

Corrective Measures Implementation Report



Prepared for:

Camp Stanley Storage Activity
Boerne, Texas

September 2017

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ACRONYMS AND ABBREVIATIONS

AFCEE	Air Force Center for Environmental Excellence
AOC	Area of Concern
bgs	below ground surface
BFZ	Balcones Fault Zone
BS	Bexar Shale
CAH	Chlorinated Aliphatic Hydrocarbon
CAO	Corrective Action Objective
CC	Cow Creek
<i>cis</i> -1,2-DCE	<i>cis</i> -1,2-dichloroethene
CMD	Corrective Measures Design
CMIR	Corrective Measures Implementation Report
CMS	Corrective Measures Study
COC	contaminant of concern
CSSA	Camp Stanley Storage Activity
CY	cubic yards
DCE	dichloroethene
DQO	Data Quality Objective
GAC	granular activated carbon
GBRA	Guadalupe Blanco River Authority
GPR	ground penetrating radar
HCSM	Hydrogeological Conceptual Site Model
IIW	ISCO injection well
ISCO	<i>in situ</i> chemical oxidation
LGR	Lower Glen Rose
LTM	long-term monitoring
LTMO	long-term monitoring optimization
LUC	land use control
MCL	Maximum Contaminant Limit
MDL	method detection limit
MS	matrix spike
MSD	matrix spike duplicate
OB/OD	Open Burn/Open Detonation
Order, the	Administrative Order on Consent
PCE	tetrachloroethene
PCL	Protective Concentration Limit
ppb	parts per billion
PVC	polyvinyl chloride
PWS	Public Water Supply
QAPP	Quality Assurance Program Plan
QA/QC	quality assurance/quality control
RCRA	Resource Conservation and Recovery Act
RFI	RCRA Facility Investigation

RMU	Range Management Unit
RPD	relative percent difference
SAWS	San Antonio Water System
SCADA	Supervisory Control and Data Acquisition
SIW	steam injection well
SVE	soil vapor extraction
SWMU	Solid Waste Management Unit
TCE	trichloroethene
TCEQ	Texas Commission on Environmental Quality
UGR	Upper Glen Rose
USEPA	U.S. Environmental Protection Agency
UU/UE	unrestricted use/ unrestricted exposure
VC	vinyl chloride
VOC	volatile organic compound
WB	West Bay

SECTION 1 INTRODUCTION

1.1 BACKGROUND

Camp Stanley Storage Activity (CSSA) is in northwestern Bexar County, Texas about 19 miles northwest of downtown San Antonio and 11 miles southeast of Boerne (**Figure 1.1**). In 1991, routine water well testing by the Texas Department of Health detected the presence of dissolved tetrachloroethene (PCE), trichloroethene (TCE), and *cis*-1,2-dichloroethene (*cis*-1,2-DCE) in a CSSA water supply well (Well 16) above maximum contaminant levels (MCLs) and the well was taken out of service. Subsequent sampling showed volatile organic compound (VOC) contamination levels above MCLs in several other wells. Sources of the waste constituents were found to be the former oxidation pond (SWMU O-1) and Burn Area 3 (later renamed SWMU B-3). Later, AOC-65 was also identified as another source of groundwater contamination.

As a result of the groundwater contamination and the U.S. Environmental Protection Agency's (USEPA) findings on an open burn/open detonation (OB/OD) area in CSSA's North Pasture (SWMU B-20), USEPA issued CSSA an Administrative Order on Consent (the Order) under Section 3008(h) of the Resource Conservation and Recovery Act (RCRA) on May 5, 1999. With the Order, USEPA is the lead agency for investigation and remediation of groundwater. The Texas Commission on Environmental Quality (TCEQ) is the lead agency for investigation and closure of waste disposal sites, although USEPA provides input.

Since the Order was issued in 1999, CSSA has closed sites under State of Texas regulations, with both TCEQ and USEPA oversight. A total of 85 sites, including 39 solid waste management units (SWMUs), 41 areas of concern (AOCs), and 5 range management units (RMUs), were identified at CSSA, and investigations and interim removal actions (if warranted) were conducted at 83 of those sites. As of July 2014, 77 waste disposal sites were either delisted or closed to unrestricted use/unrestricted exposure (UU/UE) in accordance with TCEQ requirements. A summary of past investigations and findings is provided in the RCRA Facility Investigation (RFI) Report (Parsons, 2014).

Five of the seven remaining sites are part of the active firing range. These sites will be closed when the range is no longer active. The two remaining open sites at CSSA, SWMU B-3 and AOC-65, are the remaining sources of groundwater contamination, and are the focus of groundwater remediation efforts going forward. Treatability studies to address SWMU B-3 were initiated in 1996 and to address AOC-65 in 2002. Throughout the site closure and treatability study process, USEPA and TCEQ actively participated in site investigation and treatability study planning, as well as provided extensive document review.

USEPA (2015) issued its Final Remedy for CSSA in a Decision Document on July 28, 2015. The Decision Document approved the Preferred Alternative described in the Statement of Basis issued on March 24, 2015 as the Final Remedy. The remedy utilizes source area treatment, point-of use treatment, land use controls (LUCs), and long-term monitoring (LTM) to achieve the Corrective Action Objectives (CAOs) for groundwater remediation.

1.2 CMI OBJECTIVES

The purpose of the Corrective Measures Implementation is to address the requirements necessary to implement the selected corrective measures at CSSA, and to meet the CAOs as defined in the Decision Document (USEPA, 2015). The CAOs are as follows:

1. Prevent or minimize migration of contaminants of concern (COCs) in groundwater within the source area at concentrations exceeding the MCLs and restore groundwater to its most beneficial use in a reasonable timeframe.
2. Prevent human exposure to groundwater containing COCs at concentrations that exceed MCLs in water supply wells.
3. Prevent on-site worker dermal contact and/or ingestion of COCs in shallow groundