES

Equipment and supplies for IDW management and storage may include:

- Paint pens and/or weatherproof labels
- Flagging/caution tape
- 5-Gallon buckets
- Pallets
- Lidded drums or rolloffs with liners and covers
- PPE and safety equipment per the Project-Specific APP/SSHP

Equipment and supplies to be used during IDW sampling may include:

- Approved sampling tool push sampling tools equipped with liners, core sampler, auger, spoon, bailer, drum thief, etc.
- PPE and safety equipment per the Project-Specific APP/SSHP
- Sample containers and sample preservatives per Project-Specific Work Plan

Equipment to be used for decontamination and sample labeling, packing and shipping can be found in the SOPs for those activities.

Prior to the start of field activities, the Field Site Manager and/or the Project Manager should determine that 1) necessary permits, right of entries, and utilities clearances have been obtained; 2) the Project-Specific APP/SSHP has been sent to subcontractors who will be on site; 3) appropriate PPE has been obtained for Burns & McDonnell personnel and will be available on site; 4) sample equipment and meters

are available, in working order, and complete with needed components; and 5) sample containers provided by the laboratory are the correct size and type, are preserved, if required, per the Project-Specific Work Plan, and are sufficient in number for the planned field activities.

8.0 PROCEDURES

8.1 Containerization, Labeling, and Storage of IDW

8.1.1 Liquid IDW

Liquid IDW may include well development, decontamination, purge water, and excess liquid sample. Often through existing groundwater monitoring data and field screening data collected as part of the field effort, it is possible to pre-characterize liquid IDW. Most liquid IDW generated as part of site investigations will not be hazardous waste. Liquid IDW can be stored in a frac tank or containerized separately in drums. Liquid waste known or suspected to be hazardous waste should be stored in drums. Drums and polyethylene tanks can be used for interim storage and transport of liquid IDW. Labeling will be in accordance with the guidelines outlined below. Containers will be closed and secured except when adding to or disposing of the contents. Manufacturer DOT specifications will be followed when sealing containers.

United Nations (UN)-approved drums (49 CFR 173.3), polyethylene tanks, and 5-gallon plastic buckets will be used to collect liquid IDW, depending on the volume, rate of generation, and the accessibility of the IDW source. Liquid IDW collected in 5-gallon buckets will be transferred to drums or polyethylene tanks as soon as possible after collection. Any liquid IDW suspected of being or characterized as hazardous waste will be containerized in UN-approved drums.

Containers of liquid IDW will be labeled to indicate the source and nature of the waste material. The following information will be marked on the top or sides of each container: container number(s) (boring number plus a sequential number); facility name; location number; date of generation; container contents; estimated quantity; and the client point of contact (POC).

Containers will be marked with 2-inch letters and numbers using a waterproof paint pen. An inventory of the IDW will be maintained by the Field Site Manager to facilitate identification and tracking of liquid IDW for appropriate disposal. This inventory will include all of the above information, the location of the container, and initials of the responsible POC. In addition to the inventory, the total number of containers of liquid IDW generated will be noted in the field notebook on a daily basis. Containers of liquid IDW

determined to be hazardous waste or non-hazardous waste that are sent off site for disposal will be relabeled in a manner consistent with applicable state and federal requirements including, but not limited to, Resource Conservation and Recovery Act (RCRA), Toxic Substances Control Act (TSCA), and DOT (40 CFR 171-179).

Containers of liquid IDW are typically temporarily stored until characterized. Containers of liquid IDW that will be stored during winter months should be underfilled (<2/3 full) to allow for expansion during freezing. Issues to consider in identifying storage areas include the potential for unauthorized access to the site, flooding, and freezing. Dependent upon the site and the contaminants present, provision may need to be made for secondary containment at the location where liquid IDW is being stored.

For short-term storage prior to characterization, properly labeled and closed containers of liquid IDW will be left in an upright position placed on level ground. When containers of solid IDW are staged with containers of liquid IDW, they will be clustered together with any liquid-filled containers on the interior of the cluster. Placement of IDW on pallets should be done if the IDW may require movement prior to disposal. If it is not possible to locate a secure IDW staging area with perimeter fencing, warning tape and temporary orange barrier fencing, at a minimum, will be placed around the cluster of containers.

Containers of liquid IDW should not remain in storage for longer than necessary to determine the regulatory status of the waste through laboratory testing and to evaluate disposal options. If it is anticipated that liquid-filled containers will remain in storage for 30 days or longer, the containers will be positioned to allow inspection from all sides to monitor for leakage.

8.1.2 Solid IDW

During environmental investigation activities, various activities such as soil sampling, sediment sampling, and monitoring well installation will produce solid IDW, including soil cuttings and excess soil sample material. Most soil IDW, generated as part of site investigations, will be either non-hazardous or have slightly elevated concentrations of contaminants which might classify the material as special waste. Typically, very little solid IDW is classified as hazardous waste. Solid IDW will be containerized and disposal options evaluated based upon laboratory and site historical data.

Solid IDW consisting of used PPE, disposable equipment (bailers, rope, acetate liners, etc.), and other trash that may have come into contact with contamination, will be rendered nonhazardous through the removal of gross contamination. The IDW will be double bagged and disposed with other household type

trash at a local sanitary landfill. Gross contamination removed from the IDW in accordance with the Project-Specific APP/SSHP will be placed with the appropriate IDW.

Solid IDW, consisting of soil cuttings and excess soil sample material, will be placed in rolloff boxes equipped with liners and tarps or UN-approved drums. Five-gallon plastic buckets may be used for interim handling and transport of solid IDW. Any soil suspected of being characterized as hazardous waste will be drummed rather than being placed in the rolloff boxes. Containers will be closed and sealed except when adding to or disposing of the contents. Manufacturer DOT specifications will be followed when sealing containers.

Solid IDW will be containerized on an investigation area basis. Solid IDW requiring characterization from a given area of investigation will not be mixed with that from another area, as per the *Management of Investigation Derived Waste During Site Inspections*, EPA/540/G-91/009 (USEPA, 1991). However, solid IDW from multiple soil borings or direct-push activities within a single area of investigation may be combined into a single waste stream.

Containers of solid IDW will be labeled to indicate the source and nature of the waste material. The following information will be marked on the top or sides of each container: container number(s) (boring number plus a sequential number); site name; monitoring well, direct push, or borehole number; date of generation; container contents; estimated quantity; and the POC.

Containers will be marked with 2-inch letters and numbers using a waterproof paint pen. An inventory of IDW will be maintained by the Field Site Manager to facilitate identification and tracking of solid IDW for appropriate disposal. This inventory will include all of the above information, the location of the container, and initials of the responsible POC. In addition to the IDW inventory, the total number of containers of solid IDW generated will be noted in the field notebook on a daily basis.

Solid IDW determined to be hazardous (based on the outcome of laboratory analysis) will be relabeled in a manner consistent with applicable state and federal requirements including, but not limited to, RCRA, TSCA, and DOT.

Containers of solid IDW will be temporarily stored within until characterized. If deemed necessary, the client will designate a winter storage location. Issues to consider in identifying storage areas include the potentials for freezing, unauthorized access, and flooding.

For short-term storage on site, properly labeled and closed containers of solid IDW will be left in an upright position placed on level ground. Placement of IDW on pallets should be done if the IDW may require movement prior to disposal. When containers of solid IDW are staged with containers of liquid IDW, they will be clustered together with any liquid filled containers on the interior of the cluster. If it is not possible to locate a secure IDW staging area with perimeter fencing, warning tape and temporary orange barrier fencing, at a minimum will be placed around the cluster of containers.

Containers of solid IDW should not remain in storage for longer than necessary to determine the regulatory status of the waste through laboratory testing and to evaluate disposal options.

8.2 IDW Sampling

The sampling procedures for liquid and solid IDW contained in drums or rolloffs are described in the following sections.

8.2.1 Liquid IDW Drum Sampling Procedures

Within two weeks of the completion of field activities, a sample from each container of liquid IDW that requires characterization will be obtained and composited with the exception of samples for volatile organics analysis. When IDW is to be characterized for volatile organic analysis, one representative samples will be collected from each container of IDW. Samples will be composited on a monitoring well basis for new monitoring wells, or on a per area basis for other field activities. The composite sample will be analyzed for the constituents identified in the Project-Specific Work Plan. If during field investigations, field analytical results indicate elevated levels of contaminant concentrations at some investigation points, then the IDW from these investigation points will be stored in containers separate from the main body and analyzed separately from the other liquid or soil IDW.

The procedures listed below are for collecting samples from liquid IDW stored in drums in which the IDW source is known. The liquid drum sampling procedures are as follows:

- 1. Conduct field screening near drum storage area. If elevated concentrations are detected, then increase PPE level to C or B based on the Project-Specific APP/SSHP.
- 2. Wearing clean, disposable gloves, remove bung or drum lid and store on plastic sheeting.
- 3. Dip sample collector/bailer into the drum and slowly push the device into the middle portion of the drum.

- 4. Slowly remove sample device and decant into sample container.
- 5. Repeat Steps 3 and 4 until the correct sample volume has been collected.
- 6. Replace bung or drum lid.
- 7. Dispose of sample device and plastic as solid PPE.
- 8. Label the samples per the Project-Specific Work Plan, pack and ship the samples to the laboratory per *SOP 592 Sample Packing and Shipping*. Decontaminate the equipment per *SOP 701 Field Decontamination*.

8.2.2 Soil IDW Drum Sampling Procedures

8.2.2.1 Discrete Samples

The procedures listed below are for collecting discrete samples from soil or solid debris IDW stored in drums in which the IDW source is known. The soil drum sampling procedures are as follows:

- 1. Conduct field screening near drum storage area. If elevated concentrations are detected, then increase PPE level to C or B based on the Project-Specific APP/SSHP.
- 2. Wearing clean disposable gloves, remove bung or drum lid and store on plastic sheeting.
- 3. Using a decontaminated trowel, gently scrape the top portion of the drum contents to one side.
- 4. Slowly push the sample device into the middle portion of the drum to a depth of approximately four inches.
- 5. Remove the sample device and transfer the sample immediately into the sample container.
- 6. Repeat Steps 4 and 5 until the correct sample volume has been collected.
- 7. Replace bung or drum lid.
- 8. Label the samples per the Project-Specific Work Plan, and place immediately in a cooler with ice. In general, sample containers will be filled from most volatile to least volatile. Specific sample order, sample containers, and sample preservatives will be detailed in the Project-Specific Work Plan.

- 9. Decontaminate the equipment per SOP 701 Field Decontamination.
- 10. Pack and ship the samples to the laboratory per SOP 592 Sample Packing and Shipping.

8.2.2.2 Composite Samples

The procedures listed below are for collecting composite samples from soil or solid debris IDW stored in drums in which the IDW source is known. The soil drum sampling procedures are as follows:

- 1. Conduct field screening near drum storage area. If elevated concentrations are detected, then increase PPE level to C or B based on the Project-Specific APP/SSHP.
- 2. Wearing clean disposable gloves, remove bung or drum lid and store on plastic sheeting.
- 3. Using a decontaminated trowel, gently scrape the top portion of the drum contents to one side.
- 4. Slowly push the sample device into the middle portion of the drum to a depth of approximately four inches.
- 5. Remove the sample device and transfer the sample immediately into a stainless steel bowl.
- 6. Repeat Steps 4 and 5 until the correct sample volume has been collected.
- 7. Replace bung or drum lid.
- 8. Repeat Steps 2 through 7 for each drum to be included in the composite sample.
- 9. Thoroughly homogenize the sample by mixing in the sample bowl with a spoon or by hand, wearing clean, new gloves. Clean, disposable gloves will be worn and changed after the collection of each composite sample.
- 10. Place the composited surface soil in appropriate sample containers, label, and place immediately in a cooler with ice. In general, sample containers will be filled from most volatile to least volatile. Specific sample order, sample containers, and sample preservatives will be detailed in the Project-Specific Work Plan.
- 11. Decontaminate the equipment per SOP 701 Field Decontamination.
- 12. Pack and ship the samples to the laboratory per SOP 592 Sample Packing and Shipping.

8.3 IDW Disposal

Following IDW sample analysis, analytical results will be compared to the applicable screening levels as defined in the Project-Specific Work Plan and RCRA characteristic limits. The final disposition of the IDW will be determined by the client project manager. The procedures for IDW disposal are described in the following sections.

8.3.1 Liquid IDW Disposal Procedures

Depending on the classification of the liquid IDW, several options are available for disposal. The disposal option used will be determined by the client project manager. These options are as follows:

- Non-hazardous liquid IDW may be discharged to the ground surface at some sites. This option <u>must</u> <u>have</u> client and regulator approval prior to execution. If on-site disposal of non-hazardous liquid IDW is approved, care must be taken to not cause erosion or damage to surface features. Liquid IDW should not be directly discharged to surface water. Non-hazardous liquid IDW can also be disposed at a nearby waste water treatment plant, if available. Field personnel must contact the waste water plant operator and receive approval prior to disposal of any liquid IDW. The drums used to containerize liquid IDW, once emptied, should preferably be recycled but may be disposed of at a sanitary landfill.
- If the liquid IDW is deemed to be hazardous, container labeling will be amended accordingly. At the discretion of the client project manager, hazardous liquid IDW can be disposed of via a wastewater treatment system providing the waste meets the pre-treatment standards set forth in the wastewater treatment system's National Pollutant Discharge Elimination System (NPDES) permit and is approved by the wastewater treatment plant operator. However, if the liquid IDW is above pre-treatment standards or RCRA Toxicity Characteristic Leaching Procedure (TCLP) thresholds, then authorization may also be required from the state regulatory agency. For off-site disposal, Burns & McDonnell may assist the generator (client) of the waste with coordinating manifesting and disposal; however, arrangement for disposal and signature of the waste manifests will be the generator's responsibility. Off-site disposal of IDW must be authorized by the state in which the project is located.

8.3.2 Solid IDW Disposal Procedures

Depending on the classification of the solid IDW, several options are available for disposal of soil IDW generated at the site.

- Solid IDW (consisting of used PPE, disposable equipment, and trash) will be rendered non-hazardous
 by the removal of gross contamination and then double bagged and disposed with other household
 type trash at a local sanitary landfill.
- Non-hazardous solid IDW (waste soil) may be spread on the ground surface near the point of origin
 or may be transported off site to a landfill for disposal. Note that on-site disposal of solid IDW to the
 ground surface <u>must have</u> client and regulator approval prior to execution. The drums used to
 containerize solid IDW, once emptied, should preferably be recycled but may be disposed at a
 sanitary landfill.
- If the solid IDW is deemed to be hazardous, container labeling will be amended accordingly. If the solid IDW is above applicable screening levels or RCRA TCLP thresholds established by 261.24 of RCRA, authorization may be required from the state regulator prior to disposal. For off-site disposal, Burns & McDonnell will assist the generator of the waste (client) with coordinating manifesting and disposal; however, arrangement for disposal and signing of the manifests will be the generator's responsibility.
- Many states also have additional solid IDW classifications (i.e. special waste) for IDW that will be disposed of off site. State authorization for disposal of Special Waste at a Subtitle D municipal solid waste landfill is typically dependent upon the type and concentration of contaminants in the waste. For these classifications, Burns & McDonnell will assist the generator (client) with coordinating disposal; however, arrangement for disposal remains the responsibility of the generator.

9.0 DATA AND RECORDS MANAGEMENT

Field documentation will be completed as activities are conducted and will be relayed to the Field Site Manager or Project Manager at a minimum weekly basis or on a more frequent basis if so stated in the Project-Specific Work Plan. Daily logs should be used to document activities associated with IDW. A copy of completed field forms, chain of custody records, lab analytical reports, and waste manifests will be kept in the project files. Field notes will be maintained in a logbook as described in *SOP 701 Field Documentation*.

10.0 QUALITY ASSURANCE/QUALITY CONTROL

Prior to the start of any field activity, Burns & McDonnell personnel will have read and understood the Project-Specific Work Plans as well as this SOP. Field personnel will be trained for a minimum of 40 hours prior to their working solo on environmental field activities.

11.0 REFERENCES

Burns & McDonnell Engineering, Co, Inc. (Burns & McDonnell), 2015. Policy Manual,

- Chapter 8, Safety and Health Program, February.
- Chapter 10, Quality Control Manual, January.

United States Environmental Protection Agency (USEPA), 1991. *Management of Investigation Derived Waste During Site Inspections*, EPA/540/G-91/009.

USEPA, 2007. Guidance for Preparing Standard Operating Procedures. EPA/600/B-07/001. April

12.0 ATTACHMENTS

None.

SOP 701 Field Documentation

Revision 0 01/07/2017

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TABLE OF CONTENTS

			<u>Page No.</u>
1.0	Purp	pose and Applicability	3
2.0	Sum	nmary of Method	3
3.0	Defi	initions	3
4.0	Heal	ılth and Safety	4
5.0	Cau	ıtions	4
6.0	Pers	sonnel Qualifications	4
7.0	Equi	ipment and Supplies	4
8.0	Prod	cedures	5
	8.1	Corrections to Documentation	
	8.2	Field Logbook	
	8.3	Field Forms	
	8.4	Daily Quality Control Reports	
	8.5 8.6	Chain-of-Custody Records	
	8.7	Sample LabelsCustody Seals	
	8.8	Digital Cameras	
9.0		a and Records Management	
	9.1	Field Activities	
	9.2	Filing System	11
10.0	Qua	ality Assurance/Quality Control	12
11.0	Refe	erences	12
12.0	Atta	achments	12

1.0 PURPOSE AND APPLICABILITY

The purpose of *Standard Operating Procedure (SOP) 701 Field Documentation* is to establish a uniform procedure for documentation of field activities on environmental sites. Soil and bedrock logging for excavations and borings is not included in this SOP but can be found in *SOP 521 Soil and Bedrock Logging*. This SOP covers the *process* for the field documentation; specific documentation requirements that may be required by the client, regulator, or specific processes are detailed in the Project-Specific Work Plan. *SOP 701 Field Documentation* has been prepared in accordance with the *Guidance for the Preparing of Standard Operating Procedures* (USEPA, 2007) and the Burns & McDonnell Engineering Company, Inc. (Burns & McDonnell) *Policy Manual* (Burns & McDonnell, 2015).

2.0 SUMMARY OF METHOD

Each sample, field measurement, and field activity will be properly documented to facilitate timely, correct, and complete analyses, and support actions concerning site work. The documentation system will provide a means to identify, track, and monitor individual samples from the point of collection through the final reporting of data. Field forms referenced in this SOP are attached.

3.0 **DEFINITIONS**

- **Field Forms** Forms prepared for specific activities. Forms used in the field should either be Burns & McDonnell standard forms or be included in the Project-Specific Work Plans.
- **Field Logbook** A bound logbook that is kept per team during environmental work. Whenever possible, logbooks should have pre-numbered pages and stitched bindings.
- Project-Specific Accident Prevention Plan/Site Safety and Health Plan (Project-Specific APP/SSHP) – A plan or plans that address occupational safety and health hazards associated with site operations.
- Project-Specific Work Plan The plan that details the rationale, scope, and techniques to be used at
 the site to achieve the project objectives. Project-Specific Work Plans can include work plans, field
 sampling plans, quality assurance project plans, technical memorandums, and other documentation of
 proposed work.

4.0 HEALTH AND SAFETY

Field activities as detailed in this SOP will be performed in accordance with applicable safety related documents/requirements which may include, but are not limited to: Project-Specific APP/SSHP, the Burns & McDonnell Corporate Safety and Health Program (Burns & McDonnell, 2015), and site / client-specific requirements.

5.0 CAUTIONS

Field documentation should be completed with indelible marking/ink pens preferably in blue or black. Hand entries should be printed and the author should ensure that the writing is legible and clear. Any errors made should be lined out so that the original writing is still visible, initialed, and dated. Field documentation should stay either with the field personnel on site or be kept within a secure location. Upon completion of the field activities, field documentation is kept with the project files. The Project Manager should ensure that photographs are allowed prior to the start of field activities.

6.0 PERSONNEL QUALIFICATIONS

Burns & McDonnell personnel conducting on-site environmental activities will have completed the 40-hour Occupational Safety and Health Administration (OSHA) Hazardous Waste Operations and Emergency Response Standard (HAZWOPER) course and annual 8-hour HAZWOPER refresher courses. At a minimum, one person on site will be certified in first aid and cardiopulmonary resuscitation (CPR) and, if multiple people are on site, at least one person will have completed the 8-hour HAZWOPER Supervisor Training course. If Burns & McDonnell subcontractors are on site then, at a minimum, one Burns & McDonnell person will have completed the OSHA 30-hour Construction Industry Outreach Training course.

7.0 EQUIPMENT AND SUPPLIES

Equipment to be used during field documentation may include:

- Field logbooks
- Field forms
- Labels and seals
- Indelible marking pen/ink pens, black or blue in color
- Digital cameras/recorders
- Personal protective equipment (PPE) and safety equipment per the Project-Specific APP/SSHP

Equipment to be used for sampling activities can be found in the SOPs for those activities.

8.0 PROCEDURES

Included below are procedures for completing field logbooks and specific forms and labels. Which forms and labels should be completed on a project is a function of the activities to be performed and the preferences of the client and regulator. Refer to the Project-Specific Work Plan for the specific project documentation that is to be completed.

Field documentation should be completed as the activities are being done. On a regular basis, typically not less than once a week, the field personnel should scan their field documentation for placement in the project file. At the completion of a field effort, the field personnel are responsible for ensuring that a complete scan of the documentation is in the files and that the originals have been given to the project manager for inclusion in the project files.

8.1 Corrections to Documentation

Original recorded data will be written with indelible, waterproof ink. Accountable serialized documents will not be destroyed or thrown away, even if they are illegible or contain inaccuracies that require a replacement document. Errors will be corrected by marking a line through the error, entering the correct information, and initialing and dating the correction. The erroneous information will not be obliterated. Any subsequent error discovered later on an accountable document will be corrected, initialed, and dated by the person who made the entry.

8.2 Field Logbook

Information pertinent to the investigation will be recorded in a bound logbook with consecutivelynumbered, water-resistant pages. The field personnel responsible for the entries will sign and date each entry or page. Logbook entries will be made in waterproof, indelible ink. The time and date of each entry will be noted in the logbook.

General rules cannot specify the exact information that must be entered in a logbook for a particular site. However, the logbook should contain sufficient information so that field activities can be reconstructed without discussion with the original author. Logbooks will be kept in the field personnel's possession or a secure place during the investigation. Following the investigation, logbooks will become part of the project file. The following list contains typical field logbook entries to be recorded on a daily basis, depending upon field activities being performed.

- Date
- Weather conditions
- Names of field personnel and site visitors including time on and off the site
- Documentation of daily safety meeting including topics and attendance
- Calibration record of field equipment
- Name and location of area of investigation
- Location of sample (may include a sketch)
- Type of sample (soil, groundwater, sediment, air, etc.)
- Time (military) of sample collection
- Sample identification number
- Interval and depth of sample
- Field screening results
- Sample collection procedure/equipment
- Sample description (color, odor, etc.)
- Field observations of sampling event
- Parameters requested for analyses
- Field measurements
- Quality assurance/quality control (QA/QC) sample information
- Equipment decontamination procedures
- Sample shipment information
- Number assigned to chain of custody (COC)
- Documentation of investigative derived waste (IDW) per SOP 601 Investigative Derived Waste Storage, Sampling, and Disposal
- Air monitoring results
- Level of PPE

8.3 Field Forms

Field forms can be specific forms for field measurements such as water level forms, sampling forms, forms associated with specific activities such as well development or in-situ testing, equipment calibration forms, or health and safety forms. Specific field forms to be used should be referenced in the Project-Specific Work Plan or the Project-Specific APP/SSHP. In all cases, the forms should be completed in entirety. Items on the forms that do not apply should be filled with NA. Forms should be completed in waterproof, indelible ink. Time entries should be military.

8.4 Daily Quality Control Reports

Daily Quality Control Reports (DQCR) are used to transmit a summary of daily activities to the client or to the regulators. DQCRs are used on most Department of Defense projects. DQCRs can be used on state or private projects if the client or regulator requests a daily field summary. With DQCRs, field activities will be recorded daily by the Field Site Manager (FSM) to verify that procedures outlined in the Project-Specific Work Plans are implemented. DQCRs will be completed with the following information:

- **Site Information** To accurately track field activities from one site location to another, site-specific information will be recorded on the DQCR form. Information such as site location, project number, area of investigation, date, time, crew numbers, names of crew members, and the name of the FSM will be recorded.
- Weather Conditions General weather conditions such as air temperature, relative wind speed and
 direction, and relative humidity will be estimated daily and recorded on the DQCR forms. Any
 change in weather conditions encountered during the day will be recorded on the DQCR.
- Subcontractors and Equipment The subcontractors performing work associated with the
 investigation at the site will be tracked by recording on the DQCR form the subcontractor's company
 name, crew size, and a list of the major equipment used during daily field activities.
- **Summary of Work Performed -** A brief description of the daily field activities performed at the site will be recorded on the DQCR form. For field measurements, the numerical value and units will be recorded on the DQCR form.
- Instrument Calibration Instrumentation used for sampling and personal protection, and
 verification of instrument calibration during daily field activities will be recorded on the DQCR form.
 Additional instruments used will be written in the space provided. Further information on calibration
 procedures will be recorded on the calibration log for each instrument used during daily field
 activities.
- Health and Safety Requirements The level of protection used during daily field activities and any other health and safety modifications will be recorded in the DQCR form. Modifications that may occur during field activities, including upgrading to higher levels of protection based on airmonitoring data and other chemical or physical hazards encountered at the site that were not previously known to exist, will also be recorded on the DQCR form.

- Sample Numbers Collected Including QA/QC Samples A summary of the samples collected, including QA/QC samples and the relationship of the QA/QC samples to the original samples, will be recorded on the DQCR form under the "Summary of Work Performed" heading.
- **Deviations from the Approved Site-Specific Documents** Any anticipated deviation in field activities that is not specified in the site-specific documents will be recorded on the DQCR form. The actual deviation will not be performed until a written request is submitted by the Project Manager to the client and approval, written or verbal, has been granted by the client.
- Problems Encountered/Corrective Action Taken During daily field activities, any problems
 encountered and the corrective actions taken for each incident will be recorded on the DQCR form.
 For each problem encountered, the Project Manager will be notified and the date and time recorded of when notification was given.
- Work Status for the Following Day A summary of field activities planned for the following day
 will be recorded on the DOCR form.

The FSM will verify completion by signing and dating the DQCR form. The DQCR form will be completed and forward to the Project Manager daily. The DQCRs and any attachments will be submitted to the client either daily or weekly as requested. Copies of the completed forms will be placed in the project file.

8.5 Chain-of-Custody Records

The COC will be employed as physical evidence of sample custody. Field personnel will initiate a COC with acquisition of the sample. Transferred possession of samples will be recorded on the COC by both the person relinquishing and the person receiving the samples by signing, dating, and noting the time the transfer of possession takes place. Samples are considered to be in a person's custody if they are within that person's line of sight, kept in a locked room or vehicle, or adequately sealed with custody seals.

A COC will be prepared for each cooler shipped or transported to the laboratory. All samples packed in the cooler will be recorded on the COC accompanying that cooler. A document control number consisting of the date and consecutive alphabetic suffix will be completed in the space provided on the COC. For example, if a shipment of samples is prepared on January 31, 2016 with two coolers, the document control numbers will be 01312016A for the COC(s) included with the first cooler and 01312016B for the COC(s) included with the second cooler.

The following information is to be included on the COC:

- Sample numbers
- Signature(s) of field personnel
- Date of collection
- Time (military) of collection
- Sample type (solid, etc.)
- Identification of sampling point (including depth)
- Number of containers
- Preservative used
- Parameters requested for analysis
- Signature of person(s) involved in the chain of possession
- Inclusive dates and times of possession
- Notations regarding the possible compromise of sample integrity
- Notation regarding sample temperature
- Document control number

After completing the COC, the original (white copy) will be enclosed in a plastic bag and secured to the inside of the cooler lid for the laboratory and the yellow copy will be placed in the project file.

8.6 Sample Labels

Each sample removed from a site and transferred to a laboratory for analysis will be identified with a sample label containing specific information regarding the sample. Each completed sample identification label will be securely fastened to the sample container. Complete sample labels will include the following information:

- Date
- Time (military) of sample collection
- Type of analyses requested
- Sample number
- Sample collection depth, if appropriate
- Location of sample collection
- Type of preservative
- Initials of sampler

8.7 Custody Seals

From the time the coolers are packed until they are opened in the laboratory, custody seals will be used to preserve the integrity of the cooler during shipment. Custody seals must be attached so that it is necessary to break the seals to open the cooler and should be initialized by the person applying the seal. The custody seals will be covered with clear tape. All samples shipped overnight to the laboratory will be shipped in coolers sealed on two opposite sides with custody seals. As long as the COCs are sealed inside the sample cooler and custody seals remain intact, commercial carriers and laboratory couriers are not required to sign the custody form.

8.8 Digital Cameras

Sample points and field activities may be documented using photographs. Photographs may include samples, sample collection activities and equipment, and surrounding areas. Photographs taken to document sampling points should include one or more reference points to facilitate relocating the sample location at a later date. Where appropriate, a scale should also be included in the photo. A photograph location sketch may also be drawn in the field logbook. The following information will be recorded in the field logbook for each photograph:

- Date
- Time
- Photographer
- Name of building or area
- General direction faced and description of subject
- Sequential number of the photograph
- Camera type

9.0 DATA AND RECORDS MANAGEMENT

9.1 Field Activities

Field documentation should be completed as the activities are being done. On a regular basis, typically not less than once a week, the field personnel should scan their field documentation for placement in the project file. At the completion of a field effort, the field personnel are responsible for ensuring that a complete scan of the documentation is in the files and that the originals have been given to the project manager for inclusion in the project files.

9.2 Filing System

A project file will be established to organize and maintain data throughout the life of the project. The field data file will include either hard or electronic copies of record documents generated in the field including but will not be limited to the following:

- Field logbooks
- Site planning documents and project-specific plans
- Contract specifications
- Subcontractor agreements/purchase orders
- Safety Data Sheets for chemicals used on the site
- Field instrument operating manuals
- List of important phone numbers
- Shipping forms
- Equipment calibration records
- Health and safety forms
- Applicable field forms
- Applicable laboratory forms

Field forms in hard format should be electronically scanned and placed in the electronic project files upon return to the office.

The project file in the office can also include, but is not limited to:

- Chemical laboratory data file including copies of the COCs, cooler receipt forms, requests for chemical analysis, and the laboratory results
- Physical laboratory data file including requests for physical analysis and the laboratory results
- Field data file including boring log originals, field logbooks, field transmittals, photographs, and field performance and system reviews
- Data record file including backup copies of the computerized data record system.
- Project correspondence including transmittal letters
- Project memoranda including minutes of meetings and progress reports
- QA/QC file including copies of the laboratory's QA/QC manual, the laboratory's QA/QC project plan, the laboratory's QA/QC internal audit, and performance and system QA reviews
- Report originals in pdf (portable document file) format

 Drawing and plan file including original report exhibits, original maps, and miscellaneous plans and drawings related to the field investigation

10.0 QUALITY ASSURANCE/QUALITY CONTROL

Prior to the start of any field activity, Burns & McDonnell personnel will have read and understood the Project-Specific Work Plan as well as this SOP. Field personnel will be trained for a minimum of 40 hours prior to their working solo on environmental field activities. Field documentation will be completed as activities are conducted and will be relayed to the FSM or Project Manager at a minimum weekly or on a more frequent basis if so stated in the Project-Specific Work Plan.

11.0 REFERENCES

Burns & McDonnell Engineering, Co, Inc. (Burns & McDonnell), 2015. Policy Manual,

- Chapter 10, Quality Control Manual, January.
- Chapter 8, Safety and Health Manual, February.

United States Environmental Protection Agency (USEPA), 2007. *Guidance for Preparing Standard Operating Procedures*. EPA/600/B-07/001. April

12.0 ATTACHMENTS

The following forms are attached to this SOP:

- DQCR
- COC
- Sample label
- Custody seal

Project-specific forms should be included with the Project-Specific Work Plans.

Attachments

DAILY QUALITY CONTROL REPORT

Site:		Weather (ci	rcie)				
Project No:	_	Bright Sun	Clear	Overcast	Rain	T-storm	Snow
Date:	Temp:		32-50	50-70	70-85	85+	
Crew No:	- Wind:		Gusty	Moder.	High	Direction	: NW
Crew Mem:	- Humidity:	Dry	Moder.	Humid		•	
	<u> </u>						
	_						
Subcontractors and Equipment on Site:	None						
Health and Safety Levels: (circle)	D	Mod. D.	С	ВТ	A	٦	
Summary of Health and Safety Activities:		INIOG. D.			- / \	_	
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Instrument Used: (circle) PID	pН	Cond.	i nerm.	Turbidity	DO	ORP	Other
Calibrated: (check) For actual calibration results, see field calibration form							
For actual calibration results, see field calibration form	S.						
Summary of Work Performed:							
diffillary of vvolk i efformed.							
All Samples Were Collected According to Pi	rocedures O	utlined in the	Work Pla	ın?			
Yes No	_						
Droblema Engalistara d/Carractiva Action To	den:						
Problems Encountered/Corrective Action Ta	iken.						
Time Project Manager Contacted:							
Tomorrow's Expectations:							
Name:	Signature:						
	_ ~						

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Burns & McDonnell Engineering	Laboratory:	ory:				Δ.	Document Control No:	Control	No:
9400 Ward Parkway Kansas City, Missouri 64114	Address:	66					ab. Kerei	ence Nc	Lab. Reference No. or Episode No.:
Phone: (816) 333-9400 Fax: (816) 270-0575	City/State/Zip:	ıte/Zip:				1			
Attention:	Telephone:	ine:					Ş		
Project Number:				Sarr	Tyr	ıω	ISAJEL		
Client Name:				_	Matrix		W)		
Sample Number Location		Material Sampled	Sample Collection Date	ηİΑ	əqiW	Bulk			Remarks (sq. ft, linear ft, volume)
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Sampler (signature):		Sampler (signature):			Specie	al Instr	Special Instructions:		
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elinquished By (signature):	Date/Time	Received By (signature):	Date/Time	Time	Labor	atory (Laboratory Comments:	:Si	
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Burns & McDonnell WCD 9400 Ward Parkway Kansas City, MO 64114 Phone: (816) 333-9400	ANALYSIS
Sample Group:	
Sample Designator:	· ·
Sample Round:	Year:
Sample Depth From:	To:
Date Sampled:	
Time Sampled:	
Preservation:	
090705 Form WCD-97N	

APPENDIX D - FIELD DOCUMENTATION

Drill Log

Observed Water Level Form

Well Development Form

Field Permeability ("Slug Test") Data Form

Texas Well Report

Drilling Log

Project Name			Project Num	ber						Boring	Numb	er				_
Ground Elevation		Location	1							Page			•			
Air Monitoring Equipment										Total Fo	ootage)				
Drilling Type	Hole	Size	Overburder	n Footage	,]	Ве	drocl	k Footag	je	No	o. of Sa	amples		ı	No. of Core Boxes	
Ī.																
Drilling Company		1				Driller(3)							1		
Drilling Rig			- "			Type of Sample					_					_
Date		То				Field C	bserv	/er(s)								_
Depth (feet)	Description	on		Class	Ble Co	low Rount	ecov.	Run/ Time	Sample Desig	e BZ		PID (ppn BH		S	Remarks/ Water Levels	_
1																

BZ=Breathing Zone

BH=Bore Hole

S=Sample

Burns & McDonnell

Drilling Log Continuation

											
							Boring Nu	mber			
Project N	ame						Page				
Project N	umber						Date				
Denth		Class	Blow	Recov.	Run/	Sample		PID (ppm)		Remarks/
Depth (feet)	Description	Olass	Blow Count	l iecov.	Run/ Time	Sample Desig.	BZ	BI		S	Remarks/ Water Levels
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BZ=Breathing Zone

BH=Bore Hole

S=Sample

Burns & McDonnell

Observed Water Level Form

Page 1 of ___

Project Number:			Well Number:				
Facility Name:			Ground Surface Elevation (GS):				
Location: N E			Top of Pipe Elevation (TOP): Reference Point Elevation (RP):				
Date Drilling Completed:			Total Depth of Well: feet from				
Drilling Type:			Depth to Top of Screen: feet from				
Date Well Installed:			Length of Casing Screened: feet				
B .							

Remarks:

Date	Time	By Whom	Depth to Water*	Water Level El.	Total Depth*	Remarks**
			from		from	
			from		from	
			from		from	
			from		from	
			from		from	
			from		from	
			from		from	
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			from		from	
			from		from	
			from		from	

^{*} Depth noted from Ground Surface (GS), Top of Pipe (TOP), or Reference Point (RP) ** e.g. Added or removed water, began pumping, took samples



Well Development Form

Page ___ of ___

Project Name	:	Project N	umber:	SW File Number:				Well Name:		
Project Information							of Piezome	eter		
Facility Name:						Ground Sur	face Eleva	ation (GS):		
Location:		N		E		Top of Casi	ng Elevati	on (TOC):		
Location in De	cimal Degrees:	LatDD:		LongDD:		Measuring F	Point Eleva	ation (MP):		
Well Information	on					Well Volum	ne Calcula	tion		
Date Drilled:										
Borehole Dept	h:			feet from						
Casing Depth: feet from										
Depth to Top of Screen:										
Depth to Bottom of Screen:										
Filter Top Depth:										
Filter Bottom Depth:										
Length of Casi	ng Screened:	feet		1 well volur	me (gallons)	= intial height	of water column	n (ft) x 0.0408 x (casing diameter (in))²		
Type of Formation Screened: intial height of water column (ft) = total depth (ft) - intial depth to water (ft)								n (ft) - intial depth to water (ft)		
Development	Method									
Equipment:				Drilling Me	ethods:					
Surge		Bail								
Airlift		Pump								
Observations	During Develops			1		ı	ı	ı		
		Depth to	Total	Fluid Re	moved	Temp.	pН	S.C.	Tubidity	Fluid Appearance and Remarks
Date	Time	Water* (ft)	Depth* (ft)	Gallons	Total	(degrees F)	(units)	(mS/cm)	(NTU)	(color, odor, etc.)
Trom TOC unles otherwis	se noted in Remarks	ı		<u> </u>	<u> </u>	·	<u> </u>	<u> </u>		1

Well Development Form (Continuation)

Page ___ of ___

Project Nam	ie:		Project	Number:				Piezometer Number:	
		Development							
		Depth to	Total	Fluid Re	emoved	Temp.	рН	S.C.	Fluid Appearance and Remarks
Date	Time	Water* (ft)	Depth* (ft)	Gallons	Total	(degrees F)	(units)	(µS/cm)	(turbidity, color, odor, etc.)
	wise noted in Remarks			<u> </u>					091294 Form WCLOP6-2

FIELD PERMEABILITY ("SLUG TEST") DATA										
Date:					Sheet	of				
Location:			Geologic Unit: _			Well Nun	nber:			
Field Team Member:			_Signature:							
Slug Test Method:			Injection or		Withdrawal					
Slug Dimensions or \	Volume:									
Well Construction De	etails: Casir	ng Diameter		Borehole	Diameter					
	Foot	age Slotted		Elevatio	n (TOC)					
Test Started:			Test Stopped: Test ID:							
Method of Water-Lev			_		_					
						Time				
Static Water Level:				Date.		rime.				
Comments:										
	<u> </u>		Time				Depth to			
Time of Measurement	Elapsed Time (min.)	Depth to Water (ft)	of Measuren	nent	Elapsed (min		Water (feet)			
	i									

FIELD PERMEABILITY ("SLUG TEST") DATA (continued)									
Date:				Sheet of					
Location:			Geologic Unit:Well Number:						
Test Started:			Test Stopped:	Test ID:					
	Static Water Level: Total Depth: Date: Time:								
Additional Comment	S:								
Time of Measurement	Elapsed Time (min.)	Depth to Water (ft)	Time of Measurement	Elapsed Time (min.)	Depth to Water (feet)				
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				+					
				_					
				+					

Attention Owner:

Confidentiality Privilege Notice on reverse side of owner's copy.

Texas Department of Licensing and Regulation Water Well Driller/Pump Installer Section P.O. Box 12157 Austin, Texas 78711 Toll free (800)803-9202 (512)334-5540

Email address: water.well@tdlr.texas.gov Web address: www.tdlr.texas.gov

This form must be completed and filed with the department and owner within 60 days upon completion of the well.

WELL REPORT

1) OWNER			A.	WELL	IDENTI	FICATIO	ON AN	ND LOC	ATION 1	DATA					
Name:			Address:				City:				State:		Zip	:	
2) WELL LO	OCATION		Dhyn: 1 A	ddras:			C:-				Ctoto		172:		
County:			Physical A	Address:			City:				State:		Zip	:	
3) Type of W	Vork		Lat.			Long.	•		GPS	Datum	•	Eleva	tion		
[] New Well	[] Recond		4) Prop			[] Monit			nental Soil	Boring [] D] Indus	trial [;
[] Replacemen []Other	t [] Deeper	ning	[] Irrigat [] Other:		ijection [well [] Rig S blic Supply, v					s [] No
5) Drilling D	ate	_	6)		er of Ho	le	LJIU			hod (check)					
Started Completed		<u>/</u>	Dia.(in)	Fr	om (ft)	To (ft	:)			ammer []Cabation []Other] Jetted [] Holl	ow stei	m Auger
Number of ide		rilled													
at this location		iiiieu								mpletion ed [] Filter					
From (ft.)	To (ft.)	Desci	ription a	nd color	of forma	tion mat	erial	Filter pacl	ked interval	from:ft.	to:f	t. Size: _		Гуре	
								9) Casi	ng, Blan	k Pipe, and	Well So	reen D	ata		
								ъ.	New	Steel, Plast	,		Setting	g (ft)	Gage
								Dia. (in.)	Or Used	Perf., Slott Screen Mf		nercial F	rom	То	Casing Screen
								from:	ft.	beal Data: i. to:	_ft	_ sacks c	of		
		(Use_re	everse side	of Well O	wner's cop	y, If necessa	ary)_	from: _	ft.	to:	_ft	_ sacks c	of		
14) Plugged	[] Well	plugge	d within 4	48 hours				Distance	e to septic f	ield or other co Fank:ft.	oncentrated	contami	nation:		ft.
Casing left in we			Bentonite p	olaced in w				Method	of Measure	ement:nt.	App	roved by	Varian	ce #:	1t.
From (ft)	To (ft)	From (ft	t)	To (ft)	#Sacks	or Material	used			ompletion		eted by			
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15) Type Pu	mn							[] Oth 12) W	ater Lev	el		[] Steel	Cased		
[] Turbine	III p [] Jet	[]	Submersib	ole	[] Cyl	inder		Static le Artesian	vel	ft.	Date:	/	/	<u></u>	
Other Depth to pump b	owle cylinder	iet etc	ft						ckers:	gpii	i Metiloc	i oi ivieas	suremen	<u> </u>	
	-	jet etc., _		•				Туре		Depth		Type			Depth
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Depth of Strata:	W	as a chem	ical analysi	s made? []Yes []	No. Did yo	ou know	ingly penet	trate a strata	a which contain	ns injurious	s constitu	ents? []Yes	[] No
f yes, Type of w Check One: [] I		uuality oro	undwater _	type		[]Hydr	ocarbor	ns (i.e. gas	oil etc)	[] Hazardous	material/w	aste cont	aminat	ion enc	countered
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<u>Addi</u>	Additional information or comments:							

WELL REPORT CONFIDENTIALITY NOTICE

TEX. OCC. CODE Title 12, Chapter 1901.251, authorizes the owner (owner or the person for whom the well was drilled) to request that information in Well Reports be made confidential. The Department shall hold the contents of the well report confidential and not a matter of public record if it receives, by certified mail, a written request to do so from the owner or the person for whom the well was drilled.

From (ft)	To (ft)	Description and color of formation material

Groundwater Classification

Objectives: This document provides recommended procedures for classifying groundwater and

documenting the classification under the Texas Risk Reduction Program.

Audience: Regulated Community and Environmental Professionals

References:

The Texas Risk Reduction Program (TRRP) rule, together with conforming changes to related rules, is contained in 30 Texas Administrative Code Chapter 350. The TRRP rule was initially published in the September 17, 1999 Texas Register (24 TexReg 7413-7944). The rule was amended in 2007 (effective March 19, 2007; 32 TexReg 1526-

1579) and 2009 (effective March 19, 2009; 34 TexReg 1861-1872).

Find links for the TRRP rule and preamble, Tier 1 PCL tables, and other TRRP

information at: < www.tceq.state.tx.us/remediation/trrp/>.

TRRP guidance documents undergo periodic revision and are subject to change. Referenced TRRP guidance documents may be in development. Links to current

versions are at: <www.tceq.state.tx.us/remediation/trrp/guidance.html>.

Contact: TCEQ Remediation Division Technical Support Section: 512-239-2200, or

< techsup@tceq.state.tx.us >.

For mailing addresses, refer to: < www.tceq.state.tx.us/about/directory/>.

1.0 Introduction

This document discusses the rule requirements for groundwater classification and provides a recommended process for completing groundwater classifications.

1.1 Applicable Regulatory Requirements

Under the Texas Risk Reduction Program (TRRP) rule, all groundwater-bearing units affected by, or reasonably anticipated to be affected by, chemicals of concern (COCs) having concentrations at or above residential groundwater assessment levels must be characterized with regard to the applicable groundwater resource classification, in accordance with §350.52. Under §350.4(a)(40), a groundwater-bearing unit is defined as a saturated geologic formation, group of formations, or part of a formation that has a hydraulic conductivity equal to or greater than 1 x 10⁻⁵ cm/sec.

TRRP at §350.52 establishes three categories of groundwater resources, designated Class 1, Class 2, and Class 3, based upon a site-specific evaluation of the current use of the groundwater-bearing unit (GWBU), as well as its potential use, as defined on the basis of natural water quality and well yield (see Table 1).

Saturated geologic units can be identified most readily during assessment by their capability to transmit water to an open borehole. Only saturated geologic units with hydraulic conductivities of K \geq 1 x 10^{-5} cm/ $_{\rm sec}$ meet the definition of groundwater bearing unit (GWBU) in §350.4(a)(40) and must be classified as Class 1, Class 2, or Class 3 groundwater. Saturated geologic units with hydraulic conductivities of K < 1 x 10^{-5} cm/ $_{\rm sec}$ are *not* subject to the classification requirements of §350.52.

1.2 Key Acronyms and Abbreviations

APAR Affected Property Assessment Report

ASTM American Society for Testing and Materials

COC Chemical of concern

gpd Gallons per day

GWBU Groundwater-bearing unit

K Hydraulic conductivity

PCL Protective concentration level

PDWS Primary Drinking Water Standards

PWS Public water supply

Q Well yield (e.g., from well)

RAL Residential assessment level

TDS Total dissolved solids

TCEQ Texas Commission on Environmental Quality

TRRP Texas Risk Reduction Program

USCS Unified Soil Classification System

1.3 Effect of Groundwater Resource Classification on TRRP Response Objectives

For each affected GWBU, the applicable groundwater response objectives, including the types of response measures that may be applied (removal/decontamination vs control) and the associated residential assessment level and groundwater protective concentration level (PCL), depend upon the groundwater resource classification of that GWBU and any other GWBUs which may be hydraulically-interconnected with it (See Sections 2.1.2 and 2.4) to the degree that it potentially can be impacted.

Applicable remedy standards and exposure pathways for Class 1, Class 2, and Class 3 groundwater resources are described below.

1.3.1 Applicable Remedy Standards

Under TRRP, the person conducting the response action may implement either Remedy Standard A (requiring removal or decontamination of affected media such that COC concentrations are less than or equal to applicable PCLs) or Remedy Standard B (requiring removal, decontamination, or control of affected media so as to prevent exposure to COCs at levels exceeding applicable PCLs). The applicability of removal/decontamination or control often is dictated by the groundwater resource classification, as follows:

1.3.1.1 Class 1 Groundwater.

For Class 1 groundwater resources, affected groundwater must be removed and/or decontaminated to the critical PCL; control options are not permitted by §350.33(b).

1.3.1.2 Class 2 or 3 Groundwater.

For affected Class 2 or Class 3 groundwater resources, affected groundwater must be removed and/or decontaminated to the critical PCL, unless: a plume management zone is approved per Remedy Standard B (§350.33), or such remediation is demonstrated by the person to be technically impracticable, in which case a plume management zone is required.

1.3.1.3 Groundwater Classification using Table 1.

Table 1 summarizes the TRRP Groundwater Resource Classification System by regulatory citation. Classification of a groundwater resource may be based on its *potential use* and/or its *current use*. A GWBU is assigned the highest water-quality classification for which *all of a citation's applicable potential use and current use conditions are true*. However, different classifications can apply to different portions of a single GWBU. For example, a GWBU can transition laterally from Class 2 to Class 3. Additionally, response objectives for each affected GWBU must be adjusted as needed to be protective of any hydraulically-interconnected GWBUs to which COCs could migrate such that the pathway can be reasonably anticipated to be complete (§350.71(c)).

1.3.2 Applicable Groundwater Exposure Pathways and PCLs

Under TRRP, a set of groundwater PCLs apply, at a minimum, to affected groundwater contained within GWBUs. The applicable groundwater exposure pathways and associated groundwater PCLs depend upon the site-specific groundwater resource classification and applicable exposure conditions, as follows:



Discussion Box

This discussion addresses *GWBUs* only. In some cases, additional response objectives may apply to soil strata based on other relevant soil PCLs, or non-aqueous phase liquids. Refer to the TCEQ document *Affected Property Assessment Requirements* (RG-366/TRRP-12) for additional discussion of applicable soil exposure pathways.

1.3.2.1 Class 1 and 2 Groundwater Ingestion Pathways.

All Class 1 and Class 2 groundwater resources are considered usable, or potentially usable, drinking water supplies. Therefore, under TRRP, the groundwater ingestion exposure pathway ($^{\rm GW}{\rm GW}_{\rm Ing}$) is applicable to Class 1 or Class 2 groundwater.

1.3.2.2 Class 3 Groundwater Resource Protection Pathways.

Class 3 groundwater resources are not considered usable as drinking water and are not subject to groundwater ingestion PCLs. Rather, Class 3 groundwater is subject to the $^{\rm GW} GW_{\rm Class~3}$ PCL, which is equal to 100 x $^{\rm GW} GW_{\rm Ing}$.

A decision-logic flowchart for determining groundwater resource classification is provided on Figure 1.

1.3.2.3 Additional Exposure Pathways.

For Class 1, Class 2, or Class 3 groundwater resources, if either the groundwater-to-surface water exposure pathway ($^{\rm SW}GW$) or the groundwater-volatilization-to-ambient air exposure pathway ($^{\rm Air}GW_{\rm Inh-V}$) is determined to be complete, the PCL for the additional pathway(s) will apply.

NOTE: If a GWBU meets the criteria for more than one groundwater classification, then the GWBU shall be assigned the higher (quality) classification (§350.52).

Table 1. TCEQ Groundwater Resource Classification System

Groundwater Classification	TRRP Citation	Potential Use of GWBU Based on Aquifer Characteristics - Well Yield Criteria	Potential Use of GWBU Based on Aquifer Characteristics - Water Quality Criteria	Current Use of GWBU
Class 1 Groundwater Resource	§350.52(1)(A)			Affected GWBU is within 0.5 miles of an existing public water supply well and COCs could impact the groundwater production zone for the well.
	§350.52(1)(B)	> 5,000 gpd (from 4-inch diameter well or equivalent)	TDS < 1,000 mg/L	GWBU is the only reliable source of water in vicinity (i.e., no public water system available) and depth to unit \leq 800 feet bgs.
	§350.52(1)(C)	≥144,000 gpd (from 12-inch diameter well or equivalent)	TDS ≤ 3,000 mg/L and water meets PDWS	No current use required
Class 2 Groundwater Resource	§350.52(2)(A)			Affected GWBU is groundwater production zone for an existing well (other than public water supply well) located within 0.5 miles of affected groundwater and used either for human consumption, agriculture, or other purpose that could result in human or ecological exposure.
	§350.52(2)(B)	< 144,000 gpd (from 12-inch diameter well or equivalent) and ≥ 150 gpd (from 4-inch diameter well or equivalent)	TDS ≤ 10,000 mg/L	No current use required
Class 3 Groundwater Resource	§350.52(3)(A)	< 150 gpd (from 4- inch diameter well or equivalent)		Groundwater from affected GWBU is <i>not</i> used within 0.5 miles in a manner resulting in human or ecological exposure.
	§350.52(3)(A)		TDS > 10,000 mg/L	Groundwater from affected GWBU is <i>not</i> used within 0.5 miles in a manner resulting in human or ecological exposure.
has = helow around sur	rface		COC = chemical c	of concern

bgs = below ground surface.

COC = chemical of concern.

gpd = gallons per day.

GWBU = Groundwater-Bearing Unit.

PDWS = Primary Drinking Water Standards per 40 CFR Part **TDS** = Total Dissolved Solids. 141.

Groundwater Production Zone – the groundwater-bearing unit(s) which contributes water to a well (see Section 2.5.2.1)

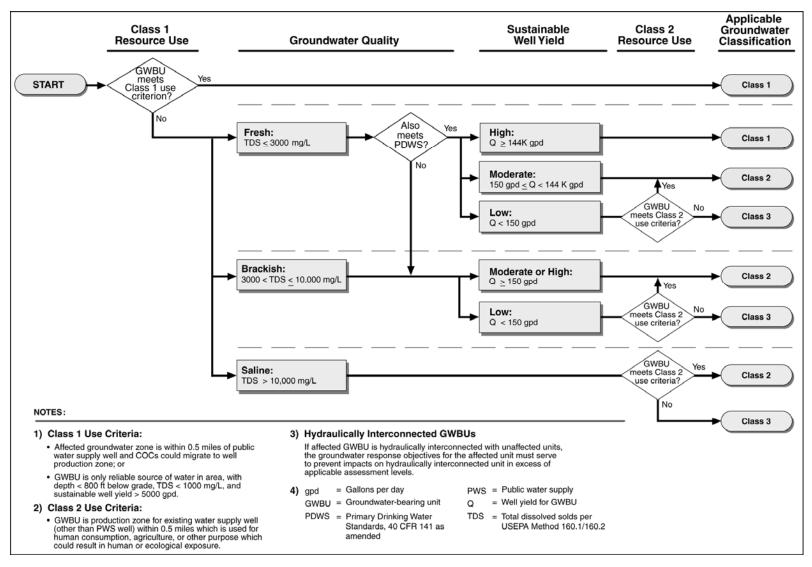


Figure 1. TCEQ Groundwater Resource Classification Logic Diagram.

1.4 Use of this Guide for Classifying Groundwater Resources

The following sections of this guide present step-by-step procedures to determine the appropriate groundwater classification for each GWBU. In general, the level of effort required for this classification process will depend upon the type of classification to be demonstrated.



Early Concurrence

Persons are encouraged to seek concurrence for groundwater classification prior to full completion and submission of the APAR in order that the completed assessment and APAR are based on the approved groundwater classification.

1.4.1 Known or Default Class 1 Groundwater Resource

By default, a GWBU has a Class 1 designation unless it can be demonstrated otherwise using the classification process described herein. If the affected GWBU is known to be a public drinking water supply aquifer (e.g., Edwards, Ogallala, Evangeline, etc.), then the applicable resource designation is probably Class 1 and no further evaluation of the

resource classification is necessary unless the person intends to demonstrate that the affected portion of that GWBU is a zone of lower productivity or water quality. However, assessment and characterization of all affected or threatened GWBUs should be submitted via the APAR. Similarly, if the affected GWBU is not a producing



Well Surveys

Field reconnaissance and a records survey are required to identify surrounding water wells per §350.51(i) even if a Class 1 designation is assumed (see Section 2).

zone for a public drinking water supply well, but the person is prepared to conduct the response action consistent with the response objectives applicable to a Class 1 groundwater resource, then a Class 1 designation may be assumed without further demonstration. Table 2 summarizes the criteria by which a Class 1 groundwater resource designation is made.

Reclassification of a groundwater resource to a lower classification (e.g., reclassify from Class 1 to Class 2) may be appropriate in instances when:

1) site conditions change, 2) when the person wishes to amend a Class 1 default classification, or 3) any other circumstance under which reclassification is appropriate. However, reclassification to a lower classification resource shall require submittal of all commensurate data associated with the amended classification (see Section 2.9).

Table 2. Class 1 Groundwater Resource Criteria

	Resource Use	Groundwate	er Quality	Well Yield (Productivity) ¹		
Case 1	Class 1 designation assumed by default	N/A	1	N/A		
Case 2	Class 1 Use Criteria Affected GWBU is within 0.5 miles of PWS well and COCs could migrate to groundwater production zone	N/A	4	N/A		
Case 3	Class 1 Use Criteria GWBU is only reliable source of water in area and Depth < 800 feet	TDS <1,00	00 mg/L	Q > 5,000 gpd		
Case 4	Class 1 Use Criteria No required use	TDS ≤ 3,0	000 mg/L	Q ≥ 144,000 gpd		
gpd = ga	llons per day	mg/L	mg/L = milligrams per liter			
PDWS =	primary drinking water standard	PWS:	PWS = public water supply			
Q = well yield			TDS = total dissolved solids			
¹ Well yie	d determined via Methods 1 and	2 (see Section 2.7).				

1.4.2 Class 2 Groundwater Resource

To show that an affected GWBU is a Class 2 groundwater resource, the person need only demonstrate that the unit does not currently qualify as a Class 1 resource. This demonstration requires, at a minimum, an accurate and thorough water well survey that identifies all water wells within 0.5 miles of the extent of affected groundwater, and if the survey reveals there is no use within 0.5 miles:

- 1. an evaluation of water quality, or
- 2. an estimate of well yield for the affected GWBU.

As indicated in Figure 1, a Class 2 designation may be applied to GWBUs that do not meet the Class 1 criteria. Table 3 summarizes the criteria by which a Class 2 groundwater resource designation is made.

	Resource Use	Groundw	ater Quality	Well Yield (Productivity) ¹		
Case 1	Class 2 Use Criteria Production zone for existing water supply well (other than PWS well) w/in 0.5 mile & used for human consumption, agriculture, etc.		V/A	N/A		
Case 2	No use within ½ mile		ackish DS ≤ 10,000 mg/L eet PDWS)	Moderate or High Q ≥ 150 gpd		
¹ Well yie 2.7) <u>.</u>	ld determined via Methods 1 and	gpd = gallons per day				
PDWS = primary drinking water standard			PWS = public water supply			
Q = well	yield		TDS = total dissolved solids			

Table 3. Class 2 Groundwater Resource Criteria

1.4.3 Class 3 Groundwater Resource

To show that an affected groundwater-bearing unit is a Class 3 groundwater resource, the person must demonstrate that the unit does not currently qualify either as a Class 1 or Class 2 resource. *This demonstration comprises a more rigorous site-specific evaluation than is required for a Class 1 or Class 2 designation*. At a minimum, the person must provide all site-specific data required for a Class 2 groundwater determination *plus* the following supporting information:

- 1. site-specific natural TDS of the affected groundwater-bearing unit > 10,000 mg/L, or
- 2. determination that the sustainable daily rate of withdrawal from a properly completed well is less than 150 gpd using Method 1 or Method 2 (see Section 2.7 and 2.8).

Table 4 summarizes the criteria by which a Class 3 groundwater resource designation is made. As shown, well yield is the critical classification criterion for Case 1 and Case 2. Groundwater quality is the critical criterion for Case 3, Case 4, and Case 5.

1.4.4 Saturated Soils

As defined by the TRRP rule, saturated geologic units with a hydraulic conductivity K $< 1 \times 10^{-5}$ cm/ $_{\rm sec}$ do not qualify as GWBUs for purposes of requisite GWBU classification. At a minimum, the person must provide the following supporting information:

- 1. site-specific evaluation of hydraulic conductivity (required), and
- 2. laboratory-determined USCS soil classification.

Table 4. Class 3 Groundwater Resource Criteria

	Resource Use	Groundwater Quality	Well Yield (Productivity) ¹	
Case 1	No well use	N/A	Q<150 gpd	
Case 2	No well use	TDS ≤10,000 mg/L	Q<150 gpd	
Case 3	No well use	TDS > 10,000 mg/L	Q>150 gpd	
Case 4	No well use	TDS > 10,000 mg/L	Q>50 gpd	
Case 5	No well use	TDS > 10,000 mg/l	N/A	

¹Well yield determined via Methods 1 and 2 (see Section 2.7), gpd = gallons per day

PDWS = primary drinking water standard

Q = well yield

TDS = total dissolved solids

2.0 Principal Steps in Groundwater Resource Classification Process

To establish the appropriate groundwater resource classification, the person must first identify the GWBUs that have been affected (or could reasonably be expected to be affected) by a COC in excess of the applicable residential assessment level (RAL). See TCEQ guidance document Affected Property Assessment Requirements (RG-366/TRRP-12) for information on COC assessment. Since the applicable RAL is determined on the basis of the groundwater classification, the groundwater COC assessment and groundwater classification procedures often will be iterative. However, a preliminary evaluation of background information on local hydrogeology and groundwater use may give the person an indication of the likely GWBU classification before initiating a drilling program. Since the assessment level is the same for Class 1 and Class 2 groundwater, but is different for Class 3 groundwater, the critical consideration is whether the GWBU is likely Class 3.

Therefore, before following the steps outlined in this section, it is recommended that the on-site groundwater COC assessment be completed at a minimum. Particular attention should be given to recognition of any natural preferential groundwater transport pathways for the COCs as these indicate zones that should be focused upon when characterizing a GWBU. Note that even if the on-site COC assessment indicates that groundwater is not yet affected, the upper-most GWBU still must be classified in order to set soil PCLs that are protective for that upper-most GWBU. Alternatively, the unaffected upper-most GWBU can be presumed to be Class 1.

2.1 Overview of Classification Process

A groundwater-bearing unit is defined as a saturated geologic formation, group of formations, or part of a formation that has a hydraulic conductivity equal to or greater than $1 \times 10-5$ cm/sec.

Groundwater resource classifications are determined on a site-specific basis, requiring hydrologic and geologic information for the GWBU under investigation. Available information from nearby sites may be used to augment the site-specific evaluation – but typically will not be acceptable

as a substitute for requisite site-specific information.

In each step of the groundwater resource classification process, care must be taken to demonstrate that all information provided is representative of that GWBU. Significant lithologic and stratigraphic heterogeneities, and variability of measured aquifer parameters and water chemistry, should be considered and reconciled for the purpose of delineating GWBUs whose physical, chemical, geologic, and

Use of Existing Aquifer Test
Data

Aquifer test data from an adjacent (or nearby) site may be accepted by the TCEQ in lieu of site-specific test data if the hydrostratigraphy from which the data originate can be *properly correlated* to the same hydrostratigraphic unit whose groundwater resource is being classified.

hydraulic properties are internally consistent with and representative of that unit.

For each affected GWBU, determination of the appropriate groundwater resource classification is achieved through an orderly progression of steps. Depending on the actual classification, some steps may be optional (see Section 2.2). Table 5 summarizes the steps for determination of the groundwater resource classification on a site-specific basis.

The Classification Steps are summarized as follows:

2.1.1 Step 1: Describe Affected Groundwater-Bearing Unit(s)

Identify groundwater-bearing units by:

- 1. characterizing the *site-specific* stratigraphy and relevant water-saturated units with soil borings and USCS soil classification; and
- 2. grouping the saturated stratigraphic units into the fewest number of GWBUs that is reflective of hydrogeologic conditions.

Depositional environment and hydrostratigraphic considerations should factor into these evaluations (see Sec 2.3).

2.1.2 Step 2: Determine Hydraulic Interconnectivity

Determine any hydraulic interconnectivity with other GWBUs by using:

- 1. stratigraphic methods, including detailed site stratigraphy, levels at which water is first encountered, and static water levels;
- 2. hydraulic methods to determine if water levels in one GWBU respond to pumping stresses in the other GWBU, and/or
- 3. water chemistry methods, including affected groundwater and natural water quality tracers.

Table 5. Summary of Steps in Groundwater Resource Classification

		Procedures	Section	Notes	Required and Optional Classification Steps			
					Class 1	Class 2	Class 3	Sat. Soil
Step 1	Describe Affected GWBUs or Saturated Soil	Identify and define GWBU	2.3		•	•	•	•
Page 1	Colombia Philada Intercentedido	Stratigraphic method						
Step 2	Determine Hydraulic Interconnectivity	Water chemistry method	2.4	Important if proving no threat to groundwater production zone				
		Hydraulic method						
Step 3	Determine Current Groundwater Use	Field reconnaissance	2.5					
		Records search *						
Step 4	Evaluate Natural Groundwater Quality	Determination of TDS	2.6	Important if not assuming Class 1				N/A
Step 5	Evaluate GWBU Productivity	Determine GWBU aquifer parameters or well yield	2.7					•
Step 6	Evaluate GWBU Sustainability	Ephemerality of saturation	2.8.1	Important if classification not based on wells or TDS	N/A		N/A	N/A
- Table	Evaluate GWBU Sustainability	Hydrostratigraphic extent of GWBU	2.8.2	Important if classification not based on wells or TDS	N/A		N/A	N/A
Step 7	Document Results	Reporting requirements	2.9					•
* Not red	quired if GWBU is u	naffected and assumi	ng Class 1					
■ = Req	uired Step	□ = Optional Step						

2.1.3 Step 3: Determine Current Groundwater Use

Identify current use of affected and interconnected GWBUs using:

- 1. field reconnaissance surveys within 500-foot radius of affected property; and
- 2. record searches for existing water supply wells within 0.5 miles in any direction from the affected groundwater zone.



Affected Property

Affected Property is defined as the extent of environmental media containing COCs in excess of residential assessment levels. Affected Property is not defined by a property boundary. See Affected Property Assessment Requirements (RG-366/TRRP-12) for discussion of affected property.

2.1.4 Step 4: Evaluate Natural Groundwater Quality

Characterize natural water quality of GWBU(s) based on:

- 1. background TDS concentration, and
- 2. PDWS criteria (see 40 CFR Part 141) (optional).

2.1.5 Step 5: Evaluate GWBU Productivity

Determine aquifer and yield parameters of relevant GWBUs, including:

- 1. installation of fully-penetrating test wells appropriately screened and developed;
- 2. determination of GWBU hydraulic conductivities;
- 3. single- and multiple-well aquifer tests (optional for Class 1/Class 2 GWBUs); and
- 4. well yield tests (optional for Class 1/Class 2 GWBUs).

2.1.6 Step 6: Evaluate GWBU Sustainability

Characterize the sustainability of each GWBU to be classified, based on:

- 1. demonstration of historical or predicted permanence of saturation; and/or
- 2. analysis of the geologic extent and hydrologic character of GWBU.

2.1.7 Step 7: Document Results

Prepare for submittal all supporting documentation for the information upon which all groundwater resource classifications are determined. Submit the information and the results of the groundwater classification

effort for TCEQ review as part of the *Affected Property Assessment Report* (APAR). Consider submitting the groundwater classification documentation for TCEQ approval prior to submitting the full APAR.

The appropriate content and format of the APAR is addressed in TCEQ Form No. 10325/APAR (see www.tceq.state.tx.us/remediation/trrp/guidance.html).

2.2 Required and Optional GWBU Classification Steps

Some steps in the groundwater resource classification process may be optional depending on the site-specific conditions or whether the Class 1 default is assumed. Table 5 summarizes the general minimum effort required for the classification of all affected GWBUs by indicating which classification steps are required or optional for completing the groundwater classification process.

For example, the classification process can conclude upon determination by the person that the affected GWBU could impact the groundwater production zone of a public water supply well or is the only reliable water supply source (i.e., Class 1 resource designation applies).

2.3 STEP 1: Describe Affected Groundwater-Bearing Units

Upon completion of a sufficient COC assessment, a site-specific hydrogeologic evaluation must be completed in order to characterize the stratigraphy over the depth and areal extent that soil and groundwater impacts have occurred, or could be expected to occur, and define GWBUs that must be classified. The stratigraphy should be evaluated in the context of the depositional environment in order that an appropriate hydrogeologic conceptual model is considered when defining the GWBUs.



Sealed Geoscience Work

The description and interpretation of geologic units described herein qualifies as geoscience work (22 TAC §851.10). All boring logs, cross-sections, stratigraphic sections and maps depicting geoscience work must be individually sealed by a licensed professional geoscientist (P.G.) pursuant to 22 TAC §851.156.

Sampling locations and data collection methods must be sufficient to characterize the following:

- 1. depth of occurrence, lateral continuity, thickness, and geometry of soil or rock type of affected GWBUs;
- 2. saturated thickness; and
- 3. lateral extent and continuity of affected and interconnected GWBUs.

2.3.1 Site Stratigraphy

The principal goal of the stratigraphic investigation for the affected property assessment is to characterize the occurrence and movement of groundwater affected or threatened by the COC release. The degree to which site stratigraphy is characterized should be based on the



Soils-Only Impact

Even when groundwater is not affected by a release in excess of the residential assessment level, the soils must be protective of the groundwater. Therefore, unless a site-specific evaluation demonstrates otherwise, the first (uppermost) GWBU shall be considered to be Class 1.

level of hydrogeologic complexity present at the location. The person should prepare for such an investigation by being familiar with the local geology prior to initiating an assessment in order to anticipate the full scope of the requisite work.

Stratigraphy must be correlated between different locations to define the continuity and thickness variation of each stratum across the site. At each location, the soil and/or rock column penetrated by the borehole should be discretized into individual strata based on variation of soil type, appearance, and apparent hydraulic properties. Standard stratigraphic correlation methods should be employed in constructing strike and dip sections for the site.

For the purpose of consistent stratigraphic characterization *in the field* and for presentation to the agency, soils observed and/or collected at the affected property should be classified according to the Unified Soil

Classification System (USCS) per *ASTM*Standard Practice D 2488 (field classification method).

Supplemental subsurface information may be developed using cone penetrometer testing (CPT) or geophysical logging methods to generate continuous stratigraphic logs, based on appropriate correlation to actual soil or rock core samples from the site. Data from CPT and other logging methodologies can be used to



Photo Documentation

Photographic documentation of prepared split-spoon, corebarrel, Shelby tube, and/or other undisturbed representative subsurface soil samples may be used in conjunction with other required soil information to support a GWBU Class determination.

supplement, but not replace, standard geologic log information (e.g., ASTM Standard Guide D 5434).

The number of borings necessary to satisfy a complete subsurface investigation should be commensurate with the size of the affected area(s) and the complexity of the hydrogeologic setting. The minimum number of borings is that necessary to satisfy the requirements of Section 2.3.

Various drilling and sampling methods may be employed for this purpose (e.g., hollow-stem auger, mud rotary, air rotary, etc.) as appropriate for

local soil or rock conditions (see Attachment A for recommended drilling methods).

2.3.2 Identification of Water-Saturated Units

To qualify as a GWBU, a geologic formation (or a portion thereof) must be water-saturated and have sufficient hydraulic conductivity (i.e., $K \ge 1 \text{ x} + 10^{-5 \text{ cm}}/_{\text{sec}}$).

Water saturation conditions within geologic strata can be confirmed on the basis of drilling observations, existing wells or piezometers, or installation of additional wells or piezometers. The presence of moisture or water seepage from soil cores, or water accumulation in boreholes during or after drilling operations suffices to confirm water saturation in a stratum.

For strata from which the presence of water saturation is difficult to discern during drilling (due either to low water yield rates, use of a wet drilling method, etc.), the presence or absence of water may be determined based upon inspection of an open borehole, piezometer, monitoring well, pore pressure transducer, or other reliable device that is capable of providing hydrologic information from an isolated stratum (or strata) in question and that is allowed to equilibrate for an appropriate time period following drilling or well installation (e.g., minimum 24-hour period for open borehole, piezometer, or monitoring well).

For unconfined saturated units, the depth at which water saturation occurs within the stratum can be defined based on the height of the static water level within the observation device. For confined units, the static water level will occur at or above the top of the permeable stratum, corresponding to fully saturated conditions within the permeable unit.

Perched groundwater is an unconfined zone of saturation formed above a main GWBU and is separated from the main GWBU by an unsaturated zone. Perched groundwater generally is maintained by a perching bed, or lens, of low hydraulic conductivity geologic material typically comprised of clay. If the perched groundwater exhibits Class 2 well yield characteristics, the zone may be downgraded to a Class 3 GWBU if it can be demonstrated that the unit has

Monitoring Wells

All activities associated with test well and monitorring well construction, open boreholes, and bore hole/well plugging and abandoning must comply with Texas Department of Licensing and Regulation requirements set forth in 16 TAC §76.1000 - §76.1009.

historically or predictably ephemeral saturation (*see about* Class 3 GWBUs, Sec. 1.4.3; *and* resource sustainability, Sec. 2.8).

2.3.3 Saturated Thickness

For unconfined GWBUs, the saturated thickness (b) at each location is the vertical distance from the static water level elevation to the base of the saturated unit. If static water level measurements are available for an extended time period for an unconfined GWBU, the static water elevation used for calculation of saturated thickness should be matched to the estimated mean annual static water level for the unit.

For *confined* GWBUs, the saturated thickness at each location is equal to the stratigraphic thickness of the GWBU, itself (i.e., the distance from the upper surface of the permeable stratum to its base).

Groundwater level measurements performed in accordance with ASTM Standard Test Method D 4750 are acceptable to the TCEQ.

If the GWBU is heterogeneous (e.g., consists of multiple soil types of variable hydraulic properties), refer to Section 2.3.4 for methods of organizing heterogeneous sediments into hydrogeologically coherent units.

The thickness of the saturated zone(s) beneath the affected property is recorded on geologic/soil boring logs and well logs, and should include both the level at which water was encountered and static water level measurements obtained from site monitoring wells, piezometers, or other appropriate measurement devices.

Groundwater levels that are observed to fluctuate over time should be measured over a period of time with a frequency sufficient to provide a statistically valid *mean water level* for each applicable GWBU.

Additional guidance on the collection, preparation, and presentation of groundwater-level information can be found in *ASTM Standard Guide D* 6000.

2.3.4 Characterization of Groundwater-Bearing Units

The characterization of GWBUs comprises: 1) the recognition of separate hydrostratigraphic units which possess contrasting hydraulic properties, and 2) the definition of the boundaries of hydraulically-distinct and separate GWBUs. Hydrostratigraphic units are comprised of geologic units grouped together on the basis of similar hydraulic conductivity (Fetter, 1988). The combination or separation of varied geologic materials into single, hydraulically-coherent GWBUs includes methodologies to:

- 1. *delimit* the boundaries of separate GWBUs based on hydraulic properties and the depositional environment which control the geometry of those geologic deposits, and
- 2. *organize* heterogeneous, anisotropic, rhythmic, or otherwise variable saturated geologic materials into GWBUs.

The delineation of separate GWBU sediments, performed in fulfillment of site characterization requirements for understanding COC distributions, should be placed within the context of their depositional environment and their applicable hydraulic properties. Guidelines for accomplishing the task of appropriately defining the boundaries of sedimentary GWBUs include the following:

- 1. Ensure the interpreted geometries of sediment bodies associated with zone(s) of saturation at the affected property are consistent with the general geologic framework.
- 2. Analyze site stratigraphy and assign all sediments associated with the zone(s) of saturation to an appropriate hydrostratigraphic unit.
- 3. Designate as a separate GWBU each saturated hydrostratigraphic unit that possesses unique bulk hydraulic properties.
- 4. Delineate the three-dimensional hydrostratigraphic boundaries comprising the *affected or potentially impacted* portion of each identified GWBU for the affected property.
- 5. Document the three-dimensional location and geometry of all identified and interconnected GWBUs and all intervening units (i.e., subsurface discontinuities, etc.) associated with the affected property.

Small-scale stratigraphic variations, such as thin alternating fine-grained/coarse-grained sequences may exist within a given GWBU (e.g., fluvial overbank deposits, coastal back-bay deposits, etc.). Since the coarse-grained sediments typically possess higher hydraulic conductivities and often act as the preferential COC transport pathways, it is necessary to group them appropriately when significant occurrences are observed. Small-scale sequences of interbedded sediment should be organized together into a single hydraulically-coherent GWBU when the following conditions are met:

- 1. the individual layers are too thin to practicably resolve their individual hydraulic properties using available aquifer testing methods; *and*
- 2. the bulk hydraulic property of a sub-section of the interlayered sequence is otherwise indistinguishable from the bulk hydraulic property of a different sub-section in the same sequence.

Large-scale stratigraphic units, such as homogeneous channel sand and beach sand bodies, which are sufficiently thick to practicably perform aquifer tests upon and which can yield meaningful measurements of aquifer hydraulic properties are designated as separate GWBUs.

Geoscience work performed in Step 1 should be conducted by a licensed professional geoscientist (P.G.) who is familiar with the recognition, delineation and organization of sediments from common depositional

systems. The resulting geoscience work products should be sealed by the P.G. pursuant to 22 TAC §851.156.

2.3.5 Minimum Number of GWBUs at an Affected Property

The minimum number of GWBUs that are required to be reported at an affected property are the following:

- 1. any delimited GWBUs into which a direct COC release has occurred, and
- 2. any interconnected GWBUs which potentially can be impacted by the affected GWBUs.

However, note that application of the rule in terms of setting assessment levels, demonstrating sufficient assessment, development of PCLs, defining PCLE zones and determining the appropriate response objectives will be more complicated as the number of proposed GWBUs and classifications increase. This is particularly true if multiple GWBUs and groundwater classifications are laterally distributed across the affected property. It may be more practical to assume the same higher-quality classification (e.g., Class 2 is higher than Class 3) for all GWBUs at the affected property.

2.4 STEP 2: Determine Hydraulic Interconnectivity of GWBUs

For purposes of groundwater classification, consider an affected GWBU to be hydraulically interconnected with another GWBU if flow from one GWBU may potentially cause an exceedence of a critical PCL in a receiving GWBU. The evaluation of *hydraulic interconnection* must consider the potential groundwater flow that can be induced between separate hydrostratigraphic units as a result of pumping in the unaffected unit. Such flow may occur as a result of 1) stratigraphic connections, 2) the presence of artificial penetrations, or 3) leakage through intervening confining layers. For the purpose of this evaluation, assume that the groundwater production zone of the hypothetical pumping well is screened only within the unaffected groundwater-bearing unit and is not assumed to interconnect multiple strata. Where the hydraulic interconnection is so pronounced that the two units hydraulically behave as one, consider them one GWBU.

Table 6 summarizes some methodologies and example diagnostics that can be applied to a *line of evidence* demonstration concerning the determination of GWBU interconnectivity.

General lines of evidence that indicate the potential for hydraulic interconnection of groundwater-bearing units, or the lack thereof, are listed on Table 6. In many cases, evaluation of hydraulic interconnection

may be based upon a qualitative assessment of the type, thickness, and continuity of the intervening strata, in combination with evaluation of hydraulic head elevations and water quality data. If such data are inconclusive, the TCEQ may require additional field measurements to address potential interconnections, such as 1) *in-situ* hydraulic conductivity tests for intervening confining layers, 2) an aquifer pumping test within the unaffected groundwater-bearing unit to detect the presence or absence of a hydraulic response in the affected unit, or 3) other appropriate investigations.

The applicable groundwater resource classification for a given hydraulically-interconnected GWBU will be determined based upon consideration of the current use, water quality, and well yield of that individual GWBU only. Response objectives for affected GWBUs must serve to prevent impacts to hydraulically-interconnected unaffected GWBUs in excess of the applicable assessment levels for the unaffected GWBU.

Table 6. Lines of Evidence for Hydraulic Interconnectivity of GWBUs

Type of Information	Example Line-of-Evidence Conditions for Use in Determining Hydraulic Interconnection			
	Not Interconnected	Interconnected		
Stratigraphic Data Thickness, continuity, and hydrologic properties of intervening confining layer.	Homogeneous, unfractured, continuous clay stratum ≥ 20 ft in thickness.	 Confining unit is laterally discontinuous, highly fractured, or composed of permeable material. 		
Static Water Levels (SWL) Relative hydraulic head elevations in separate GWBUs.	Significant SWL difference between wells screened above and wells screened below confining unit.	SWLs are identical above and below confining unit.		
Affected Groundwater Presence or absence of affected groundwater in GWBUs.		Affected groundwater present in all GWBUs.		
4) Natural Water Quality Contrast in natural water quality characteristics (e.g., Total Dissolved Solids (TDS), major ion distribution, etc.)	Separate GWBU is not affected and exhibits significantly different TDS and/or major ion distribution from affected unit.			
5) Field Hydraulic Conductivity Test In-situ field hydraulic conductivity tests performed on intervening confining unit.	 Confining unit is laterally continuous with vertical hydraulic conductivity ≤ 10⁻⁷ cm/sec. 	 Confining unit exhibits vertical hydraulic conductivity ≥ 10⁻⁵ cm/sec. 		
6) Aquifer Pumping Test Field test conducted to evaluate effect of pumping from unaffected unit on SWL in affected unit.	No measurable SWL drop (e.g., < 0.01 ft corrected for barometric variations) observed in affected unit within 24-hour period of continuous pumping from unaffected unit.	Measurable SWL drop observed in affected unit as a result of pumping in unaffected unit.		

2.5 STEP 3: Determine Current Groundwater Use

For the purpose of groundwater resource classification, the current use of affected GWBUs and any threatened, hydraulically-interconnected units must be characterized. The groundwater-use data support evaluation under §350.52(1)(A) and §350.52(2)(B). As specified in §350.51(i), characterization of current groundwater use will involve the following tasks:

If the groundwater is not affected above a residential assessment level and a Class 1 groundwater resource designation has been assumed for the purpose of setting ^{GW}Soil, the records survey is not required per §350.51(i). The 500-foot field survey is required in all cases when an affected property assessment is conducted.

Records and Field Surveys

- 1. **Records Survey:** Conduct a records survey to identify all water wells within a 0.5-mile distance of the limits of groundwater that contains COCs in excess of the residential assessment level (i.e., affected groundwater).
- 2. **Field Survey:** Conduct a field survey to identify any existing water wells located to at least 500-foot distance of the boundary of the affected property.

Current status and actual condition of wells that result from the above surveys should be determined. Note that the provision "existing well" in §350.52(1)(A) and §350.52(2)(A) means that as water supply wells are put into service or permanently abandoned in the vicinity of the affected property, the groundwater classification can adjust up or down during the life span of the remediation project.

2.5.1 Required Information Regarding Current Water Use

Documentation of the current use evaluation shall include:

- 1. a scale map showing water supply wells located within 0.5 miles of the affected groundwater, *and*
- 2. a complete tabulation of available information on a) well use, b) well construction (screened interval, seal, etc.), and c) groundwater production zone, as determined from available water well driller's logs, groundwater resource publications (e.g., Texas Water Development Board, United States Geological Survey, University of Texas Bureau of Economic Geology, etc.), and other relevant sources.

If documentation of water well construction/completion (i.e., drilling logs or other well construction records submitted to the State) is not available assume that the well is completed within the affected GWBU unless that well is inspected for completion construction details, well casing integrity

and potential for cross-communication. Additionally, if the well use is uncertain, *presume the well is used as a drinking water source*.

Identification of monitoring well locations is not the focus of the well surveys required for the groundwater resource classification. However, monitoring wells can provide valuable groundwater classification information (e.g., identify high TDS groundwater).

It is recommended that available groundwater resource publications be reviewed in order to 1) provide insight into and understanding of the subsurface, 2) identify the major groundwater production zones underlying the affected property, and 3) assess their potential interconnection with affected GWBUs.

2.5.2 Applicable Groundwater Resource Classification

A preliminary groundwater resource classification can be determined in this step if any of the following groundwater resource conditions are identified during the groundwater use survey (see §350.52):

- 1. **Proximity to Public Water Supply Well:** Drinking water supply well serving public water system (as defined under 30 TAC §290.38) is located within 0.5 miles, and the groundwater production zone of this well potentially could be impacted by COCs from the affected GWBU. Applicable Groundwater Resource Classification: Class 1.
- 2. **Only Reliable Water Source Affected:** The affected GWBU is the only reliable source of drinking water (i.e., a connection to a public water system is not currently available and will not be provided to the affected property as part of the remedy) located within 800 feet below grade in the area, groundwater TDS < 1,000 mg/L, and well yield for 4-inch diameter well > 5,000 gpd. *Applicable Groundwater Resource Classification*: **Class 1**.
- 3. **Proximity to Other Water Supply Well:** Domestic (private) water supply well used for drinking water, agricultural supply, or other use (other than a public water supply) that could result in human or ecological exposure is located within 0.5 miles of the affected property and has groundwater production zone within the affected groundwater-bearing unit. *Applicable Groundwater Resource Classification*: **Class 2** (**unless** otherwise Class 1, based on consideration of well yield and natural water quality).

If the results of this evaluation show the affected GWBU to qualify as a Class 1 groundwater resource (based on Conditions 1 or 2, as described above), no further evaluation of the resource classification is necessary. The person can proceed directly to Step 7: Documentation.

The following example explores the subtle distinction between §350.52(1)(A) and §350.52(2)(A) with regard to groundwater production zone. Figure 2 depicts the subsurface conditions for the example. Two GWBUs exist at the affected property. GWBU A is unconfined. GWBU B is confined and is the groundwater production zone for the well in the example. The affected groundwater is less than 0.5 miles from the well. In the example, four separate scenarios are evaluated for the purpose of illustrating how GWBU A should be classified under different conditions. In all of the scenarios, the well is sealed across GWBU A and there is no leakage down the well bore. In the scenarios, the classification of GWBU A is dependent upon whether the well is a public or domestic water supply well, the groundwater production zone, hydraulic interconnectivity between GWBUs A and B, COC transport properties, and the intrinsic characteristics of GWBU A.

- 1. **Scenario 1:** The well is a public water supply well and based on hydraulic interconnection between GWBUs A and B and the transport characteristics of the COCs, GWBU A **will contribute** COCs to the groundwater production zone (GWBU B) for the well.
 - **GWBU A Classification:** Class 1 in accordance with §350.52(1)(A) since the affected groundwater (GWBU A) is within 0.5 miles of a public water supply well, and GWBU A will contribute COCs to the groundwater production zone (GWBU B) for the public water supply well.
- 2. **Scenario 2:** The well is a public water supply well and based on lack of hydraulic interconnection between GWBUs A and B and transport characteristics of the COCs, GWBU A **will not contribute** COCs to the groundwater production zone (GWBU B) for the well.
 - **GWBU A Classification:** Class 1, 2, or 3 based on the characteristics of GWBU A. Although the affected groundwater (GWBU A) is within 0.5 miles of the public water supply well, GWBU A is not the groundwater production zone for the well and will not contribute COCs to the groundwater production zone. Therefore, §350.52(1)(A) is not applicable.
- 3. **Scenario 3:** The well is a domestic water supply well and based on hydraulic interconnection between GWBUs A and B and the transport characteristics of the COCs, GWBU A will contribute COCs to the groundwater production zone (GWBU B) for the well.
 - **GWBU A Classification:** Class 1, 2 or 3 based on the characteristics of GWBU A. Because the well is not a public water supply well, §350.52(1)(A) is not applicable. Although the affected groundwater is within 0.5 miles of the domestic well, because GWBU A is not the groundwater production zone for the well, §350.52(2)(A) is not applicable. However, because GWBU A is contributing COCs to the groundwater production

- zone (GWBU B), the standard response objectives for the applicable classification for GWBU A may need to be modified so that the response objectives for GWBU B can be met.
- 4. **Scenario 4:** The well is a domestic water supply well and based on lack of hydraulic interconnection between GWBUs A and B and transport characteristics of the COCs, GWBU A will not contribute COCs to the groundwater production zone (GWBU B) for the well.

GWBU A Classification: Class 1, 2 or 3 based on the characteristics of GWBU A.

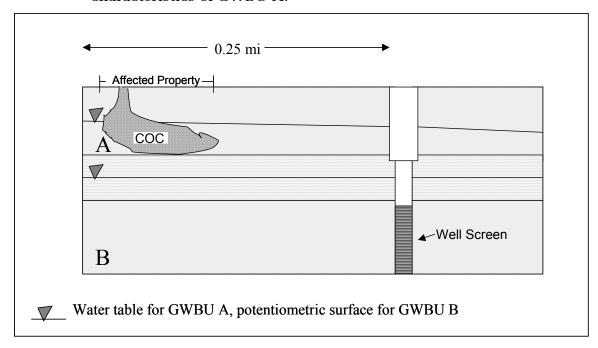


Figure 2. Hydrostratigraphic Scenario for Multiple GWBU Classification Example.

Table 7 summarizes the conditions and classification results of the example scenarios.

	Production Zone	Well Type	GWBU A Contributes COCs to GWBU B	Classification
Scenario 1	GWBU B	Public Supply Well	YES	Class 1 §350.52(1)(A)
Scenario 2	GWBU B	Public Supply Well	NO	Class 1, 2, or 3 Based on GWBU A characteristics
Scenario 3	GWBU B	Domestic Supply Well	YES	Class 1, 2, or 3 Based on GWBU A characteristics. <i>But</i> must meet response objective for GWBU B in GWBU B
Scenario 4	GWBU B	Domestic Supply Well	NO	Class 1, 2, or 3 Based solely on characteristics of GWBU A

Table 7. Example Classification of GWBU A.

2.6 STEP 4: Evaluate Natural Groundwater Quality

For the purpose of groundwater resource classification, the natural (background, not anthropogenic) water quality of a groundwater-bearing unit is to be characterized on the basis of the background total dissolved solids (TDS) content of the groundwater.

2.6.1 Characterization of Natural Water Quality

To characterize natural TDS, groundwater should be collected properly from one or more background well locations in each affected GWBU (and any hydraulically-interconnected GWBU) and submitted for laboratory analysis of TDS content using EPA Method 160.2. All groundwater sample collection, preservation and handling procedures must conform to applicable TCEQ and United States Environmental Protection Agency guidelines. Composite groundwater samples are not acceptable for TDS analysis. Estimation of groundwater TDS based on measurement of specific conductance is not acceptable for the purpose of groundwater resource classification.

If groundwater samples are collected from multiple sampling locations within a single GWBU, the representative TDS value for that unit may be estimated as the arithmetic mean of the laboratory test results for the individual samples.

In some instances, an affected property may coincide with a TDS boundary or a transition between two different groundwater classifications within the same GWBU. Before "averaging" across the two different water quality zones, the person may opt to subdivide a commensurate portion of the GWBU into a lower-quality zone based on a higher TDS content per §350.52. Otherwise, the person can opt to demonstrate that there is not a portion of the affected property where the higher-quality water would not be degraded by drawing in the lower-quality water during pumping. If there are isolated high-TDS zones, then averaging the higher TDS water in this zone is not appropriate.

2.6.2 Applicable Resource Classification by Natural Groundwater Quality

The classification of groundwater resources based on the measured TDS content of the groundwater *not meeting Class 1 or Class 2 in Step 3* (as summarized in Table 1 and Figure 1) follows:

- 1. **Representative TDS > 10,000 mg/L:** *AND* the GWBU does not qualify as Class 1 or 2 based on current groundwater use (see Step 3). *Applicable groundwater resource classification*: **Class 3**.
- 2. Representative TDS ≤ 10,000 mg/L and > 3,000 mg/L: AND the GWBU does not qualify as Class 1 based on current groundwater use (see Step 3). Applicable groundwater resource classification: Either Class 2 or Class 3, depending on well yield.
- 3. Representative TDS ≤ 3,000 mg/L: Applicable groundwater resource classification: Either Class 1, Class 2, or Class 3, depending on use and/or well yield.

If the results of the TDS evaluation show that the affected GWBU qualifies as a Class 3 groundwater resource based on TDS > 10,000 mg/L, no further evaluation of the resource classification is necessary. The person can proceed directly to Step 7: Documentation.

2.7 STEP 5: Evaluate Groundwater Resource Productivity

Aquifer parameters of GWBUs and well yield determinations must be estimated or directly measured from relevant GWBUs using appropriate protocols and methods. Discussion and methodologies that support the activities related to determining groundwater resource productivity include the following:

- 1. Monitoring/test well installation, development, and/or rehabilitation; and
- 2. Determination of hydraulic conductivity using single-well tests, multiple-well tests, or direct yield measurements.

Table 8 summarizes the purpose, applicability, requirements, and some caveats associated with the hydraulic test methods described herein.

	Purpose	Applicability	Requirements	Caveats
Method 1 Section 2.7.1	Estimate of well yield by known <i>K</i> and <i>b</i> via calculations or well yield graphs	High to low GWBU transmissivities	Site-specific K and b (Attachment A)	Direct measurement method required if within 20% of GW class boundary
Method 2a Section 2.7.2.2	Direct determination of well yield by cyclic discharge	High to low GWBU transmissivities	Measure total volume withdrawn and time to recharge	Minimum of three (3) cycles; Recharge cannot exceed 90%
Method 2b Section 2.7.2.3	Direct determination of well yield by equilibrium discharge	Low GWBU transmissivities	Constant discharge rate (pumped or bailed)	Wells should not be pumped dry
Method 2C Section 2.7.2.4	Direct determination of Class 2/Class 3 yield boundary by constant discharge	Low GWBU transmissivities	Constant discharge rate (0.1 gpm)	Discharge rate and water level should be monitored continuously

Table 8. Methods for Groundwater Classification by Well Yield.

Figure 3 provides a decision tree to assist the person in the selection of the appropriate productivity method. Figure 3 shows a general framework to aid in selecting appropriate hydraulic testing and a guide to choices inherent in the use of the productivity methods.

Aquifer parameter and well yield determinations should be performed only after the following *caveats* have been addressed:

- 1. The person should be thoroughly familiar with all standard methods employed in the construction and development of test wells, implementation of test procedures, and reduction of test data. (See Attachment A.)
- 2. Test wells should be constructed in accordance with 16 TAC §§76.1000 76.1009. Additional guidance on appropriate test well depths, placement, development, and rehabilitation (if necessary) can be found in standard methods presented in Table A1 (Attachment A). It is strongly recommended that the use of non-standard methods be pre-approved by the TCEQ.
- 3. Guidance for multi-well test, single-well test and well yield determination procedures, data collection methods, and data reduction can be found in standard methods summarized in Tables A2, A3 and A4 (Attachment A). It is strongly

- recommended that deviations from the standard test methods be pre-approved by the TCEQ.
- 4. Aquifer parameter and well yield determinations should be completed in wells that are most likely to produce the greatest yields or optimum flow rates from the GWBU. Typically, evaluation of the lithologic descriptions for the well borings, evaluation of well design, construction, completion and development, and observation of relative recharge rates following purging preparations for sampling will provide sufficient basis to identify the wells that are most suitable for testing.

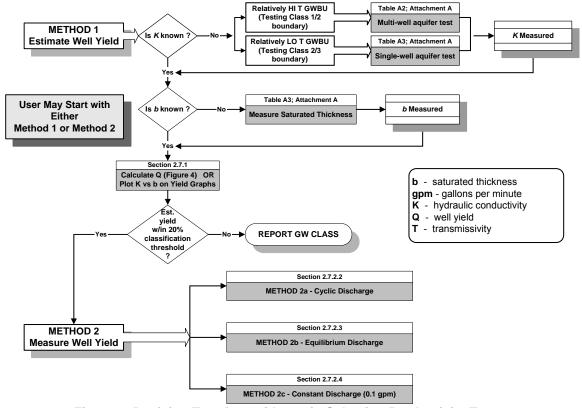


Figure 3. Decision Tree for Guidance in Selecting Productivity Tests.

2.7.1 METHOD 1: Groundwater Classification by Calculation and Yield Graphs

For each location evaluated within a GWBU, the well yield is estimated using the hydraulic conductivity, the saturated thickness (or the confining head, for confined units only) at that location, and the appropriate form of the Method 1 equation (i.e., Equations A or B for

τ

Use of Confined Yield Graph.

Figure 4 (for *confined units*) is based on a default confining head (hc) of 10 feet. To use the graph, multiply the saturated thickness value (b) at the site by a correction factor equal to the *actual* site-specific confining head (hc) in feet and divide by 10 feet. Then define and plot the (K, b) point for the representative hydraulic conductivity and the adjusted saturated thickness value.

confined units and Equations C or D for unconfined units in Figure 4). For use in evaluation of the Class 3 yield boundary (150 gpd), the default well radius in Equations A and C is set to 2 inches (4-inch diameter well screen). For use in evaluation of the Class 1 yield boundary, Equations B and D assume a default 6-inch well radius (12-inch diameter well screen).

Figure 4 summarizes the Method 1 well yield equations. For convenience, the Q = 150 gpd and the Q = 144,000 gpd well yield curves (and their respective \pm 20% envelopes) are plotted on Figure 5 (for confined groundwater) and Figure 6 (for unconfined groundwater).

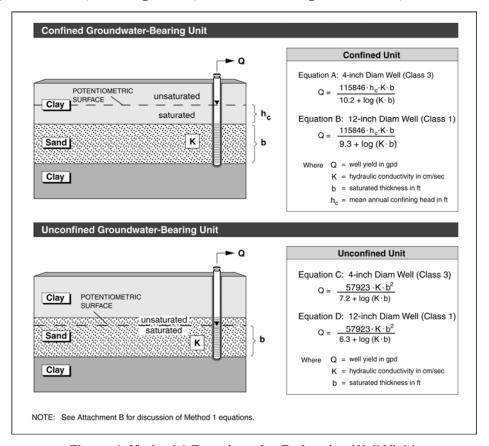


Figure 4. Method 1 Equations for Estimating Well Yield.

To use Figures 5 and 6, find the intersection of the saturated thickness value (b) and the hydraulic conductivity value (K) to define a point on the plot. The location of this (K, b) point on the plot indicates whether the well yield (Q) at that location falls in the Low (Q < 150 gpd), Moderate (150 gpd \leq Q < 144,000 gpd), or High (Q \geq 144,000 gpd) yield range.

Derivation of the Method 1 equations and **full-scale reproductions of Figures 5 and 6** (for use in plotting actual data) **are provided in Attachment B** of this guide.

NOTE: If a GWBU meets the criteria for more than one groundwater classification, then the GWBU shall be assigned the higher (quality) classification (§350.52).

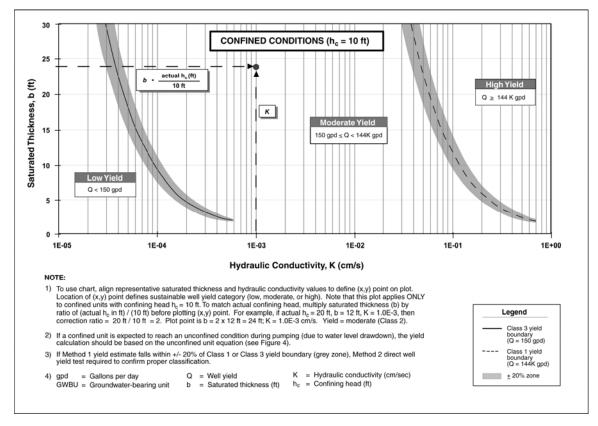


Figure 5. Method 1 Estimate of Well Yield for Confined GWBUs.

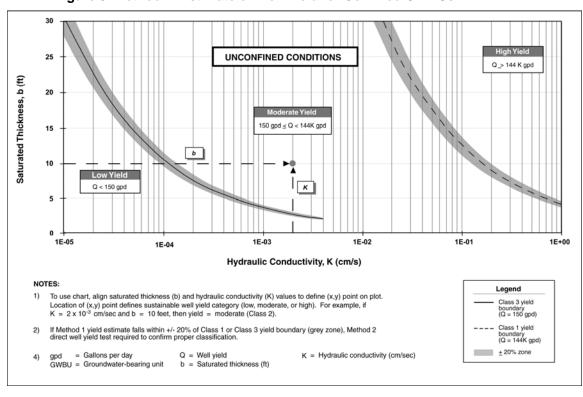


Figure 6. Method 1 Estimate of Well Yield for Unconfined GWBUs.

2.7.2 METHOD 2: Direct Well Yield Determination

If the representative well yield (Q) estimated from Method 1 indicates that the well yield is within ±20% (shaded area around boundary curves) of the Class 1 or Class 3 yield boundaries (Figure 5 or 6) and the resource classification is not otherwise dictated by current use or water quality (per Steps 3 and 4), then a Method 2 direct determination of well yield is required to



Use of Method 2.

In all cases, the person conducting the affected property assessment may choose in advance to use Method 2 rather than Method 1 to define the representative well yield for the GWBU

confirm the appropriate groundwater resource classification. The use of Method 2 determinations is required for the following two conditions:

- 1. Fresh Water, Class 1 Yield Boundary: GWBU contains fresh water (water meets PDWS and TDS \leq 3000 mg/L), and Method 1 well yield estimate (using Figure 4 Equations B or D, as appropriate) falls within \pm 20% of the Class 1 yield boundary (i.e., 115,200 gpd \leq Q \leq 172,800 gpd).
- 2. **Non-Brackish Water, Class 3 Yield Boundary:** GWBU has representative TDS content that is ≤ 10,000 mg/L, and Method 1 well yield estimate (using Figure 4 Equations A or C, as appropriate) falls within ±20% of the Class 3 yield boundary (i.e., 120 gpd ≤ Q ≤180 gpd).

Method 2 is particularly useful for *low* transmissivity GWBUs and could be useful for high transmissivity units, but can generate high volumes of wastewater in the latter. Method 2 comprises three different techniques by which a direct measurement of well yield can be obtained from a test well completed

Well Diameter Conversions.

Conversions to equivalent 4-inch or 12-inch diameter test well discharges from other test well diameters can be accomplished by using Table C1 in *Attachment* C_2

within a GWBU. If more than one test well is employed in these field measurements, they must be: 1) constructed with similar specifications, 2) located such that they are testing only the same GWBU (see Section 2.3.4), and 3) representative of the flow rate of water the GWBU is capable of transmitting to that well. If more than one test well location is used to test a single GWBU, the representative well yield should be determined as the geometric mean of the individual well test results.

Results from field tests previously conducted at the affected property can be used to evaluate well yield if the well construction and test procedures used in the prior tests are documented to conform to Method 2 guidelines, as detailed above.

NOTE: If a GWBU meets the criteria for more than one groundwater classification, then the GWBU shall be assigned the higher (quality) classification (§350.52).

2.7.2.1 METHOD 2: Discharge Methods.

The discharge method (e.g., hand bailing, suction pump, submersible pump, etc.) used in the yield test must be selected to meet the requirements of the test procedure and ensure that the measured well yield is not "pump-limited". In all cases, the pump curve should show that the pump has sufficient power to produce water at the desired test flow rate, under the applicable suction intake and discharge pressure. The water intake point for the pump (i.e., pump intake for



Withdrawal in Method 2.

Suction pumps (such as centrifugal pumps, jet pumps, or peristaltic pumps) are typically limited to a practical suction-lift capacity of 25 feet below the pump intake, and may result in reduced discharge if the pumping water level falls below this depth during the test. In low-yield units, hand-bailing methods may be sufficient to evacuate the well, so long as bail-out speed does not cause limitations to test.

submersible pumps, suction hose for suction pumps, etc.) should be positioned below the lowest depth to water anticipated for the test.

2.7.2.2 METHOD 2a: Well Yield by Cyclic Discharge.

Primarily used to test the Class 2/Class 3 150 gpd yield boundary in relatively *low-yield GWBUs* (defined as hydrostratigraphic units whose hydraulic conductivity can not be practicably measured using the techniques described in Attachment A).

Method 2a comprises a cyclic *bail down – recovery* test. Method 2a is performed using the following procedure:

- 1. **Well Construction:** Test well must be *fully-penetrating*, have a minimum diameter of 2 inches, and be completed with construction details consistent with requirements of 16 TAC §\$76.1000 76.1009.
- 2. Initial Water Level: Measure static water level in well.
- 3. **Water-Level Bail-Down:** Use bailer, pump, or other device to effectively evacuate *all* water from the well. Contain all discharged water and measure total volume (*V1*). Measure static water level in well immediately upon completion of water removal.
- 4. **Time for Water-Level Recovery:** Monitor static water level in well and measure elapsed time (*t1*) from completion of water removal until static water level in well recovers to the *same specified level*, *up to, but not greater than 90%* of height to initial static water level.
- 5. **Repeat Bail-Down and Recovery:** Repeat Steps 2 and 3 above twice. *This procedure requires a minimum of three* bail-

down/recovery cycles. Record total volume of water (V1 ... Vn) removed from well during each successive bail-down and the elapsed time (t1 ... tn) from completion of water removal until water level in well recovers to the same specified level used in prior cycle(s) (i.e., up to, but not greater than 90% of height to initial static water level).

The maximum well yield corresponds to the total bailed water volume $(\sum V_n)$ divided by the combined recovery time $(\sum t_n)$ measured during at least three bail-down/recovery cycles (see Equation 1).

Well Yield =
$$\frac{\sum_{i=1}^{n} V_i}{\sum_{i=1}^{n} t_i}$$
 [EQ 1]

Figure 7 provides an example of a bail-down test calculation performed for a well with approximately 3 feet of available drawdown. In such case, the well yield should be calculated as the total bailed water volume divided by the cumulative recovery time for all cycles and presented in units of *gallons per day* (gpd).

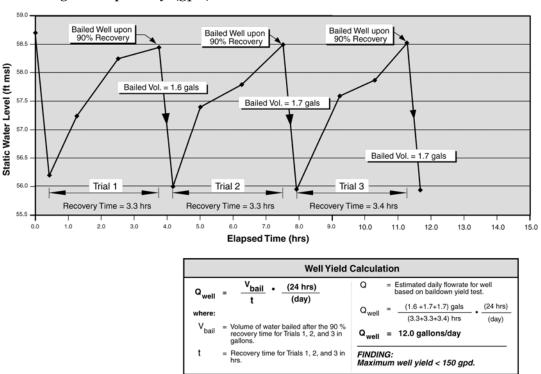


Figure 7. Example of Cyclic Bail-Down and Recovery Well Yield Test

2.7.2.3 METHOD 2b: Well Yield by Equilibrium Water Level Test.

To determine if a test well is capable of producing a yield of 150 gpd, the well may be pumped continuously at a discharge rate equivalent to well

recharge rate (well yield). In this Method, the well is pumped at a rate such that the pumping water level is maintained as near as practical to the base of the well screen. Test procedures are as follows:

- 1. **Well Construction:** Test well must be fully-penetrating, be a minimum diameter of 2 inches, and be completed with construction details consistent with requirements of 16 TAC §\$76.1000 76.1009.
- 2. Initial Water Level: Measure static water level in well.
- 3. **Pump Installation:** Equip well with pump capable of maintaining a constant drawdown elevation near bottom of well.
- 4. **Water Level Equilibrium:** After pump and hose installation, monitor static water level in well until water has re-equilibrated to initial water level.
- 5. **Well Pumping:** Activate pump and set discharge rate to achieve a pumping water level as near as practicable to the base of well screen. Adjust pump discharge rate until it is equivalent to well recharge rate (i.e., water level near the bottom of well remains constant and is lower than static water level).
- 6. **Measure Equilibrium Discharge Rate:** Once the new water-level equilibrium has been established in the test the pump discharge rate is determined. The pump discharge rate is then converted to units of gallons per day (gpd). Test is complete when a total water volume of 50 gallons has been produced or pumping has been underway for 8 hours, whichever comes first.
- 7. (**Optional:** The person may choose to perform the test for a longer period of time. There is no limit on the maximum length of the test period. However, if the test period extends beyond 24 hours, bear in mind the results need to be evaluated and conclusions must be presented in a manner consistent with the per day yield criteria of the rule.)

2.7.2.4 METHOD 2c: Well Yield by Constant Discharge (0.1 gpm) Test.

To determine if a test well is capable of producing a yield of 150 gpd, the well may be pumped continuously at a discharge rate equivalent to 0.1 gallons per minute (gpm), or 150 gpd. In this Method, the well is pumped as near as practicable to the base of the well screen at a rate equal to 0.1 gpm. If the well's water level does not fall to the pump inlet level during the test, the well is considered capable of producing a minimum yield of 150 gpd. Test procedures are as follows:

1. **Well Construction:** Test well must be *fully-penetrating*, have a minimum diameter of 2 inches, and be completed with

construction details consistent with requirements of 16 TAC §\$76.1001-76.1005.

- 2. **Initial Water Level:** Measure static water level in well.
- 3. **Pump Installation:** Equip well with pump capable of maintaining a **constant** *discharge rate of 0.1 gpm* and a pump inlet placement near bottom of well.
- 4. **Water Level Equilibrium:** If the test well water level remains constant during test, or if the test well water level falls to a new *static* equilibrium water level elevation, the well yield is 150 gpd or greater.
- 5. **Well Pumping:** The pumping should be monitored continuously and the discharge rate corrected for deviations due to changes in hydrostatic pressure when test well water level falls.
- 6. **Test Termination:** Test is complete when a total water volume of 150 gallons has been produced, when test well water level falls to bottom of well (no re-equilibrium), or when test duration reaches 8 hours, whichever comes first. The ability to maintain the 0.1 gpd discharge rate indicates Class 2 well yield. The results should be converted to a volume discharged per 24 hour (gpd).
- 7. (**Optional:** The person may choose to perform the test for a longer period of time. There is no limit on the maximum length of the test period. However, if the test period extends beyond 24 hours, bear in mind the results need to be evaluated and conclusions must be presented in a manner consistent with the *per day* yield criteria of the rule.)

2.7.3 Saturated Soil

Zones of saturation with bulk hydraulic conductivities, $K < 1 \times 10^{-5}$ cm/ $_{\rm sec}$ are not classified or regulated as GWBUs. Rather, such zones are regulated as saturated soils.

Demonstrations intended to show that certain saturated geologic strata are *not* GWBUs should be based on the following *minimum* supporting documentation (*see also* Table 5 for additional requirements):

- 1. data requirements for Class 3 demonstrations (Sec 1.4.3),
- 2. field measurements showing a representative hydraulic conductivity, K $< 1 \times 10^{-5}$ cm/_{sec} (required); **and**
- 3. laboratory USCS classification as a clay or silty clay soil stratum (i.e., CH or CL), as confirmed by laboratory testing.

All water-saturated strata or groups of water-saturated strata that are shown not to meet one or more of the exclusion criteria listed below will

be assumed to be GWBUs for the purpose of the affected property assessment.

2.7.3.1 Direct Measurement of Hydraulic Conductivity.

To demonstrate that a water-saturated stratum is only a low hydraulic conductivity saturated soil, the person conducting the affected property assessment must obtain a site-specific measurement of hydraulic conductivity, usually by a single-well (slug) test, as described in Section A.3 (Attachment A)

Measurements of K.
Measurements of hydraulic conductivity for confirming the presence require adherence to the *same* protocols in Step 1.
Measurements should be conducted at a sufficient number of locations to provide a representative characterization for each water-saturated unit.

of this document. Hydraulic conductivity *estimates* based on laboratory permeability tests or soil grain-size analyses are *not acceptable* for the purpose of classifying a hydrostratigraphic unit as a saturated soil. Test wells used for purposes of measuring hydraulic conductivity must be properly constructed and developed so as to provide an accurate indication of the hydraulic properties of the stratum (*see* Section A.2; Attachment A).

When the saturated unit has a hydraulic conductivity that is too low to test effectively (e.g., no recharge observed during a test period of appropriate length), then an assumption that the hydraulic conductivity is less than 1 x 10⁻⁵ cm/sec may be appropriate, provided the person can provide a sound and reasoned justification that the inability to effectively test the unit is reflective of the characteristics of the saturated unit and not the design, construction or development of the test well (e.g., insufficient well screen, partial penetration, skin effects, etc.). The reasoned justification should include the USCS soil classification referenced in Section 2.7.3.

2.7.3.2 USCS Soil Classification.

Laboratory confirmation, by ASTM Standard Practice D2487, of a CL or CH designation for a homogenous clay stratum is recommended to corroborate the low hydraulic conductivity measurement.

2.7.3.3 Interbedded Soils.

A clay stratum (i.e., CL or CH) containing water-saturated sand or silt seams or partings is classifiable as a GWBU if the measurable bulk lateral hydraulic conductivity of the stratum is $K \ge 1 \times 10^{-5}$ cm/ $_{\rm sec}$. In the instance of the presence of interbedded seams or partings within a clay stratum, additional information will be required to confirm the appropriate

hydrologic characterization of the stratum. For example, a more detailed analysis of the stratigraphic profile may be necessary. Field measurements of bulk hydraulic conductivity of small intervals of the greater stratigraphic column may be required to demonstrate that the stratum's effective K is less than 1 x 10^{-5} cm/_{sec}.

2.7.3.4 Confirmation by COC Transport.

A confirmation check should be applied based on the observed patterns of COC migration in the subsurface. If the lateral extent of COCs within the stratum is indicative of an effective $K \geq 1 \times 10^{-5}$ cm/ $_{\rm sec}$ (i.e., groundwater or the COC plume has traveled a lateral distance within the stratum from the source with a travel time that indicates an effective $K \geq 1 \times 10^{-5}$ cm/ $_{\rm sec}$), then the discrepancy must be resolved and a higher burden of proof may apply to verify that the stratum is not a GWBU. See TCEQ guidance document Affected Property Assessment Requirements (RG-366/TRRP-12) for requirements for assessment of COCs in such low permeability saturated soils.

2.8 STEP 6: Evaluate Groundwater Resource Sustainability

An important aspect of discriminating between Class 2 and Class 3 groundwater resources is the ability for that resource to produce useable water at a *sustainable rate of 150 gallons per day* ... [§350.52(3)]. The

capability of a groundwater resource to maintain an annualized *sustainable* daily withdrawal rate of 150 gpd is the basis by which a GWBU is classified in this step. Sustainability is also a consideration for Class 1 groundwater resources, but since most classification

Class 3 by Sustainability
A Class 2 GWBU may be
downgraded to a Class 3
designation if the well yield can be
demonstrated to be not sustainable.

efforts are focused on distinguishing Class 2 and 3 groundwater resources, sustainability guidance here emphasizes distinguishing the Class 2/Class 3-classification boundary.

All well yield determinations are considered to be representative of a sustainable resource. However, in lieu of a short-term hydraulic test that can predict the consequence of long-term sustained withdrawal of water of useable quality from a groundwater resource, alternate methods can be applied to demonstrations that a GWBU does not meet the "sustainable" qualification. These non-hydraulic methods include:

- Ephemeral saturation, and/or
- Limited hydrogeologic extent

Demonstrations can be based on relevant characteristics of the unit. Such demonstrations require *rigorous analysis* and can include characteristics

such as geologic extent, ephemeral saturation, *etc.*, and combinations thereof. Content of these demonstrations are described below:

2.8.1 Ephemeral Saturation

GWBUs that can be demonstrated to be: 1) historically ephemeral (not persistently saturated) and 2) hydraulically isolated from other GWBUs such that they do not produce sustainable yields may be downgraded to Class 3. Demonstrations must be based on documented historical water level observations or other unequivocal information that permits a conclusion that the GWBU is not permanently saturated, or otherwise is predictably ephemeral.

If a GWBU is historically or predictably dry on a seasonal basis, then it meets the criterion for classification as Class 3 unless there is a current use of the GWBU. Such examples can include groundwater accumulations within a perched GWBU, underlain by unsaturated soils, and which diminishes during dry weather periods. If the GWBU goes completely dry at any time during the year, such that no water can be collected within a fully-penetrating monitoring well, then a Class 3 groundwater resource classification applies to the GWBU. The TCEQ may require documentation in the form of periodic water-level monitoring for a minimum of one year to support the classification.

2.8.2 Limited Hydrogeologic Extent

Certain GWBUs may be demonstrated to be insufficiently extensive laterally and/or volumetrically and/or to be hydraulically isolated from other GWBUs and other sources of recharge such that the GWBU can not sustain the required long-term daily withdrawal rate to be a Class 1 or a Class 2 groundwater resource. Demonstrations of limited hydrogeologic extent



Perched groundwater zones ($K > 10^{-5}$ cm/s), which contain groundwater during all or part of the year, are considered GWBUs (see Section 2.3.2).

must be based on both site-specific and regional hydrogeology, including detailed hydrostratigraphic analysis. Hydrogeological analysis of a sedimentary GWBU should include placement of the hydrostratigraphic unit within its overall stratigraphic context. The geometry of the hydrostratigraphic unit must be determined on a site-specific basis and the demonstration must rely on the limited extent of that geometry.

Examples of qualifying hydrostratigraphic units include lobes of permeable alluvial fans isolated by intercalated impermeable units, perched groundwater zones, and other isolated zones of saturation that are not used as groundwater resources.

2.8.3 Additional Lines of Evidence for Non-Sustainability Demonstration

Demonstrations to show that a groundwater resource is non-sustainable by ephemeral saturation and/or limited hydrogeologic extent may be strengthened using supplemental information from regional aquifer studies, groundwater resource assessments, water budget analyses, groundwater-surface water interactions, saline water intrusion studies, etc.

2.8.4 Classification of Karst or Fractured Groundwater-Bearing Units

A karst (or karstic) GWBU is defined here as a hydrostratigraphic unit composed primarily of soluble carbonate rock (such as limestone or dolomite) in which water flows appreciably through joints, fractures, faults, bedding-plane partings and/or cavities, any of which have been enlarged by dissolution.

A fractured GWBU is defined here as a hydrostratigraphic unit that exhibits breaks, whether or not caused by displacement, resulting from mechanical failure due to stress and includes cracks, joints, faults and other mechanical discontinuities, and groundwater movement is principally limited to the fractures.

In situations where the karstic or fractured character of a GWBU is the primary control on groundwater flow such that porous media flow is not the dominant character of the GWBU, then all aquifer parameter measurements (e.g., transmissivity) and calculations must be conducted by methods specifically appropriate to usage in *karst* or *fractured* GWBUs, as applicable. However, the direct well yield test methods presented in this guide should be generally applicable provided the test wells are designed and located such that their measurements are representative of the karst or fracture network when karst or fractures are expected to be the principal control on groundwater flow. See Table A4 (Attachment A) for more specialized methods for karst and fractured GWBUs. Also, bear in mind that a GWBU can be so intensely fractured or karsted such that it can mimic porous media flow. Therefore, unless it is clear that porous media flow is not reflective of the GWBU because of its karst or fracture character, the standard tests described in this document can be used.

2.9 STEP 7: Document Results

The results of the groundwater resource classification for all affected GWBUs and threatened hydraulically-interconnected GWBUs shall be submitted for TCEQ review in Section 2.5 of the Affected Property Assessment Report (APAR). The report should provide sufficient explanation and documentation to demonstrate proper classification of the groundwater resource and support TCEQ review. The responsibility is on the person to methodically present a convincing justification that the groundwater is Class 2 or Class 3. Applicable documentation includes the following:



Early Approval of Classification.

The person is encouraged to submit to the TCEQ groundwater information used to support a *Class 3* classification *prior to full completion and submittal of the APAR*. Submit information on applicable APAR worksheets and attachments. In some instances, ensuring early TCEQ concurrence with a Class 3 groundwater classification can eliminate delays and remobilizations for additional assessment, revision of portions of the APAR, and duplication of work.

NOTE: All geoscience work submitted must be sealed by a licensed P.G. (per 22 TAC §851.156).

2.9.1 Identification of Groundwater-Bearing Units

Describe stratigraphic conditions, including geologic cross-sections and field and laboratory soil classification results, and provide supporting data related to identification of GWBUs, including soil type, water saturation, and applicable hydraulic conductivity. Evaluate potential hydraulic interconnection of affected GWBUs with other unaffected units.

2.9.2 Current Use and General Hydrogeologic Context

Provide a scaled map showing water supply wells located within 0.5 mile of the affected groundwater area; a tabulation of available information regarding any and all well use; and well construction (screened interval, seal, etc.), and the groundwater production zone as determined from available water well driller's logs, groundwater resource publications, and other relevant sources. Identify principal groundwater production zones for any identified wells.

2.9.3 Aquifer Testing

For Method 1, identify the applicable Method 1 equation (confined or unconfined, 4-inch or 12-inch diameter well) and selected calculation locations, and for each location, justify site-specific calculation inputs, including saturated thickness, mean annual confining head (if applicable), and hydraulic conductivity (*i.e.*, results of soil classification tests, rising head slug tests, constant-rate pumping tests, *etc.*).

For Method 2 well yield measurements, provide information on test well location(s) including the reasoning for selecting those test locations, test well construction and development, test procedures, all field data, the calculations used to reduce the data, the results of each calculation, and waste management procedures. Document all calculations of representative well yield for unit.

2.9.4 Natural Water Quality

Provide results of laboratory TDS analyses, including background sampling locations and the basis for assuming they represent natural background TDS, sample collection and handling procedures, and relevant quality assurance/quality control information. Provide information regarding compliance with PDWS criteria, if evaluated.

2.9.5 Groundwater Resource Sustainability

In the circumstance that a GWBU can be demonstrated to be a unit incapable of meeting the sustainability criterion, provide a hydrogeological analysis based on hydrostratigraphy, history of ephemeral saturation, observed ephemeral saturation, or any other site-specific hydrogeologic aspect sufficient to support the contention for a sustainability exemption.

2.9.6 Groundwater Resource Classification

Based on the results of the evaluation, identify the applicable classification in Section 2.5 of the APAR.

NOTE: If a GWBU meets the criteria for more than one groundwater classification, then the GWBU shall be assigned the higher (quality) classification (§350.52).

ATTACHMENT A

Determination of Hydraulic Conductivity in Groundwater-Bearing Units

The determination of hydraulic conductivity in GWBUs may be performed using either multiple-well or single-well methods. Tables A1 through A4 summarize the guidelines useful for determining what drilling and testing methods may be the best for specific site conditions. Acceptable methods are not limited to ASTM methods.

NOTE: If a GWBU meets the criteria for more than one groundwater classification, then the GWBU shall be assigned the higher (quality) classification (§350.52).

A.1 Monitoring/Test Well Installation, Development and Rehabilitation

Monitoring wells employed for measurement of hydraulic properties must be screened within the GWBU under investigation and must be designed, constructed, and developed in accordance with 16 TAC §§76.1000-76.1009. For convenience, additional guidance on recommended methods for the design, construction and installation of monitoring/test wells can be found in Tables A1 and A4.

Wells used for test purposes should be of conventional construction with a minimum nominal 2-inch diameter (push probes, etc. are not acceptable). Some recommended methods for the conventional advancement of borings and drilling methods for geoenvironmental investigations are listed in Table A1.

The Class 3 well yield limit (150 gpd) is based on a well with a nominal 4-inch diameter well screen or the equivalent. The Class 1 yield limit (144,000 gpd) is based on a well with a nominal 12-inch diameter well screen or the equivalent. If a well with a screen diameter other than 4-inch or 12-inch is used for the yield test(s), the equivalent vield from a 4-inch or 12-inch diameter well can be determined by multiplying the measured yield by the correction factors provided in *Attachment C*.



Well Construction.

Test results from wells that are not appropriately designed, constructed, and/or developed may not be acceptable for groundwater classification purposes.



Prior to Well Installation.

It is beneficial to obtain hydro-geologic information of the area in order to advance borings and select proper well construction specifications for future hydraulic testing.

A.2 Determination of Hydraulic Conductivity using Multiple-Well Tests

Site-specific values for hydraulic conductivity of GWBUs can be determined by multiple-well aquifer pumping tests conducted on wells screened within the GWBU. Control wells and observation wells used for this purpose must be constructed and developed in accordance with Section 2.7. The general procedure for a constant-rate pumping test involves:

- selection of a well array consisting of one control well and two or more observation wells located at various distances from the control well;
- 2. measurement of initial static water levels in all wells to be used in the test;
- 3. discharge of groundwater from the control well at a known flow rate for the time period necessary to meet test requirements (i.e., until sufficient time-drawdown or distance-drawdown data are obtained, typically 2 to 24 hours); and
- 4. measurement of recorded water levels at appropriate time intervals in all test wells during both the period of pumping and during the period of water level rebound after cessation of pumping.

Multiple-well pumping tests provide an estimate of the transmissivity (T), storativity (S) and hydraulic conductivity (K) of the GWBU over the area influenced by the test. A pumping test performed on a GWBU that is *not laterally extensive* requires a modified test method. Additional guidance on testing *areally-bound* GWBUs, such as GWBU with limited lateral extent (e.g., fluvial channels) can be found in ASTM Test Method D 5270.

Methods for selecting multiple-well pumping tests appropriate to site conditions should be conducted in accordance with ASTM Standard Guide D 4043. Procedures for conducting multiple-well pumping tests in *unconfined* GWBUs are contained in ASTM Test Method D 5920. Procedures for conducting multiple-well pumping tests in *extensive confined* GWBUs are provided in ASTM Test Methods D 4106, D 5472, D 5473, and D 5850. Procedures for conducting multiple-well pumping tests in *areally-bounded confined* GWBUs can be found in ASTM Test Method D 5270. Table A2 summarizes various recommended standard methods applicable to multiple-well tests.

Table A- 1. Recommended Methods for Drilling/Installing GWBU Monitoring/Test Wells

Procedure1	Application	Recommended Methods	
Cable-tool drilling, & soil sampling	Geoenvironmental drilling and well installation	ASTM Guide D 5875	
Auger boring for soil investigation	Auger drilling	ASTM Practice D 1452	
Hollow-stem auger, soil sampling	Hollow-stem auger drilling	ASTM Practice D 6151	
Air-rotary drilling, installation of monitoring wells	Geoenvironmental drilling and well installation	ASTM Guide D 5782	
Direct rotary drilling, casing, soil sampling	Geoenvironmental drilling and well installation	ASTM Guide D 5876	
Direct rotary drilling w/ water- based drilling fluid	Geoenvironmental drilling and well installation	ASTM Guide D 5783	
Dual-wall reverse-circulation drilling, installation of monitoring wells	Geoenvironmental drilling and well installation	ASTM Guide D 5781	
Casing advancement for monitoring well installation	Geoenvironmental drilling and well installation	ASTM Guide D 5872	
Casing advancement for monitoring well installation (wireline)	Geoenvironmental drilling and well installation	ASTM Guide D 5876	
Soil sampling in vadose zone	Geoenvironmental sampling	ASTM Guide D 4700	
Split-barrel sampling of soil	Geoenvironmental sampling	ASTM Test D 1586	
Thin-walled tube sampling of soil	Geoenvironmental sampling	ASTM Test D 1587	
Ring-lined barrel sampling of soil	Geoenvironmental sampling	ASTM Practice D 3550	
Rock core drilling and sampling	Geoenvironmental drilling and sampling of rock	ASTM Practice D 2113	
Field logging descriptions	Bore log description	ASTM Guide D 5434	
Decontamination of field equipment	Decontamination	ASTM Practice D 5088	
Monitoring well construction	Well installation/construction ASTM Practice D		
Monitoring well development	Well development	ASTM Guide D 5521	
Protecting installed monitoring wells	Monitoring well protection	ASTM Practice D 5787	
Monitoring well installation in karst and fractured-rock aquifers	Well installation in karst and fractured rock	ASTM Guide D 5717	
¹ Multiple procedures may be applicable at any one affected property.			

⁴⁴ Revised March 2010

The representative transmissivity value for a GWBU, appropriately determined, may be calculated as the arithmetic average of the transmissivity values determined for the various monitoring points used in the test (i.e., control well and observation wells). The representative transmissivity value may then be converted to a representative hydraulic conductivity (K) by dividing average T by the static saturated thickness (b) of the GWBU within the area of influence of the test, or:

$$\overline{K} = \overline{T}/h \tag{A.1}$$

where:

 \overline{K} = representative hydraulic conductivity

 \overline{T} = representative transmissivity

b = aquifer thickness

Control well locations used for the purpose of averaging hydraulic parameters within a GWBU must be confirmed to insure that mean values are not biased low. The USGS (1979) provides additional information on multiple-well pumping tests.

A.3 Determination of Hydraulic Conductivity using Single-Well Tests

Determination of site-specific hydraulic conductivity values may be determined using single-well tests. *Slug tests* (i.e., single-well *instantaneous discharge* head-change tests) must be conducted in wells that are constructed and developed in accordance with the provisions of 16 TAC §76.1000, the requirements in Section A.1 and the recommendations provided in Table A1.

Instantaneous discharge in single-well tests requires withdrawal of water from a well sufficiently rapid such that no water is removed from storage (i.e., gradual withdrawal by pumping or

multiple bailer-loads is *not*

Instantaneous Discharge

permitted).

Special attention to well development efforts is required to ensure that drilling has not caused smearing of the borehole wall, or otherwise decreased the formation hydraulic conductivity, particularly when hollowand solid-stem auger drilling methods are employed.

Table A- 2. Recommended Methods for Multiple-Well Aquifer Tests.

Mathed Has and Test				
Procedure	Method Use and Test Results	Test Applicability	Recommended Methods	
Selection of appropriate aquifer test	Guidance on selecting multiple-well tests		ASTM Guide D 4043	
Field procedures for test wells	Guidance on with- drawal/injection tests		ASTM Test D 4050	
Controlling drawdown	Measure h, Q	Constant drawdown, variable discharge	ASTM Practice D 5786	
Measuring water levels in observation wells	Measure h (in well)	Observation well	ASTM Test D 4750	
Unconfined, anisotropic	Measure T, S, q, and K_h/K_ν ratio by Neuman Method	Constant discharge, & fully- or partially- penetrating well	ASTM Test D 5920	
Unconfined, radial-vertical aniosotropy	Measure T, S, K _h /K _v	Drawdown << b	ASTM Test D 5473	
Unconfined, areally extensive	Measure T, specific capacity	Drawdown < 25% b	ASTM Test D 5472	
Unconfined, areally extensive	Measure T, S	Drawdown small vs b	ASTM Test D 4106	
Unconfined	T by Recovery test	Drawdown small vs b	ASTM Test D 5269	
Confined, non-leaky	Measure T, S	Fully-penetrating, constant discharge	ASTM Test D 4105	
Confined, non-leaky	Measure T, S	Fully- or partially- penetrating, constant discharge	ASTM Test D 4106	
Confined, non-leaky, bounded	Measure T, S for GWBU with limited areal extent	Confined unit with linear boundary	ASTM Test D 5270	
Confined, radial-vertical aniosotropy	Measure T, S, K _h /K _v	Minimum four (4) partially-penetrating wells	ASTM Test D 5850	
Confined, non-leaky, radial-vertical aniosotropy	Measure T, S, K _h /K _v	Partially-penetrating (vs fully penetrating)	ASTM Test D 5473	
Confined	Measure T, specific capacity (well yield)	Fully penetrating, constant discharge	ASTM Test D 5472	
Confined, non-leaky	T, by recovery test	Partially-penetrating	ASTM Test D 5269	
b - aquifer thickness		h – head		
K - hydraulic conductivity		K _h – horizontal hydraulic conductivity		
K _v – vertical hydraulic conductivity		Q – discharge rate		
S - storativity		T - transmissivity		

If slug tests are performed to measure hydraulic conductivity for use in the Method 1 Calculation (see Section 2.7.1), the tests should be conducted at a minimum of three locations within each separate identified GWBU to provide a representative measure of the potential variability. Additionally, a minimum of three slug tests should be performed at each well to evaluate the possibility that "skin effects" are not



Single-Well Test Methods.

The appropriate test method depends both on the hydraulic condition of the GWBU (confined vs unconfined) and the degree of well penetration (fully or partially). See Table A3.

dominating the results of the test. Butler *et al.* (1996) recommend using the same head displacement in the first and third test while using another head displacement for the second test.

The representative hydraulic conductivity value for a *single* GWBU is the *geometric mean* of the inter-well results from a single GWBU. The representative hydraulic conductivity value of a *single* well is the *arithmetic mean* of the intra-well results from that single well. The *geometric mean* of inter-well hydraulic conductivity is defined as:

$$\overline{K} = \sqrt[n]{K_1 \cdot K_2 \cdot \ldots \cdot K_n} \tag{A.2}$$

where,

 \overline{K} = representative hydraulic conductivity

 K_n = inter-well average hydraulic conductivity values

n = number of inter-well measurements

The general procedure for a single-well test involves:

- 1. measuring the initial static water level within the well to be tested;
- 2. inducing an *instantaneous* positive or negative change of water level; and
- 3. measuring the recovery towards static water level at appropriate time intervals.

NOTE: If a GWBU meets the criteria for more than one groundwater classification, then the GWBU shall be assigned the higher (quality) classification (§350.52).

Recommended field protocols, test procedures and data analysis methods for single-well tests are summarized on Table A-3.

Table A- 3 Recommended Methods for Single-Well Tests.

Procedure ¹	Method Use and Test Results	Test Applicability	Recommended Methods
Selection of appropriate aquifer test	Single-well and multiple-well tests	Properly completed wells	ASTM Guide D 4043
Slugs for instantaneous discharge (head change)	Slug test	Properly completed wells	ASTM Test D 4044
Measuring water levels in observation wells	Slug test	Properly completed wells	ASTM Test D 4750
Unconfined	К	Instantaneous discharge	ASTM Test D 5912
Confined, non-leaky over-damped well response	Т	Instantaneous discharge	ASTM Test D 4104
Confined, non-leaky under-damped well response	Т	Instantaneous discharge	ASTM Test D 5785
Confined, non-leaky, critically-damped well response	Т	Instantaneous discharge	ASTM Test D 5881
Constant head injection	T, S	Packers and pump	ASTM Test D 4630
Pressure pulse	Т	Low transmissivity	ASTM Test D 4631
¹ Multiple procedures may be applicable at any one affected property.		K – hydraulic conductivity	1
S - storativity		T – transmissivity	

Table A- 4. Recommended Methods for Drilling and Monitoring Well Installation in Karst and Rock.

Procedure ¹	Method Use and Test Results	Test Applicability	Recommended Methods
Selection of appropriate aquifer test	Single-well and multiple-well tests	Properly completed wells	ASTM Guide D 4043
Rock core drilling and sampling	Geoenvironmental drilling and sampling of rock	Drilling method for rock	ASTM Practice D 2113
Monitoring well installation in karst and fractured-rock aquifers	Well installation in karst and fractured rock	Monitoring wells in karst/rock	ASTM Guide D 5717
Multiple procedures may be applicable at any one affected property.		K – hydraulic conductivity	
S - storativity		T – transmissivity	

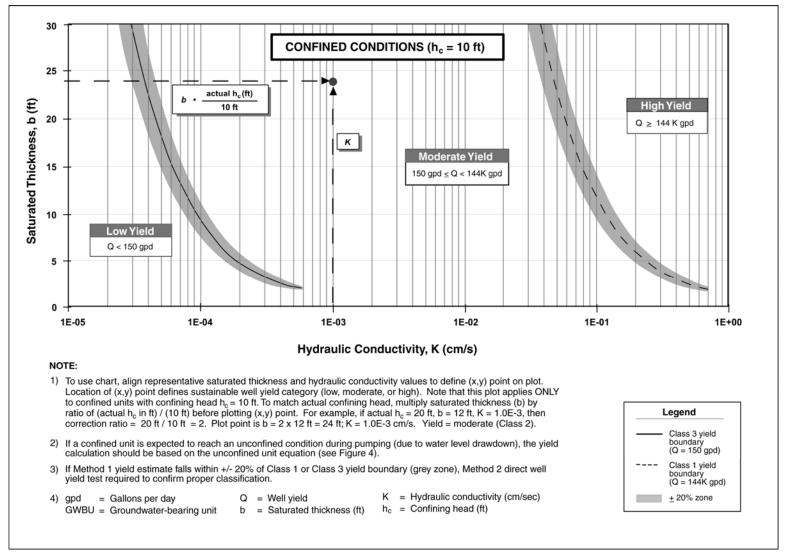


Figure 8. Confined Conditions

49

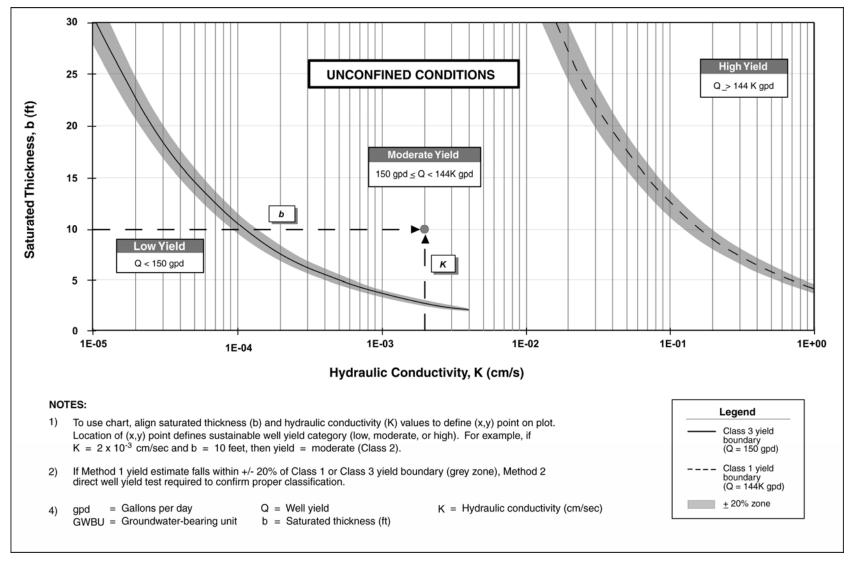


Figure 9. Unconfined Conditions

ATTACHMENT B

Method 1: Estimation of Well Yield Using Idealized Well Function Equation

Application of NonEquilibrium Well Function Equation

The Cooper and Jacob (1946) approximation to the Theis (1935) solution for radial groundwater flow to a pumping well is as follows:

$$s = \frac{2.3Q}{4\pi T} \left[\log \left(\frac{2.25Tt}{r^2 S} \times \frac{ft^3}{7.48gal} \right) \right]$$
 (B.1)

where:

Q = rate of pumping (gallons per day)

T = transmissivity of water bearing unit (gpd/ft)

r = radial distance from well (ft)

S = coefficient of storage (dimensionless)

s = water level drawdown (ft) at pumping rate (Q) and distance (r)

t = time of pumping (days)

The equation is valid for large values of time (t) and/or small values of radial distance (r), such as will occur at a pumping well. For use in estimation of well yield, the equation may be simplified by incorporation of typical default values for less sensitive input parameters, as follows:

r = radius of well (2-inch for TRRP Class 3 yield limit, 6-inch for Class 1 yield limit)

 $S = 1.0 \times 10^{-4}$ (confined aquifer), 1.0×10^{-1} (unconfined aquifer) (see Driscoll, 1986)

t = 7 days

T = K x b,

 $K = hydraulic conductivity (gpd/ft^2)$ and

b = saturated thickness of the unit in ft.

Incorporating these default values, well yield Q may be expressed in terms of drawdown (s), hydraulic conductivity (K), and saturated thickness (b).

For a confined aquifer, 12-inch diameter well screen:

$$Q = \frac{5.46(s)(K)(b)}{4.93 + \log(Kb)}$$
 (B.2a)

For a confined aquifer, 4-inch diameter well screen:

$$Q = \frac{5.46(s)(K)(b)}{5.88 + \log(Kb)}$$
 (B.2b)

For an unconfined aquifer, 12-inch diameter well screen:

$$Q = \frac{5.46(s)(K)(b)}{1.93 + \log(Kb)}$$
 (B.2c)

For an unconfined aguifer, 4-inch diameter well screen:

$$Q = \frac{5.46(s)(K)(b)}{2.88 + \log(Kb)}$$
 (B.2d)

Estimation of Well Yield Based on Hydrologic Parameters

The Cooper-Jacob equation may be used to calculate an estimate of well yield associated with a pumped water level drawdown (s) equal to the available drawdown in the well (i.e., the distance from the static water level to the lowest efficient pumping water level in the well).

In unconfined aquifers, a water level drawdown in excess of two-thirds of the saturated thickness does not significantly increase well yield. Consequently, design guidelines call for screening the lower one-half to one-third of the saturated unit, corresponding to an available drawdown ($s_{\rm max}$) equal to 50% to 67% of the saturated thickness (Driscoll, 1986). However, wells completed in unconfined GWBUs that are used both for COC concentration monitoring and hydraulic testing should be fully penetrating.

In confined GWBUs, design guidelines call for screening the full saturated thickness of the aquifer, corresponding to an available drawdown equal to 100% of the confining head (h_c).

Based on these design guidelines, available drawdown may be expressed as:

• Confined unit: $s_{max} = (1.0)(h_c)(e)$

• Unconfined unit: $s_{max} = (0.5)(b)(e)$ where:

 $h_c = \text{confining head}$

b =saturated thickness

e = well efficiency

Substituting these available drawdown terms into the Cooper-Jacob expression (Equations 2a through 2d above), the well yield (Q) associated with utilization of the full available drawdown (s_{\max}) can be calculated based on site-specific values of saturated thickness (b), hydraulic conductivity (K) and (for confined units) confining head (h_c), as follows:

Confined Aquifer

3a) 12-inch diameter well screen:

$$Q = \frac{(115,846)(h_c)(K)(b)}{9.25 + \log[(K)(b)]}$$
 (B.3a)

3b) 4-inch diameter well screen:

$$Q = \frac{(115,846)(h_c)(K)(b)}{10.2 + \log[(K)(b)]}$$
 (B.3b)

Unconfined Aquifer

3c) 12-inch diameter well screen:

$$Q = \frac{(57,923)(K)(b^2)}{6.25 + \log[(K)(b)]}$$
 (B.3c)

3d) 4-inch diameter well screen:

$$Q = \frac{(57,923)(K)(b^2)}{7.2 + \log[(K)(b)]}$$
 (B.3d)

where:

b = saturated thickness of water-bearing unit (ft)

 h_c = confining head above top of water-bearing unit (ft)

K = hydraulic conductivity of water-bearing unit (cm/s)

Q = well yield (gpd)

e = well efficiency (assumed to be 100%)

Note that, in each of the above expressions, well efficiency (which typically ranges from 70 to 80% in properly designed and developed wells) is assumed to be 100%, providing a theoretical upper-bound yield from an ideal well.

ATTACHMENT C

Estimation of Equivalent Method 2 Well Yield Based on Alternate Test Well Diameter

Overview of Method 2 Screen Diameter Correction Factors

For the purpose of the TRRP groundwater resource classification process, the person conducting the affected property assessment may estimate the yield from a properly constructed and developed well screened within the GWBU. Under the TRRP classification system, the Class 3 yield limit (150 gpd) is based on a well with a nominal 4-inch diameter well screen or the equivalent. The Class 1 yield limit (144,000 gpd) is based on a well with nominal 12-inch diameter well screen or the equivalent.

These specified well diameters have been incorporated in the Method 1 idealized well function equations presented in this guide (see Figures 4, 5, and 6 and Attachment A). No adjustment for well diameter is

Method 2 Correction Factors.

These correction factors apply *only* to Method 2 direct well yield tests and *do not* apply to slug tests or to any other Method 1 calculations.

necessary or appropriate when using the Method 1 equations. However, under Method 2, any properly constructed and developed pumping well of nominal well screen diameter of 2 inches or greater may be used for the direct well yield tests. If a well with a screen diameter other than 4-inch or 12-inch is used for the yield test(s), the equivalent yield from a 4-inch or 12-inch diameter well can be determined by multiplying the measured Method 2 yield by the correction factors provided on Table C1. The derivation of the correction factors shown on Table C1 is provided below.

Application of Equilibrium Well Function Equation

The effect of the screen diameter on the well yield of a production well may be estimated using the equilibrium well function (Driscoll, 1986). The equilibrium well function equation (Thiem, 1906) relates well discharge to drawdown assuming two-dimensional radial flow toward the well as follows:

Unconfined Aquifer:

$$Q = \frac{K(H^2 - h^2)}{1,055\log(R/r)}$$
 (C.1a)

Confined Aquifer:

$$Q = \frac{Kb(H - h)}{528\log(R/r)}$$
 (C.1b)

where:

Q = rate of pumping (gpm)

K = hydraulic conductivity of groundwater-bearing unit (gpd/ft²)

H = static head in well measured from base of the aquifer prior to pumping (ft)

h = pumping head in well measured from base of the aquifer while pumping (ft)

b = saturated thickness of the aquifer (ft)

R= radius of the cone of depression (ft)

r = radius of the well (ft)

Equations C.1a and C.1b are valid when all dynamic conditions in the well and groundwater are assumed to be in equilibrium (i.e., constant discharge, stable water level drawdown and radius of influence, and water flow converging on well at equal rates from all directions). The relationship of well yield to well screen diameter may be defined based on a simplified version of these equations, incorporating a constant term (C), as follows (Driscoll, 1986):

$$Q \approx \frac{C}{\log(R/r)} \tag{C.2}$$

For a 4-inch diameter well (Class 3) and a 12-inch diameter well (Class 1) in either an unconfined or confined aquifer, the well yield (Q) may be expressed in terms of the radius of the cone of depression (R), as follows:

12-inch diameter well screen

$$Q = \frac{C}{\log(R/0.5)}$$
 (C.3a)

4-inch diameter well screen

$$Q = \frac{C}{\log(R/0.17)} \tag{C.3b}$$

Derivation of Conversion Factors for Equivalent Well Yield from 12 inch or 4 inch Diameter Well Screen

Equations C.3a and C.3b can be used to calculate the equivalent yield from a 12-inch or 4-inch diameter well based on a measured yield from a well of a different diameter (e.g., 2-inch or 6-inch diameter well screen). For this purpose, the measured yield from the test well is multiplied by a correction factor equal to the ratio $Q_{12\text{-in}}/Q_{\text{test}}$ for conversion to an equivalent flow from a well with a 12-inch diameter well screen or $Q_{4\text{-in}}/Q_{\text{test}}$ for conversion to an equivalent flow from a well with a 4-inch diameter well screen.

For purpose of simplicity, the radius of the cone of depression (R) in Equation C.2 may be set equal to typical values for confined and unconfined groundwater-bearing units (i.e., 1,000 feet and 200 feet, respectively). Derivation of correction factors to estimate equivalent yields from wells with 12-inch or 4-inch diameter screens in either confined or unconfined units is shown below.

Conversion Factors for Confined Unit

12-inch Diameter Well Screen

Correction

$$= \frac{Q_{12-in}}{Q_{test}} = \frac{\log(R/r_{test})}{\log(R/r_{12-in})} = \frac{\log(1000/r_{test})}{\log(1000/(6/12))} = \frac{\log(1000) - \log(r_{test})}{\log(1000/0.5)} = \frac{3 - \log(r_{test})}{3.3}$$
(C.4a)

4-inch Diameter Well Screen

Correction

$$= \frac{Q_{4-in}}{Q_{test}} = \frac{\log(R/r_{test})}{\log(R/r_{4-in})} = \frac{\log(1000/r_{test})}{\log(1000/(2/12))} = \frac{\log(1000) - \log(r_{test})}{\log(1000/0.17)} = \frac{3 - \log(r_{test})}{3.8}$$
(C.4b)

Conversion Factors for Unconfined Unit

12-inch Diameter Well Screen

Correction

$$=\frac{Q_{12-in}}{Q_{test}}=\frac{\log(R/r_{test})}{\log(R/r_{12-in})}=\frac{\log(200/r_{test})}{\log(200/0.5)}=\frac{\log(200)-\log(r_{test})}{\log(200/0.5)}=\frac{2.3-\log(r_{test})}{2.6}$$
(C.5a)

4-inch Diameter Well Screen

Correction

$$=\frac{Q_{4-in}}{Q_{test}}=\frac{\log(R/r_{test})}{\log(R/r_{4-in})}=\frac{\log(200/r_{test})}{\log(200/0.17)}=\frac{\log(200)-\log(r_{test})}{\log(200/0.17)}=\frac{2.3-\log(r_{test})}{3.1}$$
(C.5b)

For above Equations C.4a through C.5b:

 r_{test} = radius of wellscreen of test well (feet)

R= radius of the cone of depression (feet)

Q = well yield (gallons per day)

Table C1 provides calculated conversion factors for a range of typical well screen diameters. For any given case, the appropriate conversion factor must be selected based upon: 1) the hydraulic condition of the groundwater-bearing unit (confined or unconfined), 2) the well screen diameter of the test well, and 3) the well screen diameter for which an equivalent yield is to be calculated (4-inch or 12-inch). The well yield determined from a Method 2 direct well yield test procedure (Q_{test}) is then multiplied by the appropriate correction factor to obtain the *equivalent yield* from a well with a 12-inch or 4-inch diameter well screen. This equivalent well yield is then used for determining the groundwater resource classification.

Table C- 1. Method 2 Correction Factors for Estimation of Equivalent Yield Based on Alternate Test Well Diameter

	Correction Factor for Equivalent Yield From:			
Nominal Screen Diameter of Test Well	4-inch Diameter Well		12-inch Diameter Well	
	Confined Unit	Unconfined Unit	Confined Unit	Unconfined Unit
2-inch	1.08	1.10	1.24	1.30
4-inch	1.00	1.00	1.14	1.18
6-inch	0.95	0.94	1.09	1.12
8-inch	0.92	0.90	1.05	1.07
10-inch	0.89	0.87	1.02	1.03
12-inch	0.87	0.85	1.00	1.00
16-inch	0.84	0.80	0.96	0.95
24-inch	0.79	0.75	0.91	0.88

Multiply well yield measured in test well by the specified correction factor to obtain the equivalent yield of a well with either a 4-inch diameter screen or a 12-inch diameter screen.

Example Calculation of Equivalent Well Yield

As an example, a Method 2 direct well yield test conducted on a 2-inch diameter test well determined well yield in a confined aquifer to be 110 gpd. A conversion factor to estimate the equivalent well yield from a 4-inch diameter well can be obtained from Table C1.

For this case, the test well diameter is 2-inches, the equivalent well diameter to be evaluated is 4 inches, and the groundwater-bearing unit is confined, corresponding to a correction factor of 1.08 from Table C1. The well yield determined from a Method 2 direct well yield test procedure $(Q_{test} = 110 \text{ gpd})$ is then *multiplied* by the correction to obtain the *equivalent yield* from a well with a 4-inch diameter well screen:

$$110 \text{ gpd x } 1.08 = 119 \text{ gpd}$$

This equivalent well yield can then used for purposes of evaluating the Class 3 yield boundary. In this example, the well yield of the GWBU (119 gpd) is less than 150 gpd for a 4-inch diameter well (or equivalent), corresponding to a Class 3 groundwater resource.

ATTACHMENT D

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- USGS, 1979. *Ground-Water Hydraulics*, Professional Paper 708, U.S. Geological Survey, Reston, VA, 70 pp.



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Burns & McDonnell World Headquarters 9400 Ward Parkway Kansas City, MO 64114 •• 816-333-9400 •• 816-333-3690 •• www.burnsmcd.com APPENDIX B - DRILLING LOGS WELLS AD-23
AND AD-24

STATE OF TEXAS WELL REPORT for Tracking #653823

Owner: Oklaunion Industrial Park, LLC Owner Well #:

Address: 500 Seneca St. Suite 504 Grid #: 13-63-5

Buffalo, NY 14204

Well Location: 12567 FM 3430 Latitude: 34° 04' 53.67" N

Vernon, TX 76384 Longitude: 099° 10' 38.02" W

Well County: Wilbarger Elevation: 1227 ft. above sea level

Type of Work: New Well Proposed Use: Monitor

Drilling Start Date: 10/24/2023 Drilling End Date: 10/24/2023

 Diameter (in.)
 Top Depth (ft.)
 Bottom Depth (ft.)

 Borehole:
 2.25
 0
 37

Drilling Method: Direct Push

Borehole Completion: Open Hole

Annular Seal Data:

Top Depth (ft.)

Bottom Depth (ft.)

Description (number of sacks & material)

Bentonite

Seal Method: **Poured** Distance to Property Line (ft.): **No Data**

Sealed By: **Driller** Distance to Septic Field or other

concentrated contamination (ft.): No Data

Distance to Septic Tank (ft.): No Data

Method of Verification: No Data

AD-23

Surface Completion: No Data

Water Level: No Data

Packers: No Data

Type of Pump: No Data

Well Tests: No Test Data Specified

Water Quality:

Strata Depth (ft.)	Water Type
No Data	No Data

Chemical Analysis Made: No

Did the driller knowingly penetrate any strata which contained injurious constituents?: **No**

Certification Data: The driller certified that the driller drilled this well (or the well was drilled under the

driller's direct supervision) and that each and all of the statements herein are true and correct. The driller understood that failure to complete the required items will result in

the report(s) being returned for completion and resubmittal.

Company Information: Envirotech Drilling Services LLC

226 E. Tidwell Rd Houston, TX 77022

Driller Name: Jaime Vasquez License Number: 58171

Comments: No Data

Lithology: DESCRIPTION & COLOR OF FORMATION MATERIAL

Top (ft.) Bottom (ft.) Description Red/brown clay, moist/wet, mixed with gravel/rocks 0 1 2.5YR 4/8 Clay/loam, red/brown, dry 1 1.5 2.5YR 3/4 Red clay sand mix, dry 2.5YR 1.5 2.5 2.5 5 Red/brown clay, dry 2.5YR 4/6 5 6 Red/brown clay, dry 2.5YR 4/6 Mixed with grey/green rocks 6 7 and sand Dark brown clay, dry 2.5YR 7 8 2.5/1 8 9.5 Red/brown clay, dry 2.5YR 4/5 Dark brown clay, dry 2.5YR 9.5 10 3/3 10 11 Brown clay, moist 2.5YR 3/3 Red clay, moist, mixed rocks 11 12.5 2.5YR 3/6 Red brown clay with rocks, 12.5 13.5 moist 2.5YR 3/6 Deep red clay/loam, dry 2.5YR 15 13.5 4/8 15 16 Red clay, moist 2.5YR 3/6

Casing: BLANK PIPE & WELL SCREEN DATA

Dia. (in.) New/Used	Туре	Setting From/To (ft.)
No Data		

16	18.5	Red/brown clay, moist 2.5YR 3/4
18.5	20	Red/brown clay, moist 2.5YR 3/4
20	22.5	Red clay, moist/wet 2.5YR 4/4
22.5	23.5	Red clay, wet/saturated 2.5YR 4/4
23.5	25	Red clay, moist/wet 2.5YR 4/4
25	27	Red clay, wet/saturated 2.5YR 4/4
27	28	Red clay/sand mixture, saturated 2.5YR 3/4
28	30	Red clay/saturated 2.5YR 4/4
30	32	Sand mixed w/red clay, saturated
32	35	Red/brown clay mixed with sand, saturated 2.5YR 4/6
35	36	Sand/gravel mixed with clay, saturated 2.5YR 4/4
36	37	Dark red/brown clay mixed with rocks, saturated 2.5YR 4/4

IMPORTANT NOTICE FOR PERSONS HAVING WELLS DRILLED CONCERNING CONFIDENTIALITY

TEX. OCC. CODE Title 12, Chapter 1901.251, authorizes the owner (owner or the person for whom the well was drilled) to keep information in Well Reports confidential. The Department shall hold the contents of the well log confidential and not a matter of public record if it receives, by certified mail, a written request to do so from the owner.

Please include the report's Tracking Number on your written request.

Texas Department of Licensing and Regulation P.O. Box 12157 Austin, TX 78711 (512) 334-5540

STATE OF TEXAS WELL REPORT for Tracking #653821

Owner: Oklaunion Industrial Park, LLC Owner Well #: AD-24

Address: **500 Seneca St. Suite 504** Grid #: **13-63-5**

Buffalo, NY 14204

Well Location: 12567 FM 3430 Latitude: 34° 04' 53.67" N

Vernon, TX 76384 Longitude: 099° 10' 38.02" W

Well County: Wilbarger Elevation: 1227 ft. above sea level

Type of Work: New Well Proposed Use: Monitor

Drilling Start Date: 10/24/2023 Drilling End Date: 10/24/2023

 Diameter (in.)
 Top Depth (ft.)
 Bottom Depth (ft.)

 Borehole:
 2.25
 0
 27

Drilling Method: Direct Push

Borehole Completion: Open Hole

Annular Seal Data:

Top Depth (ft.)

Bottom Depth (ft.)

Description (number of sacks & material)

Bentonite

Seal Method: **Poured** Distance to Property Line (ft.): **No Data**

Sealed By: **Driller** Distance to Septic Field or other

concentrated contamination (ft.): No Data

Distance to Septic Tank (ft.): No Data

Method of Verification: No Data

Surface Completion: No Data

Water Level: No Data

Packers: No Data

Type of Pump: No Data

Well Tests: No Test Data Specified

Water Quality:

Strata Depth (ft.)	Water Type
No Data	No Data

Chemical Analysis Made: No

Did the driller knowingly penetrate any strata which contained injurious constituents?: **No**

Certification Data: The driller certified that the driller drilled this well (or the well was drilled under the

driller's direct supervision) and that each and all of the statements herein are true and correct. The driller understood that failure to complete the required items will result in

the report(s) being returned for completion and resubmittal.

Company Information: Envirotech Drilling Services LLC

226 E. Tidwell Rd Houston, TX 77022

Description

Reddish clay, moist 2.5YR 4/6

Dark/dull red clay, moist

Red clay, moist 2.5YR 4/6

Dull red clay, moist/dry 2.5YR

Reddish/brown clay, moist

Driller Name: Jaime Vasquez License Number: 58171

Comments: No Data

Bottom (ft.)

Top (ft.)

0

Lithology: DESCRIPTION & COLOR OF FORMATION MATERIAL

Rocky layer mixed with clay, 1 2.5 reddish/brown clay, moist 2.5YR 4/3 2.5 3.5 Rocky layer encountered 3.5 5 Red clay, dry, 2.5YR 4/4 5 6.5 Brown/tan Sandy loam 6.5 8 Red/Brown clay, dry 2.5YR 4/3 8 10 Red/brown clay, dry 2.5YR 4/4 10 12 Red clay, dry 2.5YR 4/4 Dark brown/red clay, dry 12 14 2.5YR 3/4 Red clay, dry with grey/green 14 15 rocks 2.5YR 4/4 Reddish/brown clay, dry, 15 17.5 mixed with rocks 2.5YR 4/6

2.5YR 4/4

Casing: BLANK PIPE & WELL SCREEN DATA

Dia. (in.) New/Used	Type	Setting From/To (ft.)
No Data		

20

22.5

24

25

17.5

20

22.5

24

25	26	Red/brown clay, dry 2.5YR 5/4
26	27	Red clay, damp 2.5YR 4/4 Resistance hit

IMPORTANT NOTICE FOR PERSONS HAVING WELLS DRILLED CONCERNING CONFIDENTIALITY

TEX. OCC. CODE Title 12, Chapter 1901.251, authorizes the owner (owner or the person for whom the well was drilled) to keep information in Well Reports confidential. The Department shall hold the contents of the well log confidential and not a matter of public record if it receives, by certified mail, a written request to do so from the owner.

Please include the report's Tracking Number on your written request.

Texas Department of Licensing and Regulation P.O. Box 12157 Austin, TX 78711 (512) 334-5540 APPENDIX C - FEDERAL CCR FINAL RULE PROGRAM GROUNDWATER SAMPLING AND ANALYSIS PLAN



Federal CCR Final Rule Program Groundwater Sampling and Analysis Plan for Oklaunion Power Station



Oklaunion Industrial Park, LLC

Oklaunion Power Station: Inactive CCR Surface Impoundments

TCEQ IHW Permit: 33936 EPA ID: TXD982294803

Project No. 135110

January 2024

Federal CCR Final Rule Program Groundwater Sampling and Analysis Plan for Oklaunion Power Station

prepared for

Oklaunion Industrial Park, LLC
Oklaunion Power Station:
Inactive CCR Surface Impoundments
Vernon, Texas

TCEQ IHW Permit: 33936 EPA ID: TXD982294803

Project No. 135110

January 2024

prepared by

Burns & McDonnell

TABLE OF CONTENTS

				Page No.
1.0	INTR	ODUCT	ON	1-1
	1.1	Purpose		1-1
	1.2	CCR Fi	nal Rule Program	1-1
	1.3	Rationa	le	1-2
	1.4	Respon	sible Agency	1-2
	1.5	Site De	scription	1-2
		1.5.1	Pond 6	1-3
		1.5.2	Pond 21	1-3
		1.5.3	Pond 22	1-3
		1.5.4	Pond 23	1-3
		1.5.5	Wastewater and Sludge Storage and Dewatering Pond (WWSF) 1-4
	1.6	Geolog	y	1-4
	1.7	Overvie	eW	1-5
	1.8	Modific	cation to Sampling and Analysis Plan	1-5
2.0	FIEL	D PROC	EDURES	2-1
	2.1		èW	
	2.2		water Monitoring Networks	
	2.3		nel	
	2.4		and Safety	
	2.5		water Sampling Procedures	
		2.5.1	Sampling Frequency	
		2.5.2	Pre-Sampling Activities	
		2.5.3	Well Integrity Inspection	
		2.5.4	Well Maintenance	
		2.5.5	Water Level and Total Well Depth Measurements	
		2.5.6	Monitoring Well Purging and Sample Collection	
	2.6	Ground	water Quality Control Samples	
		2.6.1	Field Duplicate Samples	
		2.6.2	Matrix Spike and Matrix Spike Duplicate Samples	
	2.7	Sample	Documentation	
	2.8	-	s of Groundwater Samples	
	2.9		ring Well Re-Development	
	2.10		ring Well Abandonment	
	2.11		amination of Groundwater Sampling Equipment	
	2.12		tion of Excess Sample Volume and Decontamination Water	
	2.13		Custody and Documentation Procedures	
	2.13	2.13.1	Documentation Procedures	
		2.13.1	Field Logbook Record	
		2.13.3	Chain of Custody Record	
			Cample I shale	2-10 2-10

		2.13.5	Custody Seals	2-19	
		2.13.6	Electronic Field Records	2-19	
	2.14	Sample	Container Handling, Packaging, and Shipping	2-20	
3.0	QUA	LITY AS	SURANCE/QUALITY CONTROL	3-1	
	3.1		On		
		3.1.1	Laboratory Control Sample/Laboratory Control Sample Duplicate.	3-2	
		3.1.2	Matrix Spike/Matrix Spike Duplicate		
		3.1.3	Field Duplicate Samples	3-3	
	3.2	Accurac	cy	3-4	
		3.2.1	Blank Samples	3-4	
		3.2.2	Spike Recovery Studies	3-4	
	3.3	Represe	entativeness	3-6	
	3.4	Comple	eteness	3-7	
	3.5		rability		
	3.6		tory QA/QC		
	3.7		A/QC		
	3.8				
	3.9		nent/Equipment Calibration and Frequency		
	3.10		ion/Acceptance of Supplies and Consumables		
	3.11	Data M	anagement	3-9	
4.0	DATA	4 VALID	ATION AND USABILITY	4-1	
	4.1	Data Re	eview, Validation, and Verification Requirements	4-1	
	4.2	Validati	ion and Verification Methods	4-2	
	4.3	Reconc	iliation with User Requirements	4-4	
5.0	REP	ORTING		5-1	
	5.1	Laborat	tory Reports	5-1	
	5.2	Annual	Groundwater Monitoring and Corrective Action Reporting	5-1	
	5.3		Keeping, Notifications, and Public Reporting		
6.0	REFE	ERENCE	S	6-1	
APP	IRES ENDIX ENDIX	B - LOC	GIONAL GENERALIZED GEOLOGIC CROSS-SECTIONS CAL GENERALIZED GEOLOGIC CROSS-SECTIONS LD DOCUMENTATION		

APPENDIX D - LABORATORY QUALITY ASSURANCE MANUAL

LIST OF TABLES

Table No.	<u>Title</u>		
1	Summary of Monitoring Well Construction		
2	Groundwater Sampling Collection Summary		
3	Groundwater Detection Monitoring Constituents		
4	Groundwater Assessment Monitoring Constituents		
	LIST OF FIGURES		
Figure No.	Title		
1	Topographic Site Vicinity Map		
2	Groundwater Monitoring Well Network		
<u>~</u>	Groundwater Monitoring Wen Network		

LIST OF ABBREVIATIONS

<u>Abbreviation</u> <u>Term/Phrase/Name</u>

ASTM American Society of Testing and Materials

CCR Coal Combustion Residuals
CFR Code of Federal Regulations
CCR SI CCR Surface Impoundment
COPC chemical of potential concern
CPR Construction Progress Report

DQI data quality indicator EDD electronic data deliverable FSM Field Site Manager

GWPS Groundwater Protection Standard
IHW Industrial and Hazardous Waste

IHW Permit Industrial and Hazardous Waste Permit # 33936

J data qualified as estimated

J+ data qualified as estimated high bias
J- data qualified as estimated low bias

LCS Laboratory Control Sample

LCSD laboratory control sample duplicate

LLC Limited Liability Company
MCL Maximum Contaminant Level

MDL method detection limit mL/min milliliters per minute

MS matrix spike

MSD matrix spike duplicate

NAICS North American Industry Classification System

NELAP National Environmental Laboratory Accreditation Program
NFGI National Functional Guidelines for Inorganic Data Review
NFGO National Functional Guidelines for Organic Data Review

NTU Nephelometric Turbidity Units
OIP Oklaunion Industrial Park, LLC
PPE personal protective equipment

QA quality assurance OC quality control

R data qualified as unusable or rejected

REC percent recovery RL reporting limit

RPD relative percent difference

SA spike amount

SAP Sampling and Analysis Plan

Site Oklaunion Industrial Park, LLC – Oklaunion Power Station, Vernon,

Texas

SR Sample Results

SSI statistically significant increase

SSR Spike Sample Results
TAC Texas Administrative Code

TCEQ Texas Commission on Environmental Quality
TDLR Texas Department of Licensing and Regulation

<u>Abbreviation</u>	Term/Phrase/Name
TLAP TPDES TWDB	Texas Laboratory Accreditation Program Texas Pollutant Discharge Elimination System Texas Water Development Board
U	Qualified Undetect
USEPA	United States Environmental Protection Agency
USGS WWSP	United States Geological Survey Wastewater and Sludge storage and dewatering Pond
** ** DI	wastewater and brudge storage and dewatering round

1.0 INTRODUCTION

This Coal-Combustion Residuals (CCR) Program Groundwater Sampling and Analysis Plan (SAP) has been prepared by Burns and McDonnell to establish procedures for multi-unit groundwater monitoring at five (5) inactive CCR Units for the Oklaunion Power Station (Site) operated by Oklaunion Industrial Park, LLC (OIP) located in, Wilbarger County, Vernon, Texas. The inactive CCR Units consist of Ponds 6, 21, 22, 23, and the Wastewater and Sludge storage and dewatering pond (WWSP). A topographic site location map and a groundwater monitoring well network map illustrating the location of the inactive CCR Units is provided as **Figures 1** and **2**, respectively.

1.1 Purpose

This SAP has been prepared to present groundwater monitoring procedures to support compliance with the requirements included in the Texas Commission on Environmental Quality (TCEQ) regulations for CCR impoundments including groundwater monitoring and corrective action requirements under 30 Texas Administrative Code (TAC) §352.901-991 (Texas CCR regulations), that follows the United States Environmental Protection Agency (USEPA) *Hazardous and Solid Waste Management System; Disposal of Coal Combustion Residuals from Electric Utilities; Final Rule, 40 Code of Federal Regulations (CFR) Part 257 and 261* and in accordance with 40 CFR §257.90, collectively referred to herein as the "CCR Final Rule."

The TCEQ Industrial Hazardous Waste Permit Section (IHWP) – CCR Program issued Industrial and Hazardous Waste Permit # 33936 (IHW Permit) for the Oklaunion Power Station's inactive CCR Units. The Registration of Industrial and Hazardous Waste includes 39 separate activities, including required groundwater monitoring for surface impoundments. This SAP is intended to support compliance with CCR Final Rule groundwater monitoring requirements for the inactive CCR Units (referred to as "CCR Program").

The Oklaunion Power Station CCR Units are managed in accordance with the CCR Final Rule and the IHW Permit requiring groundwater monitoring.

1.2 CCR Final Rule Program

The CCR Final Rule is found in 40 Code of Federal Regulations (CFR) Parts 257 and 261 and was published by USEPA to regulate the disposal of CCR as solid waste under Subtitle D of the Resource Conservation and Recovery Act. This final rule applies to all CCR generating electric utility facilities and independent power producers that fall within the North American Industry Classification System (NAICS) code 221112.

This CCR Final Rule established nationally applicable minimum criteria for the safe disposal of CCR in landfills and surface impoundments. CCR includes fly ash, bottom ash, boiler slag, and flue gas desulfurization materials. The CCR Final Rule applies to owners and operators of new, existing, and/or laterally expanded landfills and surface impoundments that dispose or otherwise engage in solid waste management of CCR.

The CCR Final Rule requires inactive CCR units implement groundwater monitoring system (40 CFR §257.100) and develop a groundwater sampling program (40 CFR §257.93) capable of detecting CCR impacts on the groundwater quality for specific CCR chemicals of potential concern (COPCs).

1.3 Rationale

This SAP is prepared to support compliance with groundwater monitoring requirements in the CCR Final Rule. There are five inactive CCR surface impoundments scheduled for closure. Pond 6 was historically used for the disposal of fly ash and bottom ash. Pond 21 and Pond 22 were historically used for bottom ash storage and dewatering. Pond 23 was historically used for fly ash storage and dewatering. The last WWSP pond was utilized for wastewater, sludge storage, and dewatering. These wastes meet the definition "coal combustion by-products" given in 40 CFR §257.53 and is governed by 30 Texas Administrative Code (TAC) §352.901-991 (Texas CCR regulations) that requires groundwater monitoring and corrective action for a CCR unit in accordance with the CCR Final Rule. All five ponds are inactive and going into closure, but also require continued groundwater monitoring during closure activities and during the post-closure care period in accordance with the 40 CFR §257.90(c).

1.4 Responsible Agency

The TCEQ IHW Permits Section (CCR Program) is the regulatory agency responsible for the groundwater monitoring at the Site.

1.5 Site Description

Oklaunion Industrial Park, LLC owns and operates Oklaunion Power Station, which is a former coal-fired power generating facility located approximately two miles southeast of the junction of Texas Farm to Market Road 433 and Texas Farm to Market Road 3430, and approximately four miles southwest of Oklaunion, Wilbarger County, Texas. Oklaunion Power Station contains five inactive CCR surface impoundments scheduled for closure that include Ponds 6, 21, 22, 23, and the WWSP. These inactive CCR ponds are located within the Southern Beaver watershed which has a listed acreage of approximately 445,120 acres, however each inactive CCR pond has no outlet or spillway structures and relies solely on evaporation to manage water within in the impoundment. Therefore, each pond only

receives direct rainfall and there are no other flows into the ponds since they became inactive on May 5, 2021, when the Notice of Intent (NOI) for closure was submitted. Each inactive CCR unit is discussed in more detail below based on review of the following previous investigations and reports:

- Closure Plan, Ponds 6, 21, 22, 23, and WWSP (Civil & Environmental Consultant, Inc, 2021)
- Report 1 Groundwater Monitoring Network for CCR Compliance (Terracon 2016)
- Groundwater Monitoring System Installation Report (Terracon, 2011)

1.5.1 Pond 6

Pond 6 was constructed in 1987 and was historically used for the disposal of fly ash and bottom ash. It is located at the south-central edge of the main evaporation pond complex of the generating station. It is formed by a side hill embankment with 3H:1V inboard and outboard slopes consisting of a layer of lean clay fill, that has a crest width of 20 feet and is approximately 20-feet in height and encompasses 68 acres. In 2015, the ponds embankment was raised approximately 10 additional feet to provide additional ash storage capacity.

1.5.2 Pond 21

Pond 21 was constructed in 1987 and was historically used for bottom ash storage and dewatering. It is located at the south-central edge of the main evaporation pond complex of the generating station. It is constructed as a continuous above-ground earthen embankment with 3H:1V inboard and outboard slopes consisting of a layer of lean clay fill, which has a crest width of 20 feet and is approximately 25-feet in height and encompasses 7.33 acres.

1.5.3 Pond 22

Pond 22 was constructed in 1987 and was historically used for bottom ash storage and dewatering. It is located at the south-central edge of the main evaporation pond complex of the generating station. It is constructed as a continuous above-ground earthen embankment with 3H:1V inboard and outboard slopes consisting of a layer of lean clay fill, which has a crest width of 20 feet and is approximately 25-feet in height and encompasses 7.54 acres.

1.5.4 Pond 23

Pond 23 was constructed in 1987 and was historically used for fly ash storage and dewatering. It is located at the south-central edge of the main evaporation pond complex of the generating station. It is constructed as a continuous above-ground earthen embankment with 3H:1V inboard and outboard slopes

consisting of a layer of lean clay fill, that has a crest width of 20 feet and is approximately 25-feet in height and encompasses 12.68 acres.

1.5.5 Wastewater and Sludge Storage and Dewatering Pond (WWSP)

The WWSP was constructed in 1987. It is located within the main evaporation pond complex of the generating station. It is constructed as a continuous above-ground earthen embankment with 3H:1V inboard and outboard slopes consisting of a layer of lean clay fill, that has a crest width of 20 feet and is approximately 24-feet in height and encompasses 21.20 acres.

1.6 Geology

Site geology and hydrogeology presented below is based on review of the following previous investigations/reports:

- Groundwater Monitoring System Installation Report (Terracon, 2011)
- Report 1 Groundwater Monitoring Network for CCR Compliance (Terracon, 2016)

The OIP area is underlain by the Permian age Clearfork Group, which is the major geologic formation outcropping the vicinity of the Site. The Clearfork Group consists of mudstone, siltstone, sandstone, dolomite, limestone, and gypsum. The group is comprised mostly of a mudstone that is commonly silty and is a brownish red with minor gray color content. Calcareous nodules are abundant in the lower part and vertebrate fossils are locally common. Some inter-bedded, bluish-gray siltstone units, 1 to 3 feet in thickness, are found throughout the group. The group is locally dolomitic in the upper part of the unit. The sandstone in the group is found to be reddish-brown, very fine grained to fine grained, locally conglomeratic, cross-bedded, lenticular, and thin-bedded as channel fill. Dolomite ranges from 2 inches to 1 foot in thickness in the upper section of the Clear Fork Group. A gray limestone is found in thin discontinuous beds in the lower part. A white satin spar and alabaster gypsum are found as thin lenses and veins in the uppermost part of the group. The Clear Fork Group has a thickness of 1,200 to 1,400 feet.

Groundwater occurs through a slow infiltration rate ranging at various depths across the Site. Based on field observations of continuous sampling and drill cuttings, the thin silt seams and the bedding plans of the claystone/mudstone appear to provide preferential pathways for groundwater. Based on review of existing Site monitoring well drill logs, the unconsolidated overburden material is comprised predominately of silty clay soils with slight gravelly zones and occasional silt lenses that overly claystone/mudstone of the Clearfork Group. The screened interval for a majority of the existing monitoring wells targets the base of unconsolidated silty clay overburden immediately above the underlying bedrock. Generalized geologic cross-sections of the region (Price, 1979) in the vicinity of the

Site are provided in **Appendix A**. Based on review of existing monitoring well drill logs, local generalized geologic cross-sections were prepared and provided in **Appendix B**.

1.7 Overview

This SAP will serve as guidance for personnel performing groundwater monitoring at the Oklaunion Power Station's five inactive CCR Units in accordance with 30 TAC §352.901-991 (Texas CCR regulations) and the CCR Final Rule (40 CFR §257.93). The SAP presents procedures for the sampling and analysis of groundwater monitoring wells and is organized in sections as summarized below:

Section 2.0 Field Procedures - Section 2.0 presents a description of the field procedures to be used during groundwater sampling activities.

Section 3.0 Quality Assurance/Quality Control (QA/QC) - Section 3.0 details the methods that will be used so that only valid data are used in evaluating groundwater quality and whether or not impacts to groundwater are present. This section describes the laboratory QA/QC procedures, analyte reporting limits (RL), and analytical methodologies.

Section 4.0 Data Validation and Usability - Section 4.0 details data validation procedures to determine whether individual project data are useable, useable with qualifications, or unusable.

Section 5.0 Reporting - Section 5.0 details groundwater monitoring reporting requirements.

Section 6.0 References - Section 6.0 includes a bibliography for references made within this SAP.

1.8 Modification to Sampling and Analysis Plan

It should be noted that the existing monitoring well networks may undergo periodic re-evaluation in the future that could result in either the addition or deletion of wells from the groundwater sampling networks and changes in groundwater sampling methods. Groundwater sampling parameters may also be adjusted, following the review of data. Therefore, as changes to the groundwater monitoring networks, sampling methodology, and analytical parameters occur, this SAP will be amended appropriately.

2.0 FIELD PROCEDURES

This section of the SAP presents an overview of the field procedures, monitoring well network, and description for common field procedures to be used during groundwater sampling activities at monitoring wells.

2.1 Overview

Groundwater samples will be collected to establish background groundwater quality and determine if the inactive CCR Units have impacted the quality of the uppermost shallow groundwater. Proper sampling procedures are an important and fundamental aspect in an effective monitoring program. This SAP establishes procedures for groundwater monitoring at the inactive CCR Units to comply with the groundwater monitoring requirements in 40 CFR §257.100 and 40 CFR §257.93.

Groundwater sampling will be accomplished by personnel trained in proper sampling protocol and will consist of seven basic field activities:

- 1. Performing well integrity inspections;
- 2. Collecting water level and total well depth measurements;
- 3. Obtaining field measurements of select groundwater quality parameters;
- 4. Monitoring well purging and collecting groundwater samples;
- 5. Field documentation:
- 6. Decontamination and investigation-derived waste management;
- 7. Submitting collected samples for laboratory analysis.

Well maintenance and redevelopment may also be included in the field activities, as needed.

2.2 Groundwater Monitoring Networks

Groundwater sampling/analysis will be performed from the established groundwater monitoring well network associated with Ponds 6, 21, 22, 23, and the WWSP. The currently defined groundwater monitoring network is illustrated in **Figure 2** and consists of the following:

- Three (3) Upgradient Monitoring Wells AD-06, AD-07, and AD-08
- Five (5) Downgradient Monitoring Wells AD-13, AD-14, AD-15, AD-23, and AD-24

To support evaluation of groundwater flow conditions, six existing monitoring wells (AD-02, AD-04, AD-05, AD-12, AD-19, and AD-22) in the vicinity of the monitoring well network will be utilized for water level gauging purposes only.

A summary of the monitoring well construction details for the currently defined groundwater monitoring network at the Site is summarized in **Table 1**.

2.3 Personnel

Groundwater sampling activities at the Site will be performed in the field by a qualified technician familiar with this SAP. All samples collected will be shipped by the sampling technician to an off-site National Environmental Laboratory Accreditation Program (NELAP) and Texas Laboratory Accreditation Program (TLAP) certified commercial laboratory for analysis using the procedures presented below.

2.4 Health and Safety

Personnel will conduct operations in accordance with promulgated Occupational Safety and Health Administration regulations and the OIP Site Health and Safety Plan. Minimum field personnel protective equipment (PPE) will include steel-toed boots, safety glasses, gloves, long pants, and short sleeves. All monitoring wells are above-grade stickup completions. Any work to be completed below-grade that are considered confined space entries shall be performed by qualified confined space entry trained personnel in accordance with OIP Safety and Health Program and with proper notification and approval by OIP.

2.5 Groundwater Sampling Procedures

2.5.1 Sampling Frequency

Groundwater monitoring will be initiated under the detection monitoring program (40 CFR §257.94) and performed on a semi quarterly sampling schedule for the first year to obtain a minimum of eight independent samples from each background and downgradient well to establish background/baseline and also include a ninth sample as a compliance point to perform statistical analysis in accordance with 40 CFR §257.94(e). The semi quarterly groundwater sampling will generally include at least two rounds of sample collection in each quarter (January to March, April to June, July to September, and October to December) for the first year with one quarter including at least three rounds of sample collection to collect nine total samples. Following collection of the ninth sample under initiation of the detection monitoring program, the sampling schedule will be reduced to semiannually and will include at least one round of sample collection in each half (January to June; and July to December) of each year.

If contracting challenges, adverse weather, interruption with laboratory, global supply chains, and/or the global outbreak and spread of COVID-19 ("coronavirus") impacts the schedule, the OIP Project Manager and TCEQ Project Manager will be advised, and the schedule modified as necessary.

Table 2 includes a groundwater sampling frequency with analysis of groundwater samples provided in **Section 2.8**.

2.5.2 Pre-Sampling Activities

Prior to beginning field activities, the OIP Project Manager and the field sampling team will contact a selected NELAP and TLAP certified commercial laboratory, schedule the sampling event, and arrange for laboratory-prepared bottles with appropriate preservatives to be obtained. The sampling team will pre-schedule the necessary sampling equipment needed to conduct the groundwater sampling activities and may include the following:

- Necessary Field Paperwork
- Pneumatic Bladder Pump Control Box
- Air Compressor or Compressed Gas Canister(s) (carbon dioxide or nitrogen)
- Pressure Regulator and Associated Air Line
- Electronic Water Level Indicator
- Multi-Parameter Meter with Flow-Through Cell
- Turbidity Meter
- Thermometer
- Calibration Standards
- Trash Bags
- Liquid Measuring Cup or Graduated Cylinder
- Five-Gallon Buckets
- Disposable Gloves
- Calculator
- Decontamination Equipment
- Laboratory Grade Detergent (phosphate free; i.e., Alconox®, Liquinox®, or similar)
- Distilled, Deionized, or Potable Water
- Sample Cooler and Ice
- Sample Bottles (laboratory provided with appropriate preservatives, as needed
- Camera for documenting well conditions or any maintenance issues

Equipment for field instruments will be calibrated in accordance with manufacturers' procedures. Calibration results will be documented in the field logbook or on field calibration forms. Sampling will not commence until all sampling equipment and supplies are on site.

2.5.3 Well Integrity Inspection

Each monitoring well will be inspected prior to the start of sampling events during the collection of water level measurements (refer to **Section 2.5.5**). Items to be inspected will include condition of the well pad (no evidence of cracking, undermining, or heaving from frost), well protective cover (damage or excessively corroded), well padlock, and bumper posts (if any); presence of excessive vegetation; presence of erosional features or the indication of ponding of water near the well; condition of the polyvinyl chloride casing and well cap, and condition of well label. Screen occlusion will be measured annually (or at an alternative frequency; see **Section 2.5.5**) during total well depth gauging. The results of the well inspection will be documented in the field logbook or Field Groundwater Sampling Data Form (or equivalent) found in **Appendix C**. If a maintenance item is noted that could compromise the integrity of the groundwater sample, then a sample will not be collected until well maintenance has been conducted.

2.5.4 Well Maintenance

Well maintenance items noted in the field during well integrity inspection (see **Section 2.5.3**) or identified by OIP will be corrected prior to the next sampling event by OIP. Well maintenance items such as painting, labeling, erosion control, and vegetation management may be conducted on a yearly basis if the deficiency will not affect the groundwater sampling. Major repairs or alteration of a monitoring well (if necessary) will be corrected prior to the next sampling event and will be conducted by a Texas certified well driller in accordance with 16 TAC Chapter 76 and reported by the driller to the Texas Department of Licensing and Regulation (TDLR) by filling out a Well Report, a copy of which is provided in **Appendix** C. No monitoring well modifications shall be conducted without prior approval by the TCEQ IHWP Section who shall be notified by the certified well driller a minimum of ten (10) working days prior to modifications of each monitoring well. A Construction Progress Report (CPR) shall be submitted within 45 days of the completion of any monitoring well modification activities as stipulated in the IHW Permit. An account of monitoring well repairs will be maintained by OIP and placed in the operational record. If significant modifications are made that affect the height of the well casing above ground, re-surveying of the top of well casing shall be performed.

2.5.5 Water Level and Total Well Depth Measurements

Water level measurements will be collected from the monitoring well network monthly and during each planned sampling event prior to collecting groundwater samples. An electronic water level meter will be used to measure the water level in wells. Groundwater elevations in monitoring wells at each CCR Unit must be measured within a period short enough to avoid temporal variations in groundwater elevation

which could preclude accurate determination of groundwater flow rate and direction (i.e., less than 24 hours). Total well depths will be measured semi quarterly at the groundwater monitoring network using an electronic water level meter to measure and compare to the well construction depths to assess whether sediment is present and evaluate screen occlusion. However, the frequency of measuring total well depths may be adjusted based on review of collected data and historical trends. For wells without dedicated pumps, total well depths will be measured during water level gauging prior to sampling activities. For wells with dedicated pumps, total well depths will be measured immediately following the sampling activities to prevent the sampling technician from disturbing the water column or sediment in the wells prior to sampling when removing the dedicated pump. Another option for measuring total well depths to avoid removing pumps from the wells may be using a steel tape measure that can slide down the side of the well past the pump. Disposable nitrile or latex gloves will be worn during water level and total well depth measurements and changed in between well locations. If using a gasoline powered air compressor for groundwater sampling, new gloves will be worn after handling the compressor. In monitoring wells with watertight caps, water level measurements taken immediately after the caps are removed will be repeated at regular intervals until the readings stabilize. As an alternative method, wells with unstable water levels after removing the caps may be opened to vent to atmospheric pressure for approximately 30 minutes prior to measuring water levels.

All groundwater levels will be measured to the surveyed reference mark (or notch) on the top of the well casing. If no reference mark is present, the water level will be measured to the top of the casing on the north side of the well. The following procedure will be used to measure groundwater levels and total well depths at each well:

- Decontaminate the electronic water level meter cable and probe in accordance with Section 2.11
 of this SAP.
- 2. Turn on the water level meter and push the instrument test button to check the batteries.
- 3. Lower the water level meter probe into the monitoring well by pulling the cable from the hand-held reel until the indicator light and/or audible signal responds.
- 4. Move the cable up and down while observing the indicator. Note the exact length of cable extended from the tip of the probe sensor to the top of the well casing at the reference point when the probe sensor indicates the groundwater/air interface. Record the cable length to the nearest 0.01-foot, monitoring well number, time, and date of the measurement in a field logbook or appropriate form (**Appendix C**).
- 5. Semi quarterly, or at an alternative frequency based on review of historical data/trends, total well depths will be gauged. This will be performed following the collection of groundwater samples at

wells with dedicated pumps to prevent disturbing the water column or sediment in the well immediately before sampling. After the groundwater sample has been collected, measure the total well depth by gently lowering the probe to the bottom of the well. Add the length of the distance between the end of the probe and the probe sensor to the total well depth measurement if applicable when using an electronic water level meter. Record the total well depth measured at the top of the well casing at the reference point to the nearest 0.01-foot in a field logbook or appropriate form. When removing dedicated bladder pumps and tubing from a well to measure total well depth, care shall be taken so that the equipment does not come in contact with the ground or other surfaces that could contaminate the equipment. Following total well depth measurement, inspect bladder pump and associated tubing prior to reinserting equipment down well. Prior to reinsertion of the pump system down the well, triple rinse the outside of the pump with distilled water and wipe the outside of the pump and tubing with a clean, dry, disposable towel. Another option for measuring total well depths to avoid removing pumps from the wells may be using a steel tape measure that can slide down the side of the well past the pump.

- 6. Decontaminate the electronic water level probe and cable (see **Section 2.11**) prior to measuring the next well.
- 7. Obtain all groundwater elevation measurements within 24 hours.

Water level elevations will be compared with previous water level elevations for that monitoring well whenever possible. If a large difference in water level elevation (> 3 feet) is noted between measurements, the water level will be re-measured. If the re-measurement provides the same result, the inconsistency will be noted in the field logbook and evaluated during reporting with continued monitoring in subsequent sampling events.

The total well depth measurement of the well (if collected) will be compared with the constructed total well depth. A lesser total well depth measurement is an indication that sediment is accumulating in the well. Wells will be re-developed whenever more than 10 percent (%) of the effective well screen is occluded by sediments or records indicate a reduction in well yield and/or increase in turbidity. Well redevelopment procedures will follow those discussed in **Section 2.9** of this document.

2.5.6 Monitoring Well Purging and Sample Collection

2.5.6.1 Methodology

The overall objective in groundwater sampling is to collect a sample that is representative of the formation water for the parameters being tested. Sampling methods, equipment and procedures that are

employed during sampling are designed and selected to accomplish this objective. Groundwater samples will not be field filtered prior to analysis. Disposable nitrile or latex gloves will be worn during sampling procedures and changed in between well locations. Some of the concerns that arise in sampling a groundwater well are:

- Removing or avoiding stagnant non-representative water in the well
- Minimizing turbulent flow through the filter pack and screen, in order to avoid mobilizing solids
- Avoiding disturbance of any sediment that has collected at the bottom of the well
- Avoiding unnecessary agitation of the sampled water

The preferred method of sampling will be to use low-flow procedures with a dedicated bladder pump. For low recovery wells (if present), which do not support the stable water level requirement of standard low-flow sampling procedures or for wells where field parameters do not stabilize within one (1) hour of purging, an alternate purging and stabilization procedure will be used as discussed below.

2.5.6.2 Field Indicator and Stabilization Parameters

Some of the sampling methods presented below depend on stabilization of field indicator parameters before the collection of sample water begins. The field parameters are measured and recorded every three to five minutes in the field logbook or on sample collection forms during well purging and immediately before collection of the sample. Even with methods that do not depend on parameter stabilization, field parameters are to be measured if possible.

The instruments used to measure field parameters will be calibrated and operated according to manufacturer's recommendations. The calibration will be checked at a minimum before each day of sampling and often enough to maintain accurate readings. The pH probe on the utilized multi-parameter meter will be checked at the beginning of each sampling day and calibrated according to manufacturer instruction or recommendations. Instrument calibration will be recorded in the field logbook, field sampling forms, or on field calibration forms.

When a flow-through cell is being used, multi-parameter sensors are contained within the flow-through chamber and measurements are made during purging. The sample line is disconnected from the flow-through cell prior to sampling, so samples are never collected downstream of the flow-through cell. Care will be taken to ensure that no air is introduced into the flow-through cell system through loose fittings during low-flow purging. The flow-through cell will be decontaminated between use at each monitoring well by triple rinsing with distilled water.

2.5.6.3 Well Purging and Sample Collection

Groundwater sampling will be performed utilizing low flow purging/sampling techniques.

The following procedure will be followed during purging and sampling using the dedicated submersible bladder pump systems:

- 1. After opening the well, obtain a water level measurement. The water level probe is left in the well so that the well level can be checked regularly during pumping to monitor the drawdown. If the water level is below the top of the pump (probe is stopped at the top of the pump before contacting water) note this in the field logbook; the well likely cannot be sampled with the pump.
- 2. Connect the air charge line from the dedicated pump assembly to a portable controller equipped with a built-in air compressor. If the portable controller is not equipped with a built-in air compressor, connect the controller to either a portable air compressor or compressed gas cylinder (nitrogen or carbon dioxide), as necessary. If using a gasoline powered air compressor, place as far from the well as possible in a down-wind direction. Connect the pump discharge tube so that the sample water goes into the flow-through cell (with a multi-parameter meter equipped inside) and is discharged into a bucket. A container with volumetric markings (*i.e.*, liquid measuring cup or graduated cylinder) will be used to periodically collect discharge water prior to entering the bucket to measure and monitor flow rates. Protect the field measurement apparatus (*i.e.*, multi-parameter probe equipped inside the flow-through cell) from the effects of ambient temperature, wind and sun as necessary to minimize their influence on readings.
- 3. Care will be taken to ensure that no air is introduced into the flow-through cell system through loose fittings during low-flow purging.
- 4. Operate the pump at a discharge rate that is low enough that the water level stabilizes with minimal drawdown and that is practical for purging and sampling, but not to exceed 500 milliliters per minute (mL/min). Record the water level at the maximum drawdown during a purge cycle.
- 5. Document discharge rate, water level, and field parameters at least every three to five minutes and immediately before sample collection. Continue purging until at least three (3) consecutive field parameter measurements have stabilized.
 - A stable water level and/or minimal drawdown may be difficult to achieve under some
 conditions due to geologic heterogeneities within the screened interval and may require
 adjustment based on site-specific conditions and historical purging and drawdown data
 from the well. It is far more important to achieve a stabilized water level in a well during

- purging than to achieve a particular drawdown value, as each well is hydrogeologically unique and thus will respond differently to pumping.
- 6. If water level drawdown is observed and a stable water level cannot be achieved during initial purging, incrementally reduce the pump rate as slowly as practical based on the pump capabilities in an attempt to achieve a stable water level, not to go below 100 mL/min. If a well has a known history of exhibiting low yield/recharge conditions while pumping as slow as practical without maintaining a stable water level, then begin initial purging at a lower pump rate, not to go below 100 mL/min.
- 7. In instances where certain field parameters fluctuate and do not stabilize after 1-hour of purging, an alternate stabilization criterion will be implemented.
- 8. In the event that the water level has not stabilized with minimal drawdown by reducing the pump rate to 100 mL/min (or slowly as practical) while all other field parameters have stabilized, then sampling personnel will switch to the minimum purge procedures used for low-recovery wells (see Section 2.5.6.4). The minimum purge procedures will also be implemented under the following water level drawdown scenarios:
 - a. For wells in which the original water level is above the top of the screen (and therefore stagnant water overlies representative formation quality water) the drawdown shall generally not exceed 25% of the distance between the pump intake and the top of the screen (American Society of Testing and Materials [ASTM], 2022; D6771-21). As an example, in a monitoring well with 10 feet of screen and the pump intake is two feet from the bottom, the maximum drawdown distance is two feet (eight feet from the pump intake to the top of screen times 25%).
 - b. For wells in which the original water level is within the screened interval, the water shall not be drawn down below a level that results in an insufficient water column above the pump intake that is not adequate to collect the required sample volume.
- 9. Once the field parameters have stabilized during purging, disconnect the sample water discharge line from the flow-through cell prior to sampling, so samples are never collected downstream of the flow-through cell. Record total gallons purged and begin sample collection by filling sample containers directly from the water discharge line of the pump and add preservation (if applicable). Groundwater samples will not be field filtered prior to analysis. Care should be taken not to flush any preservative (if applicable) out of the sample container during sample collection.
- 10. Wells should be sampled immediately after purging to stabilization or in accordance with minimal purge procedures for low-yielding wells (see **Section 2.5.6.4**) but can be sampled up to 24 hours after stabilization or minimal purging (low-yield wells) if required.

- 11. During sampling, maintain the same pumping rate that achieved the stabilization criteria, but if necessary the purge rate can be decreased (but not subsequently increased).
- 12. To minimize the effects of volatilization and pH changes, the samples from each well shall be collected in the following order:
 - a. Metals
 - b. Inorganic Non-Metals and Total Dissolved Solids
- 13. Clear water from the top of the water discharge sample line at the pump assembly wellhead by pressurizing the frost-protection airline if applicable.

2.5.6.4 Minimum Purge/Sampling of Low Yield Wells

The minimum purge method for sampling wells with a bladder pump is appropriate for wells that do not recharge adequately, or have a history of exhibiting low yield/recharge, and are unable to maintain a stable water level while pumping as slowly as is practical, typically no slower than 100 mL/min. The method is intended to collect samples from the water within the screened interval, while avoiding any stagnant water that may exist in the casing above the screened interval or avoiding drawdown within the screened interval causing insufficient water column above the pump intake to collect the required sample volume.

The procedures for the minimum purge method are similar to the above-described procedures for standard sampling with a bladder pump, with the following differences:

- The pump is operated at a low discharge rate as slow as practical, typically no lower than 100 mL/min, in order to minimize any disturbance of sediment in the well screen.
- Stabilization of water level does not occur.
- Measurement of field parameters will be recorded during purging and before sample collection if possible.
- The volume of water in the well casing and filter pack will be calculated (assuming 30% filter pack porosity). A determination will be made based on the calculated well volume if there is sufficient volume to measure and record field parameters prior to sampling. If the volume of water in the well will be limited by the volume required to fill all sample bottles, then field parameters will be measured after sampling is complete if there is sufficient water and accurate readings can be obtained.
- Sample collection can begin as soon as three pump assembly volumes (pump and tubing) of
 groundwater have been discharged. This is the minimum required purge, however more water
 volume may be removed, if possible, based on the calculated volume and water column height

- and the water level depth above or below the top of well screen in comparison to the depth of the pump intake.
- For wells in which the original water level is above the top of the screen, sample collection will need to occur before or be suspended when the water level has been drawn down by the distance between the pump intake and the top of the screen, minus a safety margin of about 2 feet (Nielsen, 2002). This approximate 2-foot safety margin is to avoid drawing in stagnant water that is originally above the screened interval.
 - O As an example: In a monitoring well with 10 feet of screen and the pump intake 2 feet from the bottom, the maximum draw down distance is 6 feet (8 feet from the pump intake to the top of the screen minus the 2-footsafety margin).
- For wells in which the original water level is within the screened interval, sample collection will
 need to occur before or be suspended when the water level has been drawn down to about the
 level of the top of the pump as a practical limit during sampling or to the level of the pump
 intake.
- It may be necessary to reduce the sample bottle volumes to the minimum required by the laboratory for analysis, the OIP Project Manager and laboratory will be contacted to acquire the minimum volume requirements for each analysis and to ensure it is appropriate for the project.
- If sample collection cannot be completed, allow the well to recharge for approximately 24 hours and reattempt sample collection (maximum of one attempt).

2.6 Groundwater Quality Control Samples

Quality control samples will consist of field duplicate, matrix spike (MS), and matrix spike duplicate (MSD) samples.

2.6.1 Field Duplicate Samples

Field duplicate samples will be collected at a frequency of 10% (1 every 10 field samples) for each sampling event and will be obtained at the same time and analyzed for the same set of parameters as the parent sample it is intended to duplicate. At a minimum, one (1) field duplicate will be obtained for Appendix III detection monitoring parameters and for Appendix IV assessment monitoring parameters for every sampling event (total of one [1] field duplicate per sampling event; refer to **Table 2**). Due to the larger sample volume needed, field duplicates will typically be collected from a monitoring well with adequate recharge/recovery and not from a low recovery/yielding well. If the potential for limited volume at low recovery wells exist, it may be necessary to collect duplicates on a per analyte basis per well (*i.e.*, the total metals duplicate may come from one monitoring well while the anions field duplicate may come

from another monitoring well). The parent and field duplicate samples will be placed in identical containers and preserved in the same manner. Identification of field duplicate samples is discussed in **Section 2.7**. The well locations where field duplicates are collected will be documented in the field logbook and/or on the Field Groundwater Sampling Data Form (or similar) found in **Appendix C**.

2.6.2 Matrix Spike and Matrix Spike Duplicate Samples

Groundwater samples for the MS/MSD will be collected at a frequency of 5% (1 every 20 samples) for each sampling event and will be collected in triplicate with the three samples identified as the parent sample, the MS sample, and the MSD sample. At a minimum, one MS/MSD will be obtained for every sampling event (total of one [1] MS/MSD sample per sampling event). The parent and MS/MSD samples will be placed in identical containers and preserved in the same manner. Identification of MS/MSD samples is discussed in Section 2.7. Due to the larger sample volume needed, MS/MSDs will typically be collected from a monitoring well with adequate recharge/recovery and not from a low recovery/yielding well. If insufficient volume is present in a monitoring well for sampling, it may be necessary to collect the MS/MSD samples from another monitoring well. If the potential for limited volume at low recovery wells exist, it may be necessary to collect the MS/MSD on a per analyte basis per well (*i.e.*, the total metals MS and/or MSD may come from one monitoring well while the anions MS and/or MSD may come from another monitoring well). Well locations where MS/MSDs are collected will be documented in the field logbook and/or on the Field Groundwater Sampling Data Form (or similar) found in Appendix C.

2.7 Sample Documentation

Each sample or field measurement must be properly documented to facilitate timely, correct, and complete analyses and support actions concerning the Site. The documentation system provides a means to identify, track, and monitor each individual sample from the point of collection through final reporting of the data. Specific documentation requirements for chain-of-custody forms, sample labels, and custody seals are provided in **Section 2.13**. After sample documentation has been completed and before the samples are prepared for shipping, the groundwater sampling technician (or a field team member if applicable) will cross check the data on the chain-of-custody forms and labels and compare the data to the field logbook and field data sheet entries.

Requirements for sample packaging and shipping are provided in Section 2.14.

Samples will be identified with a unique sample number to be used on sample labels, chains-of-custody, field logbooks, and other applicable documentation. As described below, the sample numbering system will be comprised of the sample point (well name) and QA/QC designator, if appropriate.

The samples will be identified as follows:

• **Groundwater Samples** – well name (sample point) will be identified as AD-06 for Monitoring Well AD-06.

A QA/QC designator will be used for QA/QC samples. For MS/MSD, and field duplicate samples, the following suffixes will be used:

Abbreviation	QA/QC Sample Type
MS/MSD	Matrix Spike/Matrix Spike Duplicate
DUP – #	Field Duplicate

For example, a groundwater sample collected from Monitoring Well AD-06 will be labeled as AD-06. If a field duplicate is collected from this location, then this sample will be labeled with a unique sample identification number to be blind to the analytical laboratory (*i.e.*, DUP-1, DUP-2, etc.). If a MS/MSD is collected from this location, these samples will be identified as AD-06/MS and AD-06/MSD. Well locations where field duplicates and MS/MSDs are collected will be documented in the field logbook and/or on the Field Groundwater Sampling Data Form (or similar) found in **Appendix C**.

One temperature blank (if required by the lab) will be placed in each sample cooler prior to overnight shipment to the laboratory facility. The temperature blank will be labeled "TEMP BLANK".

2.8 Analysis of Groundwater Samples

Groundwater samples will be analyzed and statistically evaluated for each sampling event in accordance with the CCR Final Rule. All groundwater samples collected will be analyzed by a NELAP and TLAP certified commercial laboratory. Groundwater samples will not be field filtered prior to analysis. Upon initiating detection monitoring by obtaining a minimum of eight independent samples from each background and downgradient well to establish background/baseline (Section 2.5.1), semi-quarterly groundwater samples will be analyzed for both detection and assessment monitoring parameters listed in Appendix III and Appendix IV of the CCR Final Rule. Table 2 includes a summary of the semi quarterly groundwater sampling frequency for initiating the detection monitoring program. Tables 3 and 4 include an analyte summary along with analytical methods, specific holding times, preservatives, and sample container requirements for detection and assessment monitoring, respectively.

The last ninth semi quarterly groundwater sample (Section 2.5.1) under initiation of the detection monitoring program will be analyzed for detection monitoring parameters only listed in Appendix III of

the CCR Final Rule (**Table 3**) and serve as the first compliance point to perform statistical analysis in accordance with 40 CFR §257.94(e).

Following collection of the ninth semi quarterly groundwater sample under initiation of the detection monitoring program (Section 2.5.1), the statistical analysis of the groundwater results in accordance with 40 CFR §257.93(h) and the selected statistical method for evaluating groundwater certification for the Site will determine whether each subsequent semiannual sampling event will be under the detection monitoring program (40 CFR §257.94) or assessment monitoring program (40 CFR §257.95). If there is no statistically significant increase (SSI) over background levels for one or more of the constituents listed in Appendix III of the CCR Rule for detection monitoring (Table 3) at any downgradient monitoring well at the waste boundary then subsequent semiannual sampling will reaming under detection monitoring for all constituents listed in Appendix III of the CCR Rule (Table 3). However, if an SSI is detected for one or more Appendix III constituents then assessment monitoring is required in accordance with 40 CFR §257.95.

The practical quantitation limit for each analyte will be either at or below:

- 1. The Maximum Contaminant Level (MCL), for constituents for which an MCL has been as defined in 30 TAC §290.
- 2. The groundwater protection standards (GWPS) established in the CCR Rule for assessment monitoring parameters cobalt, lead, lithium, and molybdenum (40 CFR §257.95(h)(2)).
- 3. The statistically derived natural background concentration established from the established background monitoring wells in accordance with 40 CFR §257.91, for constituents for which an MCL or has not been established. In such cases, statistical analysis will be performed in accordance with 40 CFR §257.93(h) to determine if a (SSI) has occurred.
- 4. The background concentration established from wells in accordance with 40 CFR §257.91, for constituents for which the background level is higher than the MCL.

2.9 Monitoring Well Re-Development

Monitoring well re-development will be performed on existing monitoring wells in which more than 10% of the effective screen is occluded, or records indicate an increase in turbidity and/or reduction in well yield. Re-development will be performed to remove fine-grained material from the well and the filter pack near the screen and will be accomplished by surging and pumping the monitoring wells using a submersible pump, surge block, and/or weighted bailer. The screen will be surged from the bottom to the top by gently raising and lowering the pump surge block, and/or weighted bailer over a one- to two-foot

interval, then lowering the object and repeating this procedure. A pump will then be placed near the bottom of the screen and groundwater pumped to remove the displaced fines. This process will be repeated until the development parameters are met. Sediment and volume of water removed will be monitored and recorded on a regular basis until development is complete.

The pH, conductivity, temperature, and turbidity of the water will be recorded before beginning development. The initial static water level and total well depth of the monitoring well will be measured and recorded, and the volume of standing water in the borehole calculated. These water quality parameters will be reevaluated as development continues. Development of the monitoring well will be considered complete when all of the following requirements are met:

- Field measurements of pH, specific conductivity, and temperature have stabilized such that three consecutive measurements taken not less than one saturated well volume apart are within 10% of each other for the temperature and specific conductivity, and within 0.1 standard units for pH.
- Field measurements of turbidity are less than 5 Nephelometric Turbidity Units (NTUs) or $\pm 10\%$ for values greater than 5 NTUs (USEPA, 2010).

Development of monitoring wells will be recorded on the Well Development Form (or similar) found in **Appendix C**.

2.10 Monitoring Well Abandonment

In the event that a monitoring well is no longer being used or needed as part of the groundwater monitoring system, or is damaged, it will be properly abandoned and plugged. Monitoring well abandonment activities will be conducted by a Texas-certified driller and work will be required to be performed in accordance with all 16 TAC §76.72. No monitoring well abandonments shall be conducted without prior approval by the TCEQ IHWP Section. Well abandonment and plugging will be reported by the driller to the TDLR via the Plugging Report Form within thirty (30) days, a copy of which is provided in **Appendix C**. An account of monitoring well repairs will be maintained by OIP and placed in the operational record.

Abandoned monitoring wells will be inspected prior to plugging operations to ensure there are no obstructions that may interfere with plugging operations. All pumps, sampling equipment, debris, or other material (if any) in the well shall be removed. Measurements of the total well depth and depth to groundwater will be measured prior to plugging and photographs taken to document the current state of the well.

The protective well casing, concrete pad, and bollards (if present) will be removed, at a minimum to subsurface depth. The borehole shall be plugged with sealing-material by grout-pipe method or by pressure injection from the bottom of the boring to within three feet of the top of the borehole. The borehole may be plugged using the gravitational displacement (or free flow method) to a maximum depth of 50 feet with bentonite (minimum particle size 3/8-inch and used to manufacturer's specifications). The top two feet of the borehole shall be filled with materials consistent with the surrounding ground surface. If the riser pipe and screen cannot be removed, then approval for a variance to plug the well in place will be obtained from TCEQ IHWP Section prior to continuing the well abandonment by the driller submitting a TDLR Well Plugging Form, a copy of which is included in **Appendix C**. Certain situations may require over-drilling of the riser and screen pipe for removal, this will be determined on a case-by-case basis.

2.11 Decontamination of Groundwater Sampling Equipment

All non-disposable and non-dedicated tools which contact the sample will be decontaminated prior to the collection of each sample. Decontamination solutions will be kept in labeled, plastic, spray bottles. Disposable nitrile or latex gloves will be worn during all decontamination procedures and changed in between well locations. As dedicated sampling devices will be used at this Site, the water level meter and the field measurement meters are the only pieces of equipment that will require decontamination.

The water level meter will be decontaminated according to the following procedure:

- 1. Rinse the tape and probe of the water level indicator with a detergent solution. The solution shall consist of 1 tablespoon of non-phosphate detergent (laboratory grade) per gallon of water.
- 2. Remove any mud/dirt with a paper towel.
- 3. Triple rinse the tape and probe with distilled water.
- 4. Upon completion of sampling, allow the tape and probe of the water level indicator to air dry.
- 5. Store the equipment covered with plastic between events.

The flow-through cell probe portions of the field measurement meters for pH, conductivity, oxidation-reduction potential, dissolved oxygen, and temperature will be decontaminated by triple rinsing with distilled water.

2.12 Disposition of Excess Sample Volume and Decontamination Water

Excess liquid volume from monitoring well sampling that includes non-contaminated purged groundwater and decontamination fluids can be discharged to non-CCR ponds (evaporation ponds). All other general waste generated, including all disposable PPE, rope, bailers, paper towels, empty water bottles, etc., will be placed in trash bags. The trash bags will be placed in an appropriate solid waste receptacle.

2.13 Sample Custody and Documentation Procedures

Each sample or field measurement must be properly documented to facilitate timely, correct, and complete analyses and support actions concerning the Site. The documentation system provides a means to identify, track, and monitor each individual sample from the point of collection through final reporting of the data. Specific documentation requirements are described in the following sections.

2.13.1 Documentation Procedures

A suitable work area will be established with sufficient space available for processing forms and packaging samples. After all sample documentation has been completed and before the samples are prepared for shipping, the groundwater sampling technician (or a field team member if applicable) will cross check the data on all forms and labels and compare the data to the logbook and field data sheet entries.

The following procedure is given as a general reference for completing the sample documentation:

- 1. Determine the samples to be packaged and shipped that day and the laboratory to be used.
- 2. Complete a shipping bill (if applicable) and enter the shipping record number in the field logbook.
- 3. Complete a chain of custody record.
- 4. Prepare samples for shipment.
- 5. Complete all necessary field forms.

2.13.2 Field Logbook Record

Information pertinent to the groundwater sampling events will be recorded either in a bound logbook with consecutively numbered pages or on appropriate forms. All entries in logbooks will be made in indelible ink, and corrections will consist of line out deletions that are initialed and dated. The person responsible for the entries will sign and date each page (or entry) after entering it in the logbook. Blank spaces will be crossed through with single diagonal line and initialed by the person recording the data.

No general rules can specify the exact information that must be entered in a logbook for a particular site. However, the logbook will contain sufficient information so that sampling activities can be reconstructed, if necessary. Logbooks will be kept in a field team member's possession or a secure place during the investigation. Following the sampling event, logbooks will become part of the project file. Copies of the logbook will be included in representative groundwater sampling or corrective action reports.

A list of typical field logbook entries is as follows:

- Date
- Weather conditions
- Names of field members
- Names of observers
- Calibration record of field test equipment
- Monitoring well number
- Well inspection information including condition of the well pad, casing, well identification protective casing, well lock, and reference mark
- Water level and total well depth measurements with measurement technique
- Well purge equipment and technique
- Purge volume and time
- Initial and subsequent field measurements for each well volume of groundwater removed
- Identification number of sample
- Time of collection
- Sample withdrawal procedure/equipment
- Types and number of sample containers
- Parameters requested for analyses
- Preservatives used
- Sample description (color, odor, etc.)
- Field observations on sampling event
- Sample shipment information, name of carrier, air bill number, shipment date and time
- Any deviations from the SAP

A blank Field Groundwater Sampling Log, as found in **Appendix C** (or similar), may be used to record the details associated with the sampling event. Use of sampling forms should be noted in the field logbook at the beginning of each field day.

2.13.3 Chain of Custody Record

The chain of custody record will be employed as physical evidence of sample custody. The sampler will complete a chain of custody record to accompany each sample shipment from the field to the laboratory. The custody record will be completed using waterproof ink. Corrections will be made by drawing a line through, initialing, and dating the error and entering the correct information. Erasures will not be permissible. The following typical information is to be included in the chain of custody record:

- Sample identification numbers
- Signatures of samplers
- Date and time of collection
- Sample type
- Identification of monitoring well
- Number and type of containers
- Parameters requested for analysis
- Signatures of persons involved in the chain of possession
- Inclusive dates and times of possession
- Notations regarding compromise of sample integrity, such as broken seals, bottles, etc.
- Notation regarding the presence or absence of ice when the cooler is opened at the laboratory.

After completing a chain of custody record using the above procedure, the original signature (top) copy of the record will be sealed in a plastic bag (with any other sample documentation) and secured to the inside lid of the cooler. Laboratory personnel will sign the chain of custody and a copy will be included in the analytical data package. An example of a typical chain of custody is provided in **Appendix C**.

2.13.4 Sample Labels

Each sample removed from the Site and transferred to a laboratory for analysis will be identified with a sample label containing specific information regarding the sample. Each completed sample identification label will be securely fastened to the sample container. All sample labels will be completed in indelible ink and the well identification may be marked on the sample container lid. As an alternative, the sample labels may be covered in clear plastic tape. An example sample label is provided in **Appendix C**.

2.13.5 Custody Seals

Custody seals will be used to preserve the integrity of the sample from the time the cooler is packed until it is opened in the laboratory. Seals must be attached so that it is necessary to break the seals to open the cooler. Samples for the Site will be shipped in coolers. Each cooler will usually be sealed on two opposite sides with custody seals. As long as custody records are sealed inside the sample cooler and custody seals remain intact, commercial carriers are not required to sign the custody form. An example custody seal is provided in **Appendix C**.

2.13.6 Electronic Field Records

When available, electronic field records may be used to document field procedures provided the types of information presented above are captured and the final record is as, or more, secure than hard copy

records. Electronic field records may include, but are not limited to, spreadsheets, electronic pdfs, and proprietary tools developed to support project needs.

2.14 Sample Container Handling, Packaging, and Shipping

Sample packaging and shipping procedures are based on USEPA specifications, as well as United States Department of Transportation regulations (49 CFR Parts 172 and 173). Samples will be packed and shipped according to the requirements for low hazard level samples. All samples will be packaged and transported within one day of collection.

During field activities, loose samples will be handled in the same manner as packed samples. The samples, after being obtained and labeled, will be wrapped with protective packing material or stored in foam/bubble envelopes. At all times, ice in double sealable plastic bags will be kept in the cooler to reduce the temperature of the samples as quickly as possible. Ice will be replenished as needed. The steps outlined below will be followed to pack samples (unless laboratory has recommended packing specifications):

- 1. Arrange sample containers in groups by sample number.
- 2. Arrange containers in front of the assigned coolers.
- Pack the containers in the foam/bubble envelopes provided with the jars or wrap each glass sample container with protective packing material. Tape the packing material to the containers and secure in place.
- 4. Place approximately 2 inches of packing material in the bottom of the cooler for cushioning. Place a plastic bag inside the cooler on top of the packing material.
- 5. Place sample containers inside the plastic bag in the cooler.
- 6. Seal the plastic bag with tape.
- 7. Fill the remaining cooler space with ice packaged in double sealed plastic gallon bags.
- 8. Separate copies of forms. Seal paper copies in a large, sealable, plastic bag and tape to the inside lid of the cooler.
- 9. Close the lid of the cooler. Tape the cooler drain shut if applicable. Tape the cooler shut on both ends, making several revolutions with the strapping tape. Do not cover labels.
- 10. Place the shipping bill with the contracted laboratory's address on top of the cooler.
- 11. Affix custody seals over lid openings (front right and back left corners of cooler). Cover seals with clear, plastic tape.
- 12. Record the time the cooler is relinquished to an overnight delivery service in the field logbook.
- 13. Maintain a file of all sample documentation.

3.0 QUALITY ASSURANCE/QUALITY CONTROL

Data collected during groundwater monitoring activities will be used to evaluate the groundwater quality surrounding the inactive CCR Units. To satisfy this use, analytical data should meet the requirements outlined in USEPA's *Test Methods for Evaluating Solid Waste* (SW-846, 1993-2015) or equivalent analytical procedures. To provide the proper level of confidence, it is critical that only valid data are used. To this end, field and laboratory QA/QC procedures have been established.

To assess whether QA objectives for this project have been achieved, the following data quality indicators (DQIs) will be considered: precision, accuracy, representativeness, comparability, and completeness. To monitor the quality of field sampling techniques and potential sample transport anomalies, OC samples (including, field duplicate and MS/MSD samples) will be submitted with the samples collected for chemical analysis. QC samples will be collected at a rate of 10% (1 for every 10 samples collected) for field duplicates, and 5% (1 for every 20 samples collected) for MS/MSDs. The combined laboratory and field QC procedures will provide an adequate data set for evaluation of analytical data. Discussion of laboratory QC samples (blanks, surrogates, and laboratory control samples/laboratory control sample duplicates [LCS/LCSD]) and procedures are presented in the Laboratory QA Manual in **Appendix D**. Data will be evaluated for achievement of any method-specific QA/QC criteria. Data qualifiers, when appropriate, will generally be added to the data based on guidelines in USEPA's Contract Laboratory Program National Functional Guidelines for Superfund Organic Methods Data Review (NFGO) (USEPA, 2020a) or Contract Laboratory Program National Functional Guidelines for Inorganic Superfund Methods Data Review (NFGI) (USEPA, 2020b), as appropriate. Discussion regarding the DQIs, QC samples and control limits for each indicator, and potential corrective actions for any outliers are provided in the following sections.

3.1 Precision

Precision is the level of agreement among individual measurements of the same chemical or physical property. During the data validation process, precision is expressed in terms of relative percent difference (RPD). Chemical concentration data obtained from the analysis of field duplicate, laboratory duplicate, MSD, and/or LCSD samples will be compared to evaluate analytical precision. The RPD is calculated using the following equation:

$$RPD = |(D_1-D_2)/[(D_1+D_2)/2]| \times 100$$

Where:

RPD = Relative Percent Difference

 D_1 = First Duplicate Value

 D_2 = Second Duplicate

Perfect precision would be indicated by an RPD of 0%. In general, RPD values less than 20% for water indicate adequate precision for a given analysis. Most laboratories establish QC limits at the approximate 99% confidence interval using historical data sets. For samples having low chemical concentrations (less than five times the requested RL), a sensitivity test is conducted. If the difference in duplicate sample analytical results is less than one times the RL for water the sensitivity test is passed, and analytical data for samples having low chemical concentrations are considered acceptable.

3.1.1 Laboratory Control Sample/Laboratory Control Sample Duplicate

Certain USEPA methods require the analysis of an LCS in each analytical batch, up to a maximum of 20 samples. For the LCS, an interference-free matrix is spiked with known concentrations of target constituents and analyzed. In addition, while not required by the methodology, some laboratories analyze an LCSD. The intent is to measure analytical accuracy and precision of the method in the absence of sample matrix effects. When provided, the results of the LCS/LCSD will be utilized to assess the precision of the preparation and analysis methods. The maximum RPD between the LCS and LCSD is typically 20% for aqueous samples. However, USEPA methodology allows for statistical evaluation of the control limits on a parameter-specific basis.

Any RPD outside of control limits for the LCS/LCSD requires evaluation by the lab. At a minimum, calculations should be checked for errors and corrected when necessary. If no calculation errors occurred, instrument performance should be verified. If an instrument problem is found, it should be corrected, and the samples reanalyzed. If no instrument problem is found, then the magnitude of the result from control limits should be evaluated. Significant deviance from control limits (*i.e.*, RPDs that exceed control limits by more than 25%) may necessitate reanalysis; however, if the corresponding RPD for the MS/MSD sample is within control limits, such reanalysis is not necessary. In some instances, the corrective action will involve flagging the data during data validation (see **Section 4.0**).

3.1.2 Matrix Spike/Matrix Spike Duplicate

MS and MSD analytical results will be utilized to assess the accuracy and precision of the laboratory analytical results in the presence of any potential sample matrix interference. Field staff will collect triplicate samples and designate the samples as field, MS, and MSD samples. The project goal is to collect

a minimum of 5% MS and MSD samples during the sampling event. The laboratory will spike the MS and MSD samples with known concentrations of target analytes prior to analysis. As a measure of precision, results of the MS and MSD are compared to each other to evaluate the RPD. Laboratory methodology generally requires the analysis of a MS/MSD pair in each analytical batch, up to a maximum of 20 samples. The maximum RPD between the MS and MSD is typically 20% for aqueous samples; however, USEPA methodology allows for statistical evaluation of the control limits on a parameter-specific basis.

Any RPD outside of control limits for the MS/MSD requires evaluation by the lab. At a minimum, calculations should be checked for errors and corrected when necessary. If no calculation errors occurred, instrument performance should be verified. If an instrument problem is found, it should be corrected, and the samples reanalyzed. If no instrument problem is found, then the magnitude of the result from control limits should be evaluated. Significant deviance from control limits (*i.e.*, RPDs that exceed control limits by more than 25%) may necessitate reanalysis; however, if the corresponding RPD for the LCS/LCSD sample is within control limits, such reanalysis is not necessary, and the exceedance may be attributable to sample non-homogeneity and/or matrix interference. In some instances, the corrective action will involve flagging the data during data validation (see **Section 4.0**).

3.1.3 Field Duplicate Samples

Field duplicate sample results will indicate the precision and reproducibility of sample collection and analytical results. A field duplicate sample is obtained from a single or composite sample that is split into two similar portions to produce two samples. The project goal is to collect a minimum of 10% duplicate samples during the sampling event. The field duplicate samples will be collected in the same manner and analyzed for the same parameters as field samples from the same location. For purposes of review, the maximum allowable RPD for field duplicate samples is set at 20% for aqueous samples. Results less than five times the RL will be compared using a sensitivity test as described in **Section 3.1**.

It should be noted that field duplicate samples are expected to have greater variability than lab duplicates. Any RPD outside of control limits for the field duplicate requires evaluation. The sample collection method should be verified to evaluate likely sources of sample non-homogeneity. Additionally, the RPD calculations should be checked for errors and corrected when necessary. If no calculation errors occurred, then the laboratory should be contacted and requested to verify their results. Additionally, any information the laboratory can give regarding apparent homogeneity of the sample within the sample container should be obtained. If analytical holding times have not been exceeded and sufficient sample volume remains, it may be beneficial to have the lab repeat the sample analysis in instances where the

field duplicate RPD is significantly outside of control limits (*i.e.*, RPDs that exceed control limits by more than 50%). If the corresponding RPD for the LCS/LCSD and/or MS/MSD samples are within control limits, the field duplicate failure may be attributable to sample non-homogeneity. In some instances, the corrective action will involve flagging the data during data validation (see **Section 4.0**) or rejection of the results for the original and duplicate sample.

3.2 Accuracy

Accuracy measures the bias of a measurement system and may be defined as the degree of agreement between a measurement and its accepted or true value. The accuracy of chemical results is assessed by examining the results of spike recovery and blank samples.

3.2.1 Blank Samples

Blank (laboratory) results are used to evaluate whether laboratory handling may have contaminated samples and adversely impacted analytical accuracy. The results of these analyses allow an evaluation of whether detections may represent chemicals introduced into the samples during handling, sample shipment, or analytical preparation and analysis.

Blanks are expected to have no detections of target constituents. Any blank detection that exceeds the constituent's RL requires corrective action to assess the apparent source of contamination and/or reanalysis of the blank to confirm the detection. Detections between the method detection limit (MDL) and RL do not require corrective action. Results in field samples that are less than five times the corresponding contaminated blank value are generally considered false positives and flagged accordingly during data validation (see **Section 4.0**). Instances of gross contamination (*i.e.*, blank detections exceed applicable screening levels) may require reanalysis and/or resampling if the corresponding field samples have similar detections.

Method Blanks

USEPA methodology generally requires the analysis of a method blank sample in each analytical batch, up to 20 samples. For the method blank, a clean matrix is prepared and analyzed in the same manner as the field samples. Any detection in the method blank indicates potential laboratory contamination of the associated field samples in the analytical batch.

3.2.2 Spike Recovery Studies

Spike recovery studies (surrogates, LCS/LCSD, and MS/MSD) results are used to evaluate the ability of the laboratory to recover constituents that are intentionally spiked into the samples. Accuracy of spiked samples is expressed as the percent recovery (REC). The REC is calculated using the following equation.

$$REC = \frac{-(SSR - SR)}{SA}$$

Where:

REC = Recovery

SSR = Spiked Sample Result

SR = Sample Result

SA = Spike Amount

Perfect accuracy is defined as 100 REC. In general, REC values from 70% to 130% indicate adequate accuracy for a given analysis. Most laboratories establish QC limits at the approximate 99% confidence interval using historical data sets. It should also be recognized that not all constituents are capable of recovering within this range. An elevated REC indicates high sensitivity or high bias in detecting a compound; therefore, non-detect results would be considered reliable. A low REC indicates a low sensitivity or low bias in detecting a compound, which leaves the possibility of false negative results.

Surrogates

Surrogates are added to each sample that undergoes organic analyses. Surrogates are compounds that are not normally found in environmental samples that are added (spiked) into field and QC samples and analyzed for REC. Surrogates are utilized to give an indication of the analytical accuracy of the preparation and analysis methods on a per sample basis. In general, REC values from 70% to 130% indicate adequate accuracy for a given analysis; however, USEPA methodology allows for statistical evaluation of the control limits on a parameter-specific basis.

Any surrogate REC outside of control limits requires evaluation by the laboratory. At a minimum, calculations should be checked for errors and corrected when necessary. If no calculation errors occurred, instrument performance should be verified. If an instrument problem is found, it should be corrected, and the samples reanalyzed. If no instrument problem is found, then the sample should be re-extracted and reanalyzed, as applicable, according to method requirements. If the REC is still outside of control limits upon reanalysis, the data should be considered estimated. In some instances, the corrective action will involve flagging the data during data validation (see **Section 4.0**).

LCS/LCSD

The LCS and LCSD will be prepared and analyzed as described in **Section 3.1.1**. As a measure of accuracy, the results of these two portions are compared against the known analyte concentrations in the spike to assess REC. The purpose of the LCS/LCSD is to evaluate the performance of the laboratory with respect to analyte recovery, independent of field sample matrix interference. In general, REC values from 70% to 130% for organic analyses indicate adequate accuracy for a given analysis; however, USEPA methodology allows for statistical evaluation of the control limits on a parameter-specific basis.

Any LCS or LCSD REC outside of control limits requires evaluation by the laboratory. At a minimum, calculations should be checked for errors and corrected when necessary. If no calculation errors occurred, instrument performance should be verified. If an instrument problem is found, it should be corrected, and the samples reanalyzed. If no instrument problem is found, then the corresponding REC for the MS/MSD should be examined. If the problem is limited to the LCS or LCSD and MS/MSD results are acceptable, then the problem is likely limited to only that sample and further corrective action would not be required. Depending upon the number and magnitude of compounds with LCS and/or LCSD REC failures, corrective action may include reanalysis of only the LCS and/or LCSD or re-extraction and reanalysis of samples within the batch. In some instances, the corrective action will involve flagging the data during data validation (see **Section 4.0**).

MS/MSD

MS/MSDs will be collected, prepared, and analyzed as described in **Section 3.1.2**. As a measure of accuracy, the results of the MS and MSD are compared against the known analyte concentrations to assess REC. The purpose of the MS/MSD is to evaluate analytical performance in the presence of any sample matrix interference. In general, REC values from 70% to 130% for organic analyses indicate adequate accuracy for a given analysis; however, USEPA methods allow for statistical evaluation of the control limits on a parameter-specific basis.

Any MS or MSD REC outside of control limits requires evaluation by the lab. At a minimum, the data should be compared to the corresponding LCS/LCSD. If the problem is limited to the MS/MSD, the problem is likely attributable to sample matrix interference that is largely outside of the control of the lab. Additionally, calculations should be checked for errors and corrected when necessary. If no calculation errors occurred, instrument performance should be verified. If an instrument problem is found, it should be corrected, and the samples reanalyzed. Depending upon the number and magnitude of compounds with MS and/or MSD REC failures, corrective action may include reanalysis of the MS and/or MSD or reextraction and reanalysis of samples within the batch. In some instances, the corrective action will involve flagging the data during data validation (see **Section 4.0**)

3.3 Representativeness

Representativeness expresses the degree to which sample data accurately and precisely represents a characteristic of a population, parameter variations at a sampling point, or an environmental condition. The representativeness of the data will be evaluated by:

• Qualitative comparison of actual sampling procedures to those presented in the SAP.

- Quantitative comparison of analytical results for field duplicates and/or field splits to assess parameter variation at a sampling point.
- Invalidating nonrepresentative data or identifying data to be classified as questionable through qualitative or quantitative data validation procedures.

Nonrepresentative or questionable data are data that do not accurately reflect site conditions. If data are assessed to be nonrepresentative, they will not be used in subsequent data reduction, validation, and site characterization. If a critical data point or parameter is assessed to be nonrepresentative, the need for additional data collection will be carefully assessed by the OIP Project Manager in conjunction with TCEQ IHWP Section Project Managers.

3.4 Completeness

Completeness defines the percentage of measurements judged to be valid measurements. Completeness is assessed for both field and laboratory activities.

Laboratory Completeness

Laboratory completeness is assessed by comparing the number of valid sample results to the total number of sample results, as follows:

% Laboratory Completeness = Number of valid results
Total number of results x 100

The laboratory completeness goal for this project is 95%. If laboratory completeness falls below 95% for a critical parameter, the need for additional data collection will be carefully assessed by the OIP's Project Manager in conjunction with TCEQ IHWP Section Project Manager.

3.5 Comparability

Comparability is a qualitative parameter used to express the confidence with which one data set may be compared to another. To produce comparable data, the units specified for analytical results obtained during the sampling activities will be consistent throughout this project, sampling event data collected following the sampling procedures outlined in this SAP, and standardized analytical methods will be utilized for each parameter using the same analytical method.

3.6 Laboratory QA/QC

The laboratory will provide analytical and QC results in Level II Data package to contain the following:

Narrative

- Sample Results (including RLs)
- Batch-specific QC results (including method blanks, laboratory control/matrix spikes, and/or laboratory duplicates at a minimum)
- QC Sample Associations
- Chain-of-Custody

Any QA/QC requirements listed above that are more stringent than the laboratory's normal QA/QC procedures should be applied by the laboratory to the groundwater data to be collected. A copy of the laboratory QA Manual will be maintained in the project files.

3.7 Field QA/QC

Field QA/QC procedures were previously discussed in the sampling procedures and DQI sections. In summary, field QA/QC procedures include the following activities:

- Maintaining field logs and field notebooks
- Calibrating field instruments
- Taking multiple readings of field measurements
- Collecting material for QC samples (e.g., MS/MSD, field duplicate) at the minimum
- Preparing and handling QC sample material in the same manner as field samples
- Cross check data on all sample labels and field forms and compare the data to the logbooks, field data sheet entries, and chain-of-custody

3.8 Instrument/Equipment Testing, Inspection, and Maintenance

The use of field instrumentation during groundwater sampling activities and their maintenance, calibration, inspection, and testing will be performed according to manufacturer's specifications using known standards supplied by the manufacturer or other reputable vendor.

A maintenance, calibration, and operation program will be implemented for routine calibration and maintenance on field instruments. The groundwater sampling team members will administer the program. Trained staff members will perform field calibrations, equipment checks, and instrument maintenance prior to using equipment. Each piece of equipment will have a unique serial number for tracking during field use and calibration for maintenance records.

Team members will be familiar with the field calibration, operation, and maintenance of the equipment. They will maintain proficiency in equipment operation, perform the prescribed field operating and calibration procedures outlined in the equipment manuals accompanying the respective instruments, and

keep records of field instrument calibrations and field checks in logbooks. If on-site monitoring equipment should fail, the OIP Project Manager will be contacted as soon as practicable. The OIP Project Manager will either provide replacement equipment or have the malfunction repaired as soon as practicable.

The analytical laboratory shall perform equipment calibration and preventative maintenance as outlined in their QA Manual (**Appendix D**) and/or required by analytical methodology. The laboratory is expected to have sufficient spare parts and/or back-up equipment or such items readily available from an external vendor so to minimize analytical down time.

3.9 Instrument/Equipment Calibration and Frequency

Field sampling equipment will be calibrated according to manufacturer's specifications using known standards supplied by the manufacturer or other reputable vendor. The instruments will be calibrated at the beginning of each day, and calibration checks will be performed any time readings appear abnormal. If calibration checks are not satisfactory based upon the instrument manufacturers' recommendations, then recalibration will be performed. Each piece of equipment will have a unique serial number for tracking during field use, calibration, and maintenance records. Field calibrations will be documented in the field logbook. Instruments will not be used if calibration criteria are not met.

Laboratory instrumentation calibration, frequency, and records information is outlined in the laboratory QA Manual (**Appendix D**) and/or required by analytical methodology.

3.10 Inspection/Acceptance of Supplies and Consumables

The laboratory will supply containers for the chemical analytical samples. Sample containers will be delivered to the facility field office. The OIP Project Manager or groundwater sampling team members will verify that sampling materials and containers are consistent with specifications, which are outlined in **Tables 6** and **7**.

3.11 Data Management

The OIP Project Manager, OIP's contracted laboratory Project Manager, and OIP's groundwater reporting contractor's Project Manager have the overall responsibility for data management. These data management activities include record-keeping, tracking, document control systems, and data handling to process, compile, analyze, and transmit data. Day-to-day oversight of sampling activities, laboratory activities, and data tracking and receipt will be the responsibility of the OIP Project Manager or a designated project team member.

General record keeping, data storage, and retrieval procedures are outlined in Sections 2.7, 2.13, and 3.11 of this SAP. Project team members are responsible for handling data in a manner consistent with procedures listed in Sections 2.13, 2.14, and 3.0 which includes information pertaining to field logbooks, photographs, sample numbering, sample documentation, laboratory assignments, documentation (cooler/shipping documentation and filing system), and corrections to documentation.

The following procedures will be used to verify that samples are collected for the required parameters:

- Daily coordination/communication between the groundwater sampling team members and OIP's
 Project Manager to verify sampling is being conducted as planned.
- Chain-of-custody forms checked daily for accuracy by the groundwater sampling team members,
 OIP Project Manager, or designee.
- Coordination/communication between the OIP Project Manager and OIP's contracted laboratory
 Project Manager if there are any discrepancies between samples received for analysis by the
 laboratory (sample check-in) versus what is listed on the chain-of-custody.
- Laboratory reports reviewed upon receipt by OIP's Project Manager and OIP's groundwater
 reporting contractor's Project Chemist or project team member to verify the correct sample
 numbers and parameters have been entered into the Laboratory Information Management System
 and that the sample names are correctly recorded.
- Day-to-day responsibility for handling the database and electronic deliverables/media falls to a
 project team member that is well versed in the applicable computer programs. Analytical data
 reduction, review, reporting, and storage requirements are outlined in the contract Laboratory QA
 Manual (see Appendix D). Checklists and standard forms are provided in the Laboratory QA
 Manual and/or standard operating procedures for laboratory activities.

The laboratory will provide formal analytical reports as well as electronic data deliverables (EDD) in the format requested by OIP. The EDD will be uploaded to OIP's database for long-term data management. Information pertaining to the analytical laboratory documentation, record keeping, and narratives is provided in the laboratory's QA Manual (**Appendix D**). The minimum data anticipated for the laboratory data package are the sample and QC results associated with the analysis.

4.0 DATA VALIDATION AND USABILITY

Data validation procedures determine whether individual project data are useable, useable with qualifications, or unusable. The following sections describe the data validation procedure.

4.1 Data Review, Validation, and Verification Requirements

Section 3.0 provided a discussion of the DQIs (precision, accuracy, representativeness, comparability, and completeness) that will be evaluated as part of the chemical data review. The quality of the laboratory results will be assessed through evaluation of the results of the submitted QA/QC samples (field/trip blanks, field duplicates, MS/MSDs, etc.) and laboratory internal QA/QC samples (blanks, surrogates, duplicates, LCSs, etc.). Data validation will include a review of any method-specific QA/QC criteria as outlined in Section 4.2. Data qualifiers, when appropriate, will generally be added to the data based on guidelines within USEPA's NFGO or NFGI and as outlined below. A summary is presented in the following paragraphs:

- Analytical Precision Precision will be evaluated by calculating the RPD for field duplicates
 and MS/MSD samples. RPD criteria outside of QC limits may result in qualification of data as
 estimated (J). Data will not be qualified solely based on RPD criteria not being met. Rather,
 outlying RPD data will be reviewed with other QC data to assess the overall impact to data
 quality.
- Analytical Accuracy Accuracy will be assessed by evaluating the results of spiked samples for REC and blank samples for potential contamination of samples. REC results for spike samples (surrogates, LCSs, and MSs) will be used to assign qualifiers to analytical data. A REC above QC limits suggests the possibility of high bias in the analytical results, and detections will be qualified as estimated (J or J+) when this occurs. A REC below QC limits suggests the possibility of low bias in the analytical results, and data will be qualified as estimated (J or J-) or unusable (R) based upon the magnitude of the deviance from QC limits.
- Representativeness Representativeness will be assessed by examining sample preservation, results of the precision and accuracy evaluation, and adherence to method holding time. Failure of field or laboratory personnel to properly handle samples may result in qualification of the data as estimated or unusable. The representativeness review will qualitatively consider whether precision and/or accuracy are sufficient to characterize the samples. Analytical data for samples that are not analyzed within holding times will be qualified as estimated (J or J-) or unusable (R) based upon the magnitude of the holding time exceedance.
- Completeness Completeness will be assessed by calculation of field completeness and

- laboratory completeness as presented in Section 3.4.
- Comparability Comparability will be assessed by evaluating whether samples were collected
 and analyzed in a consistent manner during the groundwater sampling activities as presented in
 Section 3.5.

4.2 Validation and Verification Methods

Data validation evaluates the quality of field and laboratory activities and documents the quality of data generated. The goals of data validation are to evaluate achievement of DQIs for the project, to verify achievement of project contractual requirements, to evaluate the impact of DQIs that were not met, and to document the results of data validation. The intent is to evaluate the data against project DQIs and planning documents to confirm that goals are met. Ideally, the result of validation is a technically sound, statistically valid, legally defensible, and properly documented data set for decision-making purposes. General information pertaining to verification and validation activities is provided in the Guidance on Environmental Data Verification and Data Validation, EPA QA/G-8 (USEPA, 2002).

Data validation requires knowledge of the type of information that is validated. Therefore, a person familiar with field activities, such as the Field Site Manager (FSM) or site geologist or engineer, is typically assigned to the validation of field activities, documents, and records. Likewise, a person familiar with analytical methodology, such as a chemist, is typically assigned to the validation of laboratory documents and records.

Data quality will be assessed through the evaluation of both field and laboratory QC data. Validation is initiated at the time of first sample collection. Field documents are reviewed by the OIP's FSM or a field team designee to evaluate that samples and analyses were appropriately collected, containerized, labeled, and submitted to the laboratory. These items will be verified daily during sampling activities.

Additionally, the OIP Project Manager, FSM, or a field team designee will be in communication with the laboratory during sample collection and analysis to verify condition of sample receipt, appropriate sample log-in, etc. If problems are noted at this point, they can easily be corrected or locations resampled, if needed, while the field crews are still mobilized. Following field activities, field logs and forms are peer-reviewed by the OIP FSM or field team designee to ensure accuracy and completeness.

Following analysis, the laboratory data submittal is verified by OIP's groundwater reporting contractor's Project Chemist for conformance with method, procedural, and contractual requirements. The contracted laboratory will be responsible for accurately performing the prescribed methods per USEPA protocols. This includes procedures, QC checks, corrective actions, and data storage. In general, chemical data is

validated by evaluation of the laboratory submittal against any requirements established in the analytical method and QA/QC procedures (Section 3.0). Following receipt of the analytical data packages, the validation of the analytical data will include a review of the following items:

- Chain of custody forms appropriately completed;
- Requested analyses performed;
- Analysis occurred within holding times;
- Blank results (method blank);
- Duplicate results (laboratory duplicates, MS/MSD, LCS/LCSD, and field duplicates);
- Spike recovery results (surrogate, LCS/LCSD, and MS/MSD);
- Achievement of target RLs; and
- Completeness (field completeness and laboratory completeness).

The validation will include a review of any method-specific criteria for the items listed. Data qualifiers, when appropriate, will be added to the data based on guidelines and recommendations in NFGO or NFGI. Results of the chemical validation will be provided in appendices to the groundwater sampling report.

However, data validation extends beyond method, procedural, and contractual compliance to evaluate the quality of the data set and the types of uncertainty introduced by a failure to meet requirements. It includes a determination, where possible, of the reasons for any failure to meet requirements, and an evaluation of the impact of the failure upon the overall data set. In this manner, the effect of any data rejection is presented in terms of its impacts on the overall uncertainty and usability of the data set.

Following verification and validation, the OIP's Project Manager or OIP's groundwater reporting contractor's (or other end-user of the data) working with the appropriate data validator will perform a global review of the findings to evaluate overall usability of the data set for its intended purpose. It is at this point that a final analysis of the data is made, taking into consideration the following:

- Sample collection Were problems encountered during sample collection that suggest samples were potentially compromised? If so, what is the impact?
- Suitability of methodology Based upon the chemical data validation, were significant precision or bias problems noted with the data? Were significant matrix interference problems noted?
- Adequacy of RLs Was excessive sample dilution required due to interference or presence of
 elevated concentrations of target or nontarget compounds? If so, does this adversely impact the

ability to draw conclusions regarding any undetected constituents?

- Reasonableness of QC limits Do the initially established control limits for DQIs still seem appropriate for the data set? If not, is the data exhibiting higher variability than assumed during project planning?
- Patterns in qualified data Are patterns evident in the type of samples or analyses that required qualification during validation? Do these patterns suggest overall problems in one area or for a particular type of analysis?

4.3 Reconciliation with User Requirements

After data has been validated, the OIP's groundwater reporting Project Manager will evaluate the results by considering the QC parameters of precision, accuracy, representativeness, comparability, and completeness as outlined in **Section 3.0**. If DQIs do not meet the requirements as outlined or problems are noted with sample collection, the data may be discarded, and re-sampling may occur. The OIP's Project Manager will make this decision after consultation with the other key project personnel. Limitations on data use will be summarized within the data validation summary(ies) included as appendices to the applicable report deliverables. In addition, data summary tables will include data qualifiers (*i.e.*, flags) to identify rejected data that was not be used for decision-making.

5.0 REPORTING

5.1 Laboratory Reports

The minimum data anticipated for the laboratory data package are the sample and QC summary results associated with the analysis (*i.e.*, Level 2 Report). The laboratory is expected to provide a data package that, at a minimum, includes the following information:

- Field sample name and associated laboratory number;
- Results for each target analyte with appropriate units;
- MDLs and RLs for each non-detect compound, as available;
- Results of QC sample analysis and associated control limits; and
- Association of QC samples with field samples.

The laboratory is expected to retain information regarding instrument calibration, tuning, raw data printouts, etc. in accordance with their internal record-keeping procedures.

5.2 Annual Groundwater Monitoring and Corrective Action Reporting

An annual groundwater and corrective action report will be prepared no later than January 31 of the year following the calendar year that groundwater monitoring has been completed for the inactive CCR Units.

For the preceding calendar year, the annual reports will document the status of the groundwater monitoring and corrective action program for the inactive CCR Units, summarize key actions completed, describe any problems encountered, discuss actions to resolve the problems, and identify key project activities for the upcoming year. At a minimum, the annual groundwater monitoring and corrective action report will contain the following information, to the extent available in accordance with 40 CFR §257.90(e):

- A section at the beginning of the annual report that provides an overview of the current status of groundwater monitoring and corrective action programs for the inactive CCR units. At a minimum, the summary must specify all of the following:
 - At the start of the current annual reporting period, whether the inactive CCR units were operating under the detection monitoring program in §257.94 or the assessment monitoring program in §257.95;
 - At the end of the current annual reporting period, whether the inactive CCR units were operating under the detection monitoring program in §257.94 or the assessment monitoring program in §257.95;

- o If it was determined that there was a statistically significant increase over background for one or more constituents listed in Appendix III of the CCR Final Rule pursuant to §257.94(e):
 - Identify those constituents listed in Appendix III of the CCR Final Rule and the names of the monitoring wells associated with such an increase; and
 - Provide the date when the assessment monitoring program was initiated for the inactive CCR units.
- o If it was determined that there was a statistically significant level above the GWPS for one or more constituents listed in Appendix IV of the CCR Final Rule pursuant to §257.95(g) include all of the following:
 - Identify those constituents listed in Appendix IV to this part and the names of the monitoring wells associated with such an increase;
 - Provide the date when the assessment of corrective measures was initiated for the inactive CCR units;
 - Provide the date when the public meeting was held for the assessment of corrective measures for the inactive CCR units; and
 - Provide the date when the assessment of corrective measures was completed for the inactive CCR units.
- Whether a remedy was selected pursuant to §257.97 during the current annual reporting period, and if so, the date of remedy selection; and
- Whether remedial activities were initiated or are ongoing pursuant to §257.98 during the current annual reporting period.
- A map, aerial image, or diagram showing the inactive CCR units and all background (or upgradient) and downgradient monitoring wells, to include the well identification numbers, that are part of the groundwater monitoring program for the inactive CCR units;
- Identification of any monitoring wells that were installed or decommissioned during the preceding year, along with a narrative description of why those actions were taken;
- In addition to all the monitoring data obtained under §257.90 through §257.98, a summary
 including the number of groundwater samples that were collected for analysis for each
 background and downgradient well, the dates the samples were collected, and whether the sample
 was required by the detection monitoring or assessment monitoring programs;
- A summary of groundwater elevations measured from monitoring wells, including a potentiometric map with groundwater flow direction for each sampling event;

- Include signed and sealed boring logs, geological cross-sections, groundwater potentiometric
 maps, and groundwater monitoring network maps by a licensed Professional Geologist (PG) in
 Texas;
- A narrative discussion of any transition between monitoring programs (e.g., the date and
 circumstances for transitioning from detection monitoring to assessment monitoring in addition to
 identifying the constituent(s) detected at a statistically significant increase over background
 levels); and
- Other information required to be included in the annual report as specified in §257.90 through §257.98.

5.3 Record Keeping, Notifications, and Public Reporting

In accordance with the CCR Final Rule requirements, these annual reports will be placed in the facility's operating record as required by 40 CFR §257.105(h), provide notification to the TCEQ as required by 40 CFR §257.106(h), and posted to OIP's publicly accessible Internet website in accordance with 40 CFR §257.107(h).

In addition to the annual groundwater monitoring and corrective action reports, additional records and certifications presented in 40 CFR 257.105(h) will be maintained by OIP in the operating record for compliance with the CCR Final Rule. While not all of these items will be posted by OIP to their publicly accessible Internet website, these additional record keeping requirements may include:

- Documentation of the design, installation and decommissioning of any monitoring wells, piezometers, and other measurements, sampling, and analytical devices.
- The groundwater monitoring system certification required by 40 CFR 257.91(f).
- The selection of a statistical method certification.
- The notification of the establishment of an assessment monitoring program, if required.
- The results of Appendix III and Appendix IV water quality standard constituents.
- The notification of returning to the detection monitoring program, if applicable.
- Notification of detecting one or more Appendix IV constituent at statistically significant levels above the GWPS.
- Notification of initiating corrective measures requirements, if applicable.
- The completed assessment of corrective measures, if applicable.
- Documentation recording the public meeting for the corrective measures assessment, if applicable.

- The semiannual report(s) describing progress in selecting and designing the remedy and the selection of remedy report, if applicable.
- Notification of completing the remedy, if applicable.
- Demonstration, including long-term performance data, supporting suspension of groundwater monitoring requirements in accordance with §257.90(g).
- Notification will be provided to TCEQ IHWP Section as required under §257.106(h), when applicable information is placed in the operating record and on the OIP's publicly accessible Internet website.

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- USEPA, 2015, Hazardous and Solid Waste Management System; Disposal of Coal Combustion Residuals from Electric Utilities; Final Rule, 40 CFR Parts 257 and 261, Federal Register, Vol. 80, No. 74, April 17, 2015, http://www.gpo.gov/fdsys/pkg/FR-2015-04-17/pdf/2015-00257.pdf.
- USEPA, 2020a, Contract Laboratory Program National Functional Guidelines for Superfund Organic Methods Data Review, EPA Contract Laboratory Program, November 2020.
- USEPA, 2020b, Contract Laboratory Program National Functional Guidelines for Inorganic Superfund

 Data Review, EPA Contract Laboratory Program, November 2020.

TABLES

Table 1 **Summary of Monitoring Well Construction**

Federal CCR Final Rule Program Groundwater Sampling & Analysis Plan Oklaunion Industrial Park, LLC - Oklaunion Power Station Wilbarger County, Texas

		Screen			Reference	Elevation*	Casing		Filter	Pack	Scre	eened	Bottom of
Well No.	Position	Formation		ation*	TOIC	GS	Length	Size / Type		erval		erval	Boring
_			Lat	Long	(feet, NAD27)	(feet, NAD27)	(feet, TOIC)	(ID / Material)	(feet, GS	6, NAD27)	(feet, GS	S, NAD27)	(feet, GS)
Program Monitoring Wells									Тор	Bottom	Тор	Bottom	-
AD-06 (232210)	U/B	0	34.080068	-99.177909	1218.485	1215.595	49.40	2 inch / PVC	1190.6	1167.6	1189.3	1169.0	48.0
AD-07 (232202)	U	0	34.080069	-99.174530	1217.913	1214.777	23.49	2 inch / PVC	1206.8	1194.3	1204.5	1194.3	20.0
AD-08 (232303)	U	0	34.091989	-99.163351	1247.671	1244.610	27.96	2 inch / PVC	1231.6	1219.6	1230.2	1219.9	25.0
AD-13 (232215)	D	В	34.073080	-99.172494	1214.172	1210.851	65.61	2 inch / PVC	1169.9	1145.9	1168.8	1148.5	65.0
AD-14 (232189)	D	0	34.072176	-99.176616	1212.671	1209.783	38.08	2 inch / PVC	1186.8	1174.4	1184.7	1174.4	35.0
AD-15 (232214)	D	0	34.071279	-99.180818	1212.641	1209.651	47.31	2 inch / PVC	1181.7	1165.3	1180.5	1165.3	44.0
AD-23 (653823)	D	0	34.074459	-99.181895	1210.863	1210.736	37.73	2 inch / PVC	1185.7	1172.9	1183.6	1173.6	37.8
AD-24 (653821)	D	0	34.073066	-99.172559	1211.014	1211.424	27.01	2 inch / PVC	1194.4	1184.0	1194.4	1184.4	27.4
Water Level Only Wells**													
AD-02 (232301)	U/C	0	34.089565	-99.186464	1236.40	1233.20	40.79	2 inch / PVC	1214.2	1193.2	1210.7	1195.4	40.0
AD-04 (232212)	U/C	O/B	34.083091	-99.184627	1213.39	1210.70	44.97	2 inch / PVC	1185.7	1166.7	1183.8	1168.5	44.0
AD-05 (232302)	U/C	0	34.082024	-99.182844	1207.35	1204.20	23.23	2 inch / PVC	1196.2	1184.2	1194.4	1184.1	20.0
AD-12 (232305)	С	O/B	34.074778	-99.169846	1215.09	1212.30	27.77	2 inch / PVC	1202.9	1190.9	1201.3	1191.1	25.0
AD-19 (232200)	С	0	34.078099	-99.192140	1218.86	1215.90	77.88	2 inch / PVC	1179.3	1137.2	1177.5	1137.2	75.0
AD-22 (232211)	U/C	0	34.085807	-99.192366	1218.03	1214.80	31.03	2 inch / PVC	1198.8	1186.8	1197.3	1187.1	28.0

^{*} Reference elevations of monitoring wells AD-06, AD-07, AD-08, AD-13, AD-14, AD-15, AD-23, and AD-24 surveyed by Eagle Surveying, LLC in Denton, Texas, Survey coordinates were based on the Texas State Plane, North Texas Zone, NAD27 datum. TOIC elevations for program wells represent top of well cap elevation.

ID = Internal Diameter

TOIC = Top of internal casing

GS = Ground Surface

U / B = Upgradient / Background

D = Downgradient

C = Crossgradient

O = Overburden

B = Bedrock

O/B = Overburden/Bedrock interface

^{**} Well information of water level only monitoring wells AD-02, AD-04, AD-05 AD-12, AD-19, and AD-22 as reported in Groundwater Monitoring System Installation Report (Terracon, 2011). PVC = Polyvinyl chloride

Table 2 Groundwater Sampling Collection Summary

Federal CCR Final Rule Program Groundwater Sampling & Analysis Plan Oklaunion Industrial Park, LLC - Oklaunion Power Station Wilbarger County, Texas

		Initiate Detection Mor	nitoring (1st year)	Post Year 1 Monitoring ⁵				
		8 Events	9th Event	Detection Monitoring Program	Assessment Monitoring Program			
		Semi-Quarterly Events	Final Semi-Quarterly Event	Semiannual (2 events)	Semiannual (2 events)			
		Laboratory Analysis ^{1,2,3}						
Monitoring Well	Well Type	Detection & Assessment Monitoring Parameters	Detection Monitoring Parameters	Detection Monitoring Parameters	Detection & Assessment Monitoring Parameters			
OKLAUNION PO	OKLAUNION POWER STATION							
AD-06	Upgradient	Х	X	X	Х			
AD-07	Upgradient	Χ	X	X	X			
AD-08	Upgradient	Χ	X	X	X			
AD-13	Downgradient	X	X	X	X			
AD-14	Downgradient	X	X	X	X			
AD-15	Downgradient	X	X	X	X			
AD-23	Downgradient	X	X	X	X			
AD-24	Downgradient	X	Χ	Χ	X			
	Subtotal	8	8	8	8			
Field	Duplicates (10%)4	1	1	1	1			
	MS (5%) ⁴	1	1	1	1			
	MSD (5%) ⁴	1	1	1	1			
Total Samples (per event)		11	11	11	11			

% = Percent MS = Matrix spike MSD = Matrix spike duplicate

na = not applicable

Notes:

- 1. See Tables 4 and 5 for list of constituents for laboratory analysis for Detection and Assessment Monitoring, respectively.
- 2. Field water quality parameters measured for each sampling event. See Table 3 for list of field parameters and stabilization criteria.
- 3. Groundwater samples not field filtered.
- ${\bf 4.\ Field\ duplicate\ and\ MS/MSD\ samples\ collected\ from\ monitoring\ well\ with\ sufficient\ yield/recharge.}$
- 5. Following collection of the final ninth semi-quarterly groundwater sample under initiation of the detection monitoring program (Section 2.5.1), the statistical analysis of the groundwater results in accordance with 40 CFR §257.93(h) and the selected statistical method for evaluating groundwater certification for the Site will determine whether each subsequent semiannual sampling event will be under the detection monitoring program (40 CFR §257.94) or assessment monitoring program (40 CFR §257.95).

Page 1 of 1 1/9/2024

Table 3 Groundwater Detection Monitoring Constituents

Federal CCR Final Rule Program Groundwater Sampling & Analysis Plan Oklaunion Industrial Park, LLC - Oklaunion Power Station Wilbarger County, Texas

Detection Monitoring Constituents*								
Constituent	Analytical Method (or equivalent)**	Sample Container**	Preservation	Holding Time				
Inorganics / Water Quality								
Boron*	SW-846 6020	250 mL, HDPE	Nitric Acid (HNO3) to pH <2	Analyzed - 6 months				
Calcium*	SW-846 6010B	250 mL, HDPE	Nitric Acid (HNO3) to pH <2	Analyzed - 6 months				
pH*	SM 4500 H-B	Field Reading	None required	Analyzed 15 minutes				
Total Dissolved Solids (TDS)*	SM 2540 C	1 L, HDPE or glass	None required, Cool to 6℃	Analyzed 7 days				
Chloride*	SW-846 9056	250 mL, HDPE or glass	None required, Cool to 6℃	Analyzed28 days				
Fluoride*	SW-846 9056	250 mL, HDPE or glass	None required	Analyzed28 days				
Sulfate*	SW-856 9056	250 mL, HDPE or glass	None required, Cool to 6℃	Analyzed28 days				

^{*}Per USEPA CCR Rule, Appendix III to 40 CFR Part 257.

°C = degrees Celsius HDPE = high density polyethylene HNO3 = nitric acid L = liter mL = milliliter

^{**}Noted analytical method(s) and sample container(s) are for typical method requirements. These may vary slightly by method updates and/or laboratory sample volume preferences.

Table 4 Groundwater Assessment Monitoring Constituents

Federal CCR Final Rule Program Groundwater Sampling & Analysis Plan Oklaunion Industrial Park, LLC - Oklaunion Power Station Wilbarger County, Texas

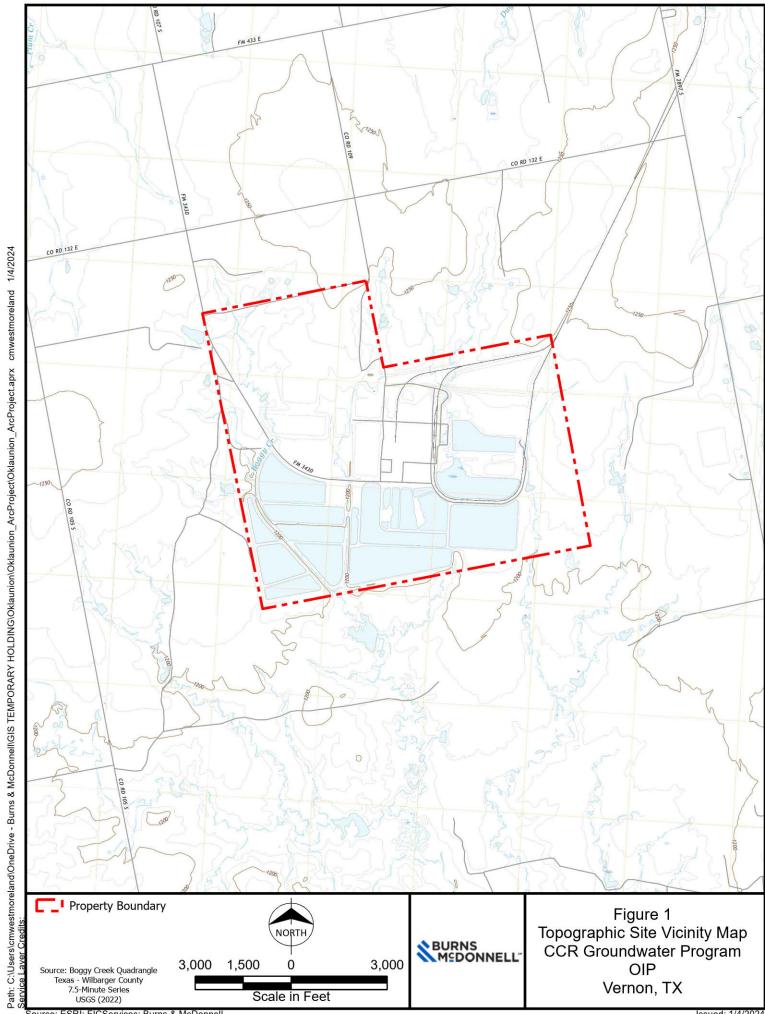
Assessment Monitoring Constituents*								
Constituent*	Analytical Method**	Sample Container**	Sample Preservation	Holding Time				
Metals, Total								
Antimony Arsenic Barium Beryllium Cadmium Chromium Cobalt Lead Lithium Molybdenum Selenium Thallium	SW-846 6020	500 mL, HDPE or glass	Nitric Acid (HNO₃) pH<2 Cool to 4 °C	Analyzed6 months				
Mercury	SW-846-6020 or EPA 245.1	250 mL, HDPE or glass	Nitric Acid (HNO₃) pH<2 Cool to 4℃	Analyzed28 days				
Radionuclides								
Radium 226 and 228 combined	EPA 903.0	1.0 L, HDPE or glass	Nitric Acid (HNO ₃) pH<2	Analyzed6 months				

^{**}Constituents included in USEPA CCR Rule, Appendix IV (Assessment Monitoring) to 40 CFR Part 257.

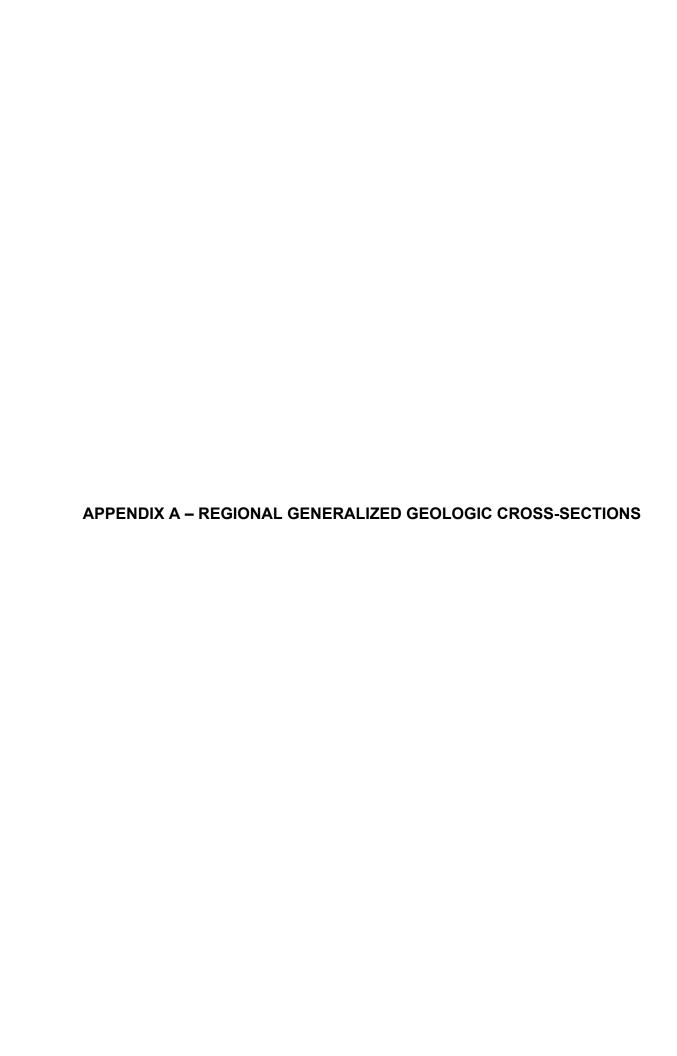
°C = degrees Celsius HDPE = high density polyethylene HNO3 = nitric acid L = liter mL = milliliter

^{**}Noted analytical method(s) and sample container(s) are for typical method requirements. These may vary slightly by method updates and/or laboratory sample volume preferences.

FIGURES



Source: ESRI; FICServices; Burns & McDonnell





TEXAS DEPARTMENT OF WATER RESOURCES

REPORT 240

OCCURRENCE, QUALITY, AND QUANTITY OF GROUND WATER IN WILBARGER COUNTY, TEXAS

Ву

Robert D. Price, Geologist Texas Department of Water Resources

TEXAS DEPARTMENT OF WATER RESOURCES

Harvey Davis, Executive Director

TEXAS WATER DEVELOPMENT BOARD

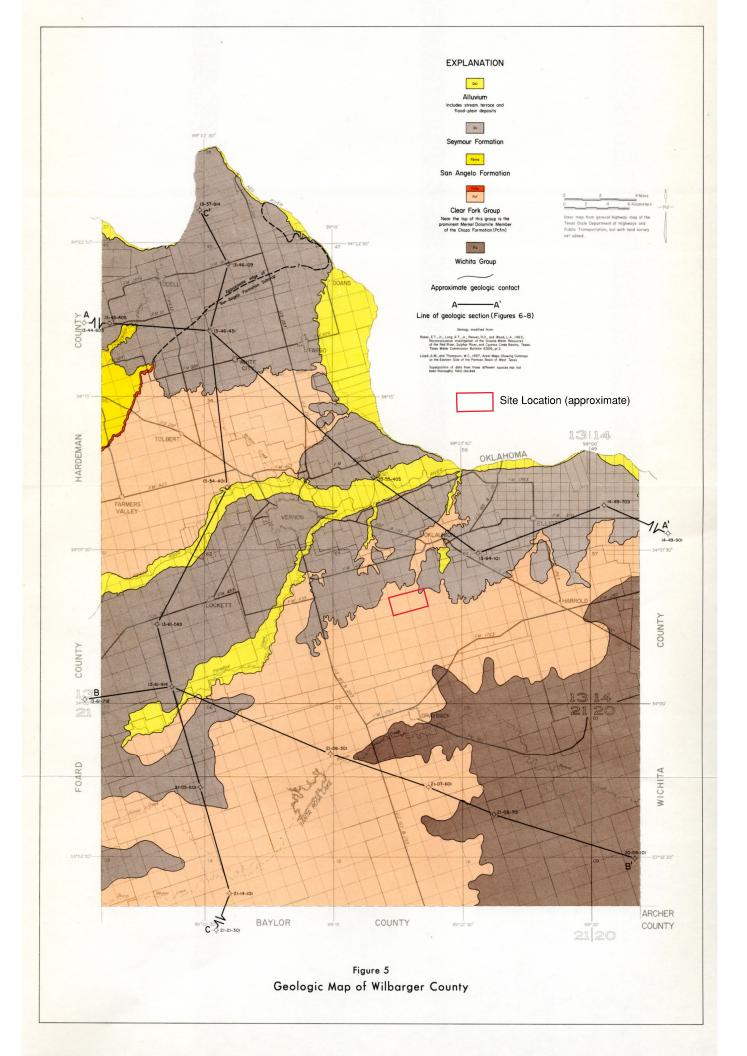
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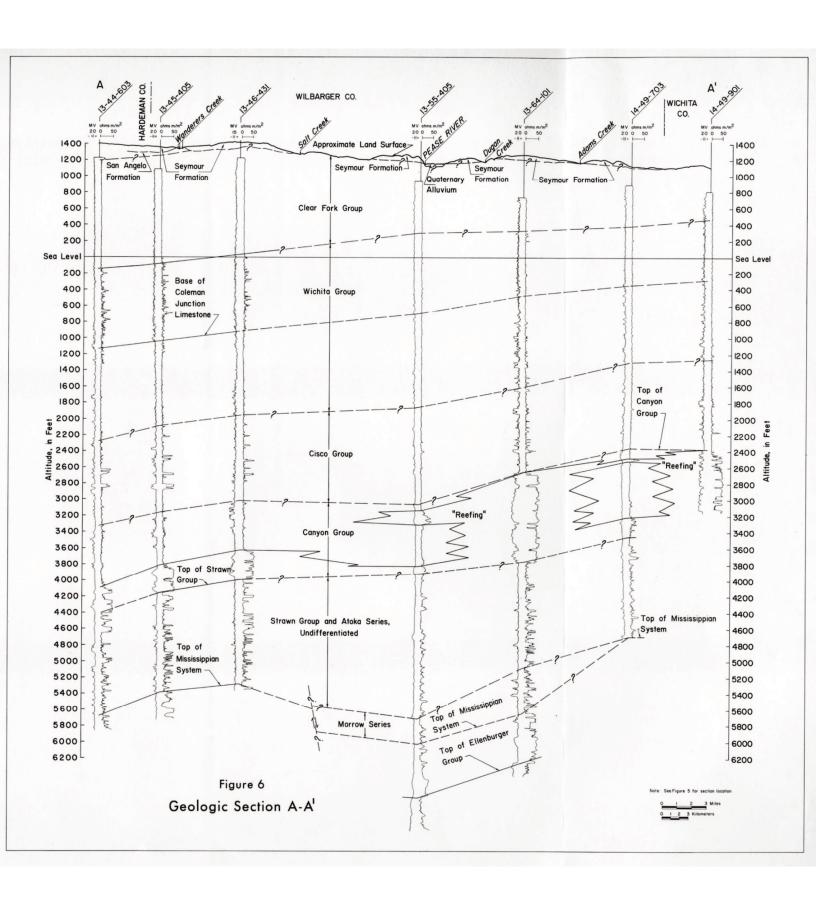
TEXAS WATER COMMISSION

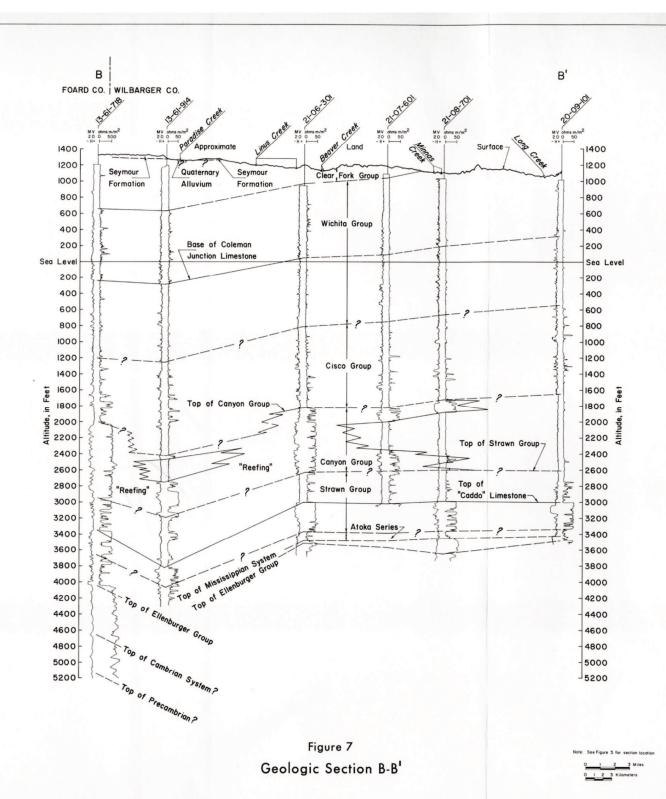
Felix McDonald, Chairman Dorsey B. Hardeman, Commissioner Joe R. Carroll, Commissioner

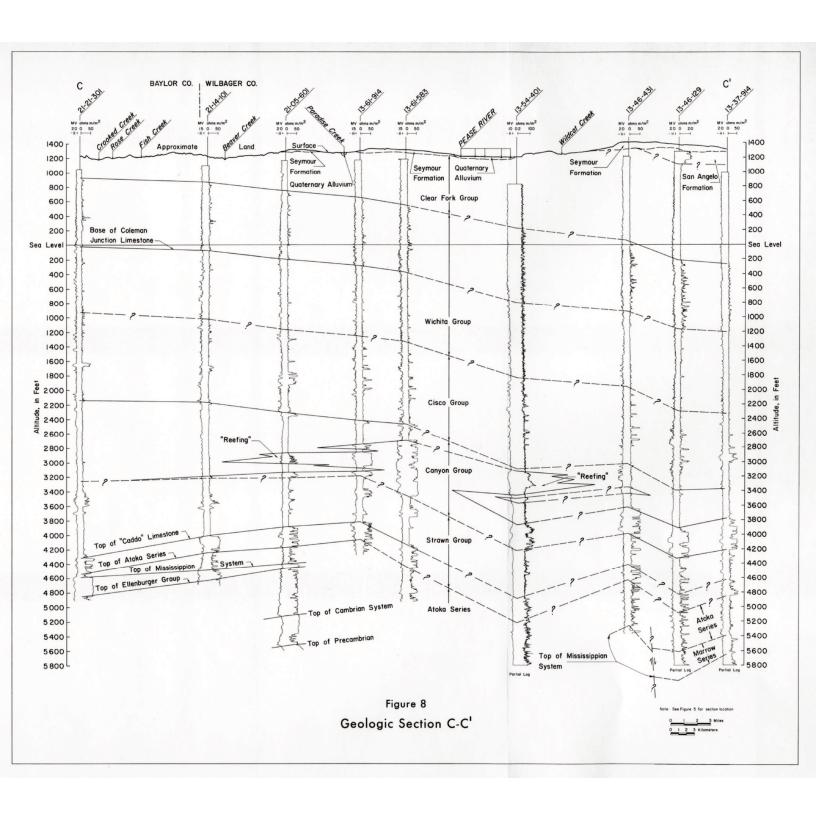
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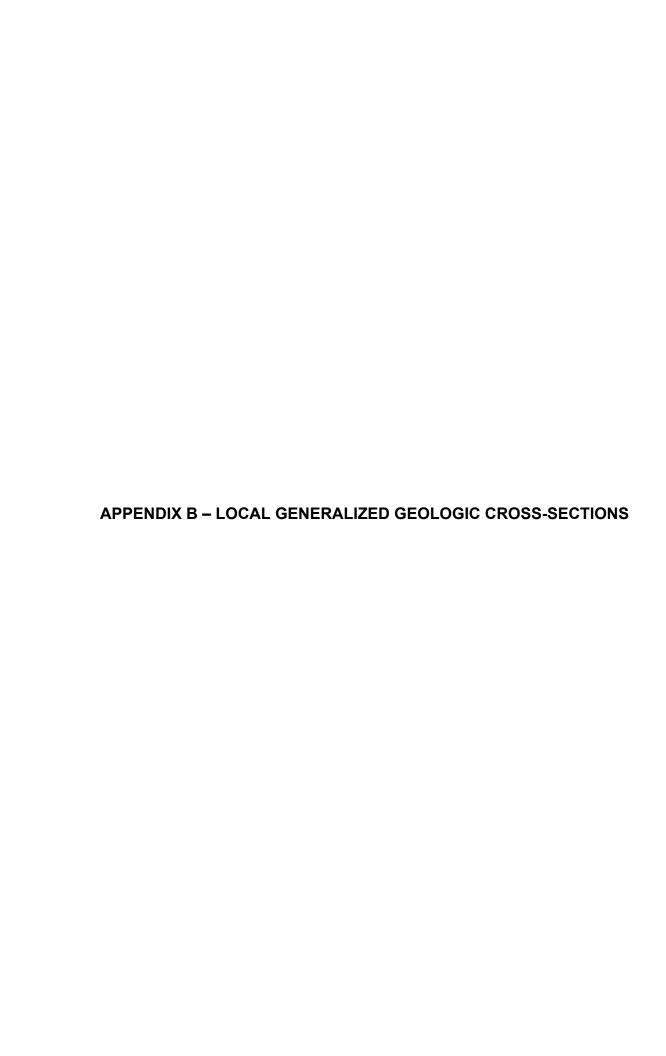
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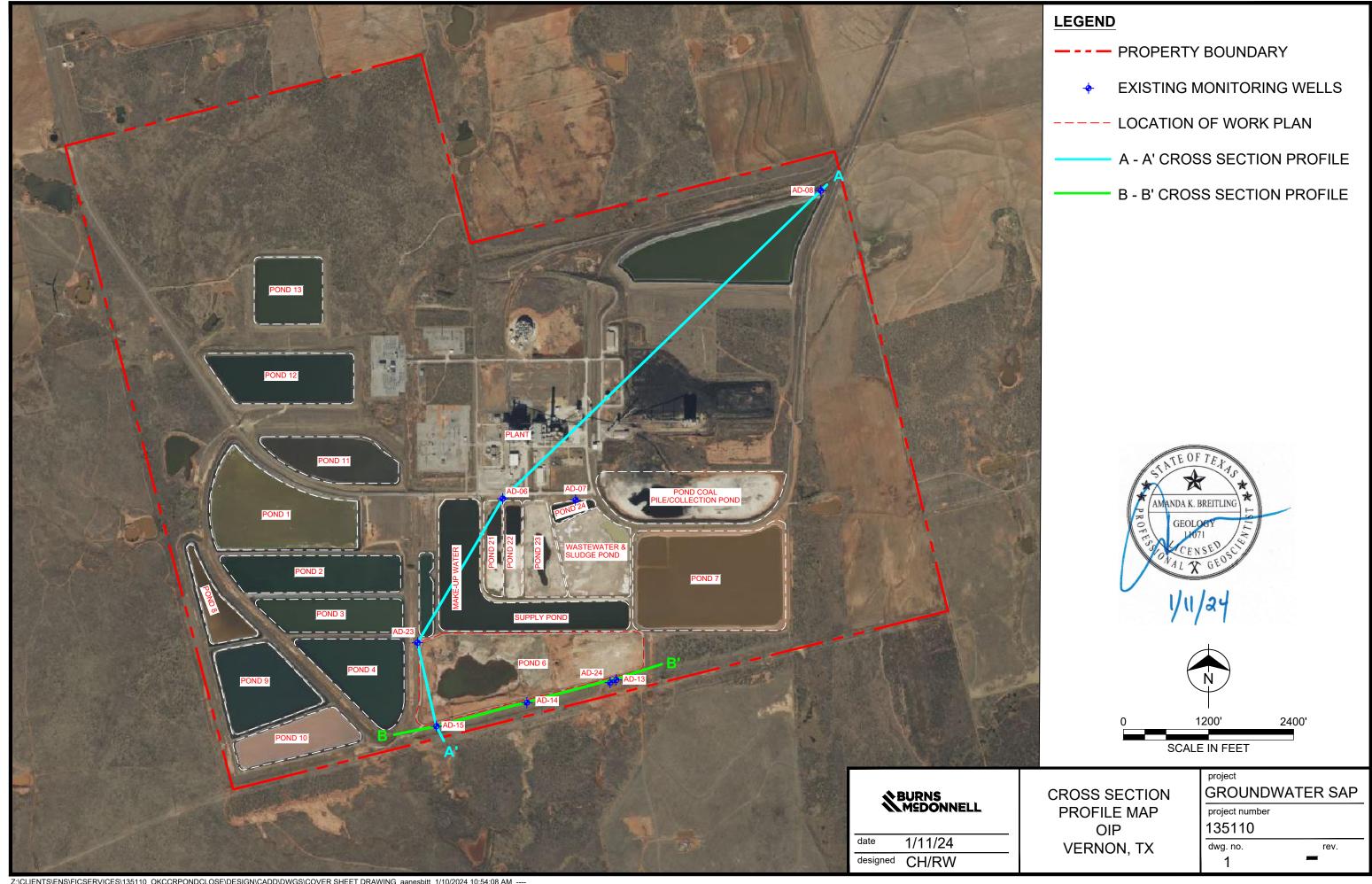


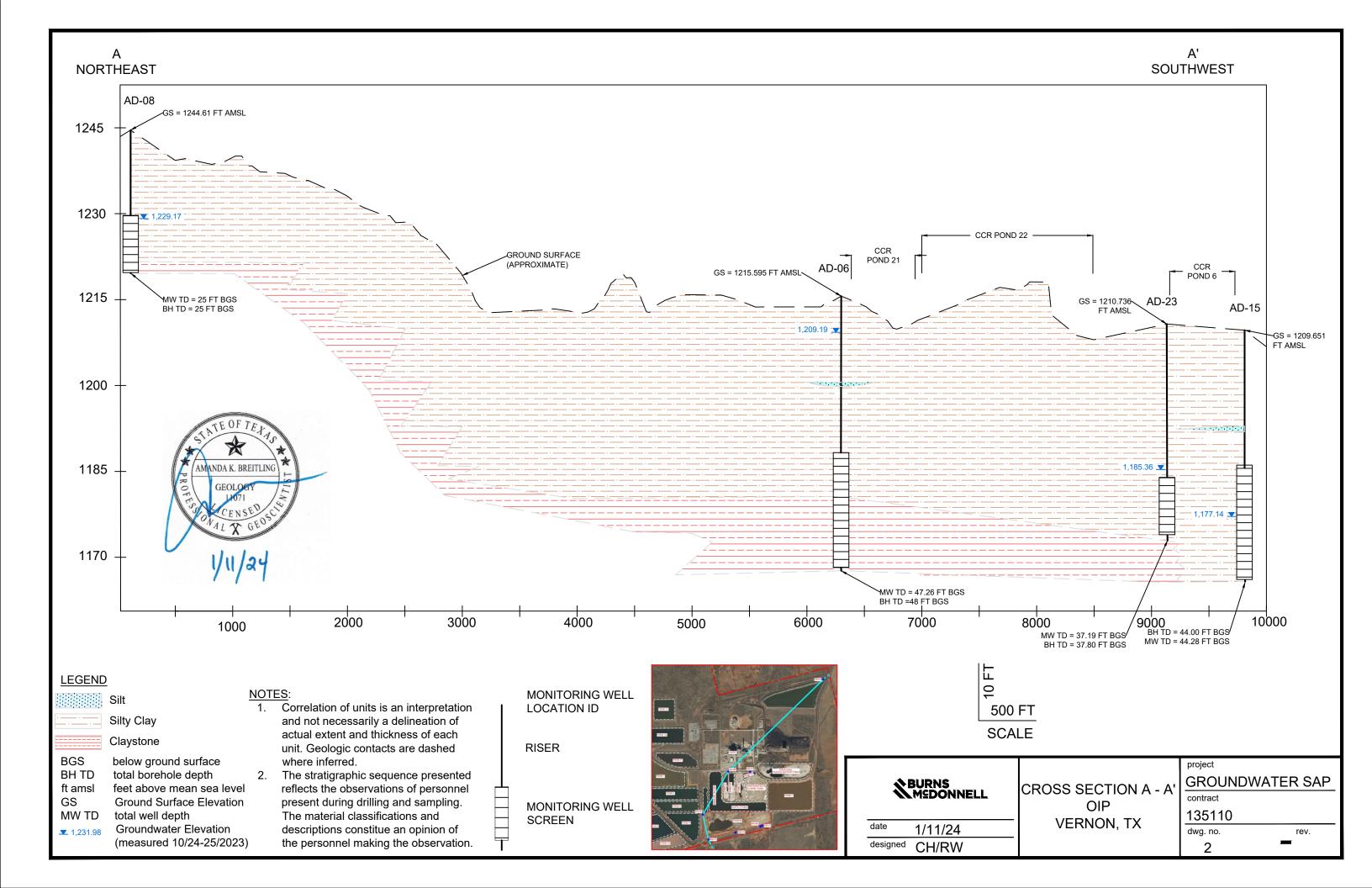


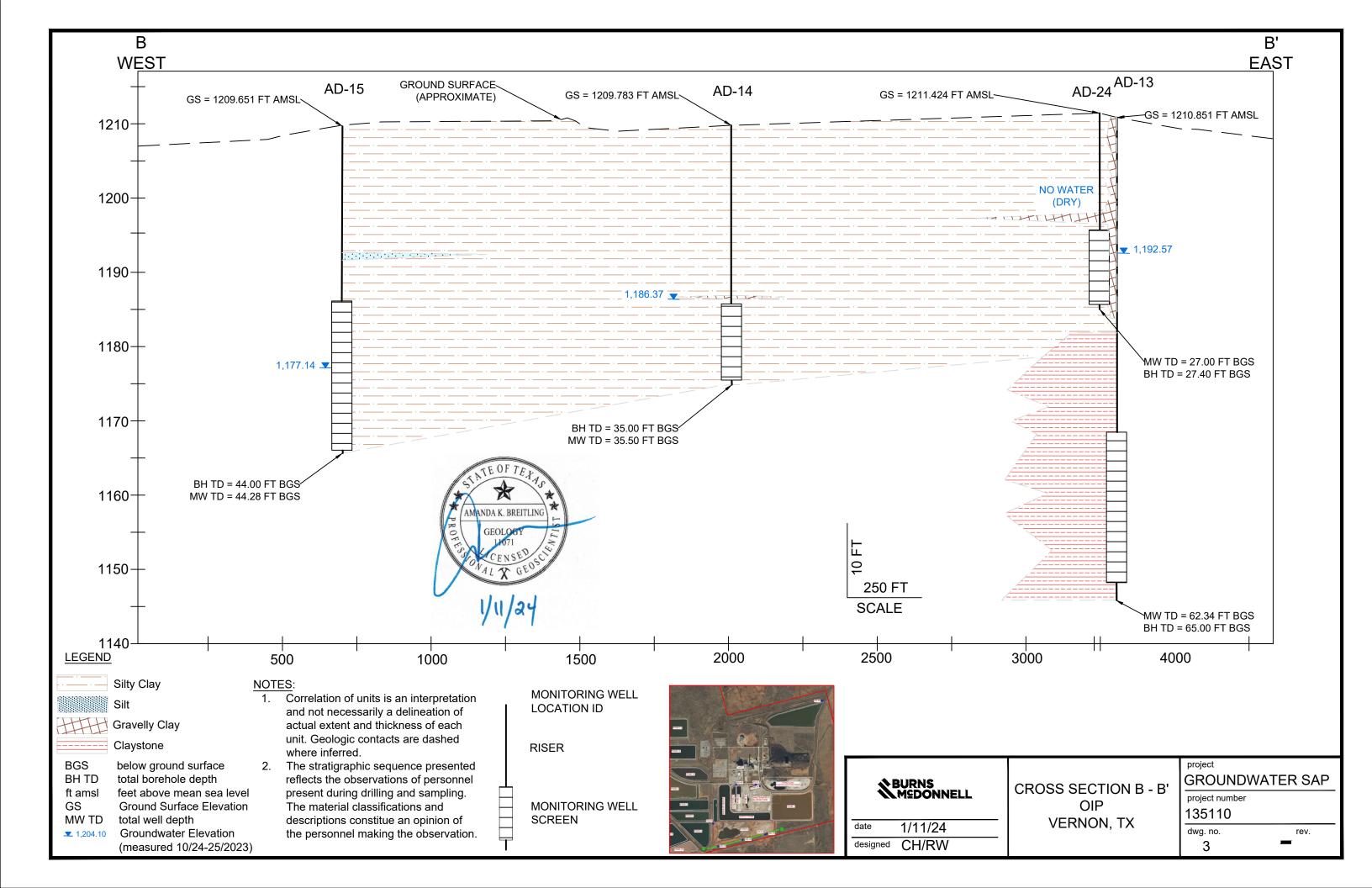














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	urge Rate (ml			-	Pump Ty				<u>-</u>
	Top of Screen:			-		Pump Top:			<u>-</u>
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				<u> </u>					-
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	Purged	Rate	İ	Temp	sc	Turbidity	ORP	DO	Water
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QA/QC Samp	oles								
QA/QC S		Q	A/QC Type	,	Γ		Comments		
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Fluid Level and Total Depth Measurements Form

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Project N					Site Name:	
Well Info	rmation:				Remarks:	
Location	N:		E:			
Ground S	urface Elev	ation (GS):				
Top of Ca	asing Elevat	ion (TOC):			1	
Date Wel	l Installed:				1	
Total Dep	th of Well:		feet from TOC			
	Top of Scre		feet from TOC			
Length of	Casing Scr	eened:	feet			
Date	Time	By Whom	Depth to Water*	Water Elevation	Total Depth*	Remarks
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 $^{^{\}star}\,$ Depth noted from Ground Surface (GS) or Top of Casing (TOC).

Fluid Level and Total Depth Measurements Form (continuation)

Project N	umber:				Well Number:	
Project Na	ame:				Site Name:	
Date	Time	By Whom	Depth to Water*	Water Elevation	Total Depth*	Remarks**
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^{*} Depth noted from Ground Surface (GS), Top of Pipe (TOP), or Reference Point (RP)

Burns & McDonnell		α	Request for Chemical Analysis and Chain of Custody Record	lysis and Chai	in of C	usto	dy Re	ecord			
Burns & McDonnell Engineering	Engineering	Laboratory:	tory:					Jocumen	Document Control No:	I No:	
9400 Ward Parkway Kansas City, Missouri 64114	i 64114	Address:	.;;					ab. Ref	rence N	Lab. Reference No. or Episode No.:	
Phone: (816) 333-94	Phone: (816) 333-9400 Fax: (816) 270-0575	City/State/Zip:	ate/Zip:								
Attention:		Telephone:	one:			:		•			
Project Number:					Sam	Sample Type	l g	ISAJEL			
Client Name:					2	Matrix)	W			
Sample Number	Location		Material Sampled	Sample Collection Date	'iA	əqiW	Bulk			Remarks (sq.ft, linearft, volume)	
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Sampler (signature):			Sampler (signature):			Speci	al Inst	Special Instructions:			
Relinquished By (signature):		Date/Time	Received By (signature):	Date/Time		lce Pr	esent	Ice Present in Container:	iner:	Temperature Upon Receipt:	
Relinquished By (signature):		Date/Time	Received By (signature):	Date/Time		Labor	atory	Laboratory Comments:	nts:		
۲.										032703 Form WCD-KC-105	135

Burns & McDonnell WCD 9400 Ward Parkway Kansas City, MO 64114 Phone: (816) 333-9400	ANALYSIS
Sample Group:	
Sample Designator:	
Sample Round:	
Sample Depth From:	To:
Date Sampled:	
Time Sampled:	
Preservation:	
090705 Form WCD-97N	

Attention Owner:

Confidentiality Privilege Notice on reverse side of owner's copy.

Texas Department of Licensing and Regulation Water Well Driller/Pump Installer Section P.O. Box 12157 Austin, Texas 78711 Toll free (800)803-9202 (512)334-5540

Email address: water.well@tdlr.texas.gov Web address: www.tdlr.texas.gov

This form must be completed and filed with the department and owner within 60 days upon completion of the well.

WELL REPORT

1) OWNED			Α.	WELL	IDENTI	FICATIO)N Al	ND LOC	CATION	DATA				
1) OWNER			4.11				Lav				la		Lev	
Name:			Address:				City:				State:		Zip:	
2) WELL LO	CATION													
County:			Physical A	Address:			City:				State:		Zip:	
						1						1		
3) Type of W	ork		Lat.			Long.			GPS	Datum		Elevat	ion	
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Completed		/	` ′			`				ation [] Othe			•	Č
Number of ide	entical wells d	rilled								1.4		** 1	10. 11.	. *** 11
at this location		inica						8) Bor	ehole Co	mpletion	[] Oper	n Hole	Straight	t Wall
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								9) Cas	ing, Blan	k Pipe, and	Well Sc	reen Da	ıta <u> </u>	
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From (ft)	To (ft)	From (f		To (ft)		or Material	used			ompletion			Priller? θ	
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Other Depth to pump b	owls cylinder	iet etc.	ft.					13) Pa	ackers:				•	
	, -,,	<u></u>						Type		Depth		Type		Depth
16) Water To														
Type test: [] I														
Yield: g 17) Water Q	pm with uality	II. draw	down after		hrs.			-						
epth of Strata:	W	as a chem	ical analysi	s made? []Yes []	No. Did yo	u know	ingly pene	etrate a strat	a which contain	ns injurious	constitue	nts?[]Yes	[] No
f yes, Type of w										F 3				
Check One: [] N			oundwater –	type		[] Hydr	ocarboi	ıs (i.e. gas,	, oil, etc.)	[] Hazardous	material/w	aste conta	mination en	countered
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andowner was i												countere	a ana ine	
18) Company					0. p.1.880.	a the street d		<u></u>	rota injing	, or position		Lic. No.	:	
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By signing this we	ell report, you	certify th	at you drill	ed or supe	rvised the	drilling of t	his wel	l and that	each and a	ll of the staten	nents herei	in are tru	and corre	ct.
ignature:							Nau	ne:_						
License	d Driller/Pump I	nstaller			Date					nsed Assistant ()		į		
DLR FORM 001	WWD / 05-17			TDLR (O	riginal)	OVER	Lando	wner (copy	y)	Driller/Pu	ımp Install	er (copy)		

<u>Addi</u>	itional information or comments:	

WELL REPORT CONFIDENTIALITY NOTICE

TEX. OCC. CODE Title 12, Chapter 1901.251, authorizes the owner (owner or the person for whom the well was drilled) to request that information in Well Reports be made confidential. The Department shall hold the contents of the well report confidential and not a matter of public record if it receives, by certified mail, a written request to do so from the owner or the person for whom the well was drilled.

From (ft)	To (ft)	Description and color of formation material



TEXAS DEPARTMENT OF LICENSING & REGULATION

P.O. Box 12157 • Austin, Texas 78711 • (512) 334-5540 water.well@tdlr.texas.gov • www.tdlr.texas.gov

				REPORT				
1.*Owner Name:	A. WEI	L IDEN	<u>TIFICATIO</u>	N AND LOC	ATIO	N DATA		
i. Owner name.								
Mailing Address:								
2.*Well Location:								
County:	Physical Address	S:		City:			State:	Zip Code:
3. Owner Well #:	4. *Lat:			5. Long:			Tracking	g #:
6. *Type of Well: W	ater Monito	or In	jection	De-watering	C	Other:		
Driller, Pump Installer the well using a Globa								
and Longitude Coordi	~ •	,	,	iei mapping	m cosii	e unu provinc	ine uccu	Tute Lumane
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O Data Dvilladi		0 Diame	ter of Hole:			40 Tatal danta	-£II.	
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		C. CU	RRENT PL	UGGING D	ATA		_	
11. *Date well plugged:						REMOVE ALL F se click a button besi	_	BLE CASING od of plugging used.
13. *Name of Licensee or	Well Owner perfo	orming the	plugging:		Tr	emie pipe ceme	nt from b	ottom to top.
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I certify that I plugged this correct. I understand that resubmitted.	well (or the well w	as plugge	d under my s	upervision) and	d that al	I of the stateme	nts herein for compl	are true and etion and
*Company or Individual	l's Name (type o	r print):						
*Street Address, City, Sta	te, Zip Code:							
Licensee or Land	owner	D	ate	Apprenti	ice or Ur	ilicensed Assistan	t	Date

Well Development Form

Project N							Well Nun	nber:		
Project N	lame:						Site Nam	ie:		
Well Info	rmation:						Developr	ment Metho	od	
Location	N:			E:			Equipmer	nt:		
Ground S	urface Elev	ation (GS):					1			
Top of Ca	asing Elevat	ion (TOC):]			
Date Wel	l Installed:						Method D	escription:		
	th of Well:			feet from						
Depth to	Top of Scre	en:		feet from	TOC					
	Casing Scr			feet						
Observat	tions Durin	g Developn	nent							
		Depth to	Total	Fluid R	emoved	Temp.	pН	sc	Turbidity	Fluid Appearance and Remarks
Date	Time	Water* (ft)	Depth* (ft)	Gallons	Total	(°C)	(units)	(mS/cm)	(NTUs)	(color, odor, particulates, etc.)

^{*}from TOC unles otherwise noted in Remarks

Well Development Form (continuation)

Project N	lumber:						Well Nun	nber:		
Project N Project N	lame:						Site Nam	e:		
Observat	tions Durin	g Developn	nent				3.00			
0.000.144		Depth to	Total	Fluid Re	emoved	Temp.	рН	SC	Turbidity	Fluid Appearance and Remarks
Date	Time	Water* (ft)	Depth* (ft)	Gallons	Total	(°C)	(units)	(mS/cm)	(NTUs)	(color, odor, particulates, etc.)
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^{*}from TOC unles otherwise noted in Remarks

APPENDIX D - LABORATORY QUALITY ASSURANCE MANUAL (To be provided by the lab)



CREATE AMAZING.

Burns & McDonnell World Headquarters 9400 Ward Parkway Kansas City, MO 64114 O 816-333-9400 F 816-333-3690 www.burnsmcd.com





January 22, 2024

Mr. Jeff Wind Oklaunion Industrial Park, LLC 500 Seneca Street, Suite 504 Buffalo, NY 14204

Re: Groundwater Monitoring System Certification for Oklaunion Industrial Park, LLC Oklaunion Power Station CCR Surface Impoundments in Vernon, TX

Dear Mr. Wind:

On behalf of Oklaunion Industrial Park, LLC (OIP), Burns & McDonnell Engineering Company, Inc. (Burns & McDonnell) is hereby submitting certification that the multi-unit groundwater monitoring system at the inactive coal combustion residuals (CCR) surface impoundments located at the Oklaunion Power Station (Site) in Vernon, Texas has been designed and constructed to meet the requirements of 30 TAC §352.911, which adopts by reference section 40 CFR §257.91- Groundwater Monitoring Systems, which is contained in the U.S. Environmental Protection Agency's (EPA's) Hazardous and Solid Waste Management System; Disposal of Coal Combustion Residuals from Electric Utilities; Final Rule (Final Rule, 40 CFR Parts 257 and 261). The Site's five (5) inactive CCR ponds (Ponds 6, 21, 22, 23, & the Wastewater and Sludge Pond [WWSP]) meet the definition of a Surface Impoundment as presented in the Final Rule and is therefore subject to groundwater monitoring requirements identified in 40 CFR §257.91. This certification is intended to fulfill the requirements presented in 40 CFR §257.91(f) and 30 TAC §352.911.

In October 2023, OIP completed installing additional monitoring wells to support the development of a multi-unit groundwater monitoring system in accordance with the *Groundwater Monitoring Network Installation Work Plan* (Work Plan) prepared by Burns & McDonnell and submitted to the Texas Commission on Environmental Quality (TCEQ) Industrial and Hazardous Waste Permits Section – CCR Program on behalf of OIP in May 2023. The TCEQ issued a letter approving the Work Plan and proposed well installations on July 27, 2023. The resulting groundwater monitoring system is compliant with the requirements presented in 40 CFR §257.91(c)(1), requiring a minimum one (1) upgradient and three downgradient monitoring wells. The established OIP multi-unit groundwater monitoring system includes three upgradient and five downgradient monitoring wells as illustrated in Figure 1. A summary of the existing groundwater monitoring system is presented below. Well construction details/diagrams and a figure providing the location of groundwater monitoring wells will be included in the OIP's operating record.

Historical Direction of Groundwater Flow

The direction of groundwater flow beneath the inactive surface impoundment is generally northeast to southwest based on historical groundwater monitoring activities. Given the historical



direction of groundwater flow, the following wells have been selected for use in the groundwater monitoring system and have been identified as either upgradient or downgradient monitoring wells.

Upgradient Monitoring Wells

Three (3) monitoring wells, AD-06 (overburden/bedrock interface), AD-07 (overburden), and AD-08 (overburden/bedrock interface), will serve as upgradient monitoring wells for the five inactive CCR ponds. AD-08 is located near the northeastern OIP property boundary, immediately adjacent to the north side of Pond 14 (non-CCR), part of the stormwater evaporation pond system. AD-07 is located along the northern boundary of the stormwater evaporation Pond 24, and AD-06 is located along the northern boundary between inactive CCR Ponds 21 and 22. Wells AD-06, AD-07, and AD-08 were all installed in September 2010. These wells are screened within predominately silty clay soil with slight gravelly zones and occasional silt lenses that overlay claystone/mudstone of the Clearfork Group. At AD-06, the well is screened across the unconsolidated overburden and bedrock, with the bottom portion of the screened interval within claystone/mudstone. These three wells exceed the minimum of one upgradient monitoring location as specified in 40 CFR §257.91(c)(1).

Downgradient Monitoring Wells

Five (5) monitoring wells, AD-13 (bedrock), AD-14 (overburden), AD-15 (overburden), AD-23 (overburden), and AD-24 (overburden) will serve as downgradient monitoring wells for the five CCR ponds. Monitoring wells AD-13, AD-14, and AD-15 are located along the southern boundary of CCR Pond 6. Monitoring well AD-24 (overburden) is located adjacent to AD-13 (bedrock) along the southern downgradient boundary of the inactive CCR Pond 6. Monitoring well AD-23 is located along the northwestern boundary of the inactive CCR Pond 6. Monitoring wells AD-13, AD-14, and AD-15 were installed in September 2010. Monitoring wells AD-23 and AD-24 were installed in October 2023. These five downgradient wells are screened within predominately silty clay soil with slight gravelly zones and occasional silt lenses that overlay claystone/mudstone of the Clearfork Group to provide continuity between the units screened by the existing upgradient and downgradient wells. These five wells exceed the minimum of three downgradient monitoring locations as specified in 40 CFR §257.91(c)(1).

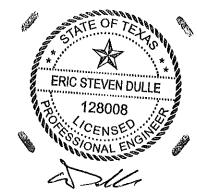
Limitations

Burns & McDonnel has prepared this groundwater monitoring system certification letter with reasonable skill, care, and diligence in accordance with customarily accepted professional practices in effect at the time it was prepared. Conclusions are interpretation of available data and constitute a professional opinion based on that data.



Engineer's Certification

I hereby certify, as a Professional Engineer in the State of Texas, that the multiunit groundwater monitoring system associated with the inactive CCR surface impoundments (Ponds 6, 21, 22, 23, and WWSP) located at the Oklaunion Power Station in Vernon, Texas that is owned and operated by Oklaunion Industrial Park, LLC has been designed and constructed to meet the requirements of 40 CFR §257.91 and 30 TAC §352.911 based on information provided in this letter, and a review of groundwater monitoring system documentation regarding the design, installation, development, and decommissioning of monitoring wells, piezometers and other measurement, sampling, and analytical devices placed in the Facility's operating record and provided by Oklaunion Industrial Park, LLC in accordance with 40 CFR §257.91(e)(1) and 30 TAC §352.911. I am a "Qualified Professional Engineer" as defined by 40 C.F.R. § 257.53 and 30 TAC §352.3 by the fact that I have the technical knowledge and experience to make the specific technical certifications set forth herein.

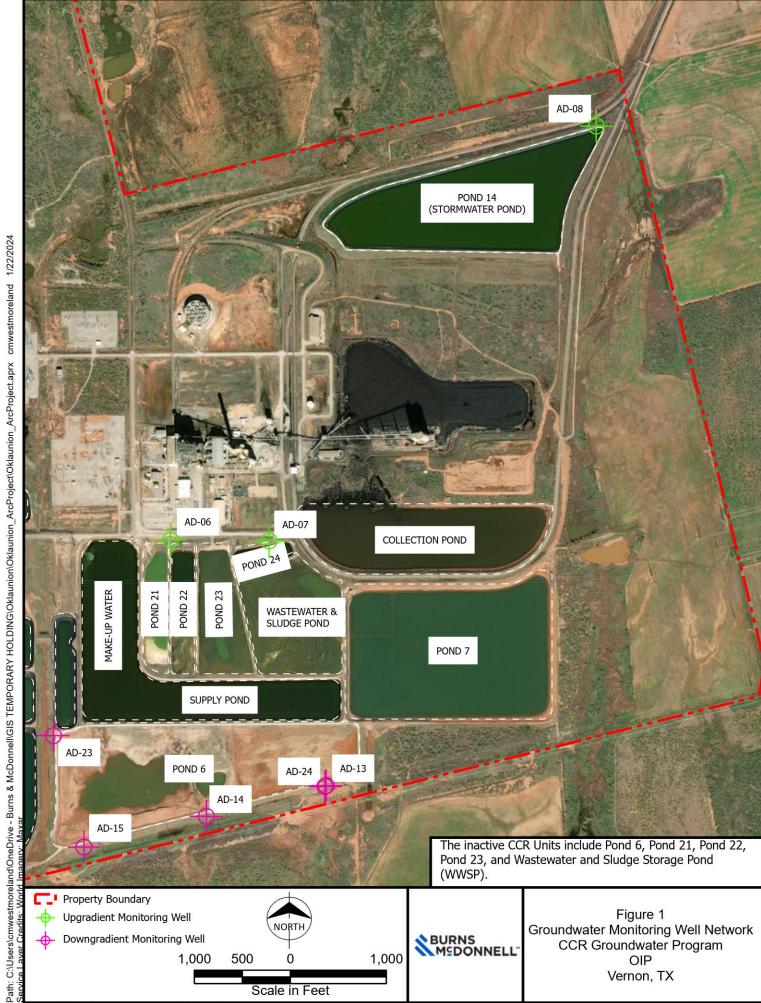


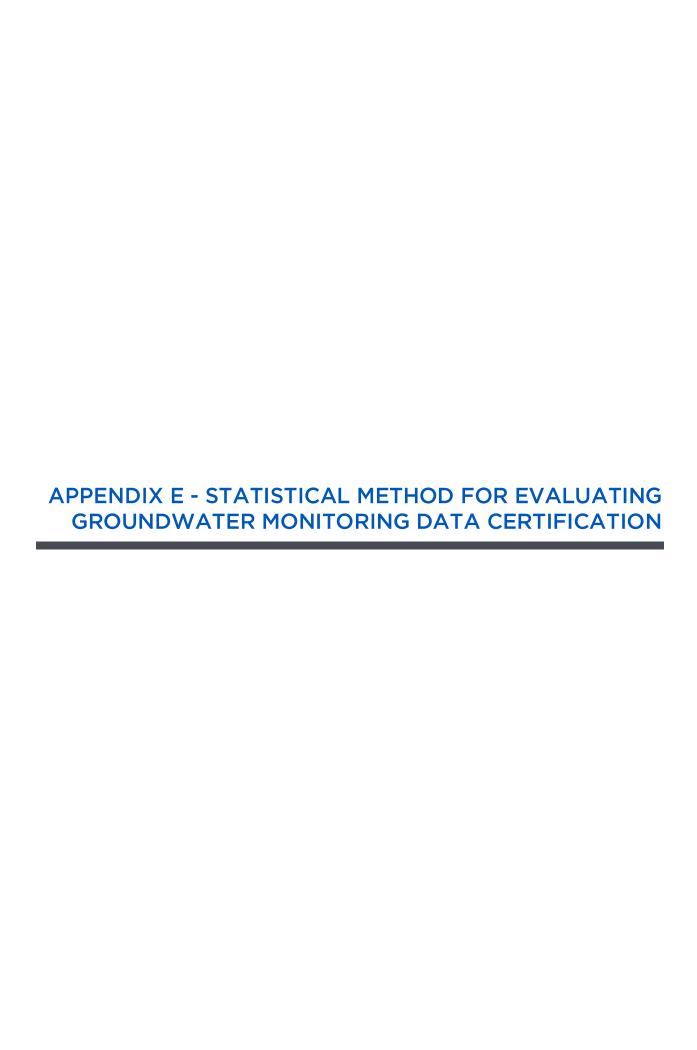
Date: 01/22/2024

Sincerely,

Mr. Eric Dulle, PE Project Engineer Mr. Ron Hager Senior Project Manager

Ronald H. Hoger







January 22, 2024

Mr. Jeff Wind Oklaunion Industrial Park, LLC 500 Seneca Street, Suite 504 Buffalo, NY 14204

Re: Statistical Method for Evaluating Groundwater Monitoring Data Certification for Oklaunion Industrial Park, LLC

Oklaunion Power Station CCR Surface Impoundments in Vernon, TX

Dear Mr. Wind:

On April 17, 2015, the final rule for the regulation and management of Coal Combustion Residuals (CCR) was published by the U.S. Environmental Protection Agency (USEPA) in 40 CFR §257 and §261 (herein referred to as the Final Rule). The Texas CCR regulations (30 TAC §352) regarding groundwater requirements adopts by reference the Final Rule. The Final Rule applies to the five inactive CCR surface impoundments (Ponds 6, 21, 22, 23, & the Wastewater and Sludge Pond [WWSP]) located at the Oklaunion Power Station (Site) in Vernon, Texas. In accordance with 40 CFR §257.93 of the Final Rule and 30 TAC §352.931, Oklaunion Industrial Park, LLC (OIP) is required to develop a groundwater sampling and analysis program to be implemented at the Site and to identify statistical methods selected to assess groundwater data generated pursuant to the rule.

Per 40 CFR §257.93(f)(6) and 40 CFR §257.105(h)(4), OIP is required to place this selection of a statistical method certification in the facility's operating record. This letter presents the method(s) that will be used to assess the available groundwater data, a narrative of the tests that will be used to assess the available groundwater data, and a narrative of the tests that will be used to perform statistical evaluations of groundwater data collected at the inactive surface impoundments.

Selection of Statistical Methods

Burns & McDonnell, in consultation with OIP, has identified appropriate statistical procedures that will be used to compare groundwater data, which has or will be generated in accordance with §257.93 through §257.95, to background conditions at the Site. The selected statistical methods include prediction interval procedures as described in §257.93(f)(3). Interwell prediction interval procedures were selected due to their ability to calculate a background limit or interval using data generated from upgradient monitoring wells. These methods also facilitate the comparison of a singular data point to this calculated background limit. Statistical analyses will be performed using the computer software package SanitasTM and in general accordance with USEPA's guidance document titled *Statistical Analysis of Groundwater Monitoring Data at RCRA Facilities*, dated March 2009. The following presents a stepwise narrative of how statistical evaluation will be performed when using these methods:



- 1. Validated groundwater data will be compiled into a database that is compatible with the SanitasTM software package.
- 2. Upon collection of sufficient background data (minimum 8 data points) from upgradient monitoring wells, upper prediction limits for each 40 CFR §257 Appendix III and IV constituent will be established using parametric or non-parametric procedures, as appropriate based on the dataset (a prediction interval will be used for pH).
- 3. The concentrations of 40 CFR §257 Appendix III and IV constituents observed in the downgradient monitoring wells will then be compared to the calculated prediction limits/interval established for upgradient wells.
- 4. In the event a constituent concentration is observed in a downgradient well above the respective background prediction limit, the concentration will be considered a statistically significant increase (SSI) above background conditions.
- 5. For any 40 CFR §257 Appendix IV constituent detected at an SSI above background, a groundwater protection standard (GWPS) will be established in accordance with 40 CFR §257.95(h).
- 6. The 40 CFR §257 Appendix IV constituents will be evaluated for statistically significant levels (SSL) over established GWPSs by calculating the lower confidence limit (LCL) at 95% confidence for each constituent/well pair using all monitoring results collected to date. If the calculated LCL is greater than the corresponding GWPS, an SSL will be determined to have occurred.

While this certification presents statistical methods that have been selected to assess groundwater data generated to date in accordance with 40 CFR §257.93, OIP and Burns & McDonnell reserve the right to adjust the procedures identified above or select a different statistical approach altogether. In the event statistical methods other than tolerance or prediction interval procedures are used to assess groundwater monitoring data in accordance with 40 CFR §257.93 through §257.95, a subsequent certification will be prepared pursuant to the Final Rule.

Limitations

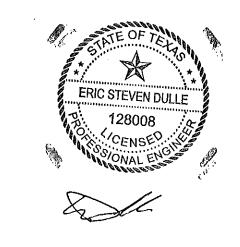
Burns & McDonnel has prepared this statistical method for evaluating groundwater monitoring data certification letter with reasonable skill, care, and diligence in accordance with customarily accepted professional practices in effect at the time it was prepared. Conclusions are interpretation of available data and constitute a professional opinion based on that data.

Engineer's Certification

I hereby certify, as a Professional Engineer in the State of Texas, that the chosen statistical method for evaluating groundwater monitoring data from the multiunit groundwater monitoring



system associated with the inactive CCR surface impoundments (Ponds 6, 21, 22, 23, & WWSP) located at the Oklaunion Power Station in Vernon, Texas that is owned and operated by Oklaunion Industrial Park, LLC is appropriate for evaluating such groundwater monitoring data. I am a "Qualified Professional Engineer" as defined by 40 C.F.R. § 257.53 and 30 TAC §352.3 by the fact that I have the education, technical knowledge, and experience to make the specific technical certifications set forth herein.



Date: 01/22/2024

Sincerely,

Mr. Eric Dulle, PE Project Engineer Mr. Ron Hager Senior Project Manager

Ronald H. Hager

cc: Wayne Weber (BMcD), Chris Hoglund (BMcD), Pete Hartung (OIP), Ryan Jacobs (OIP)



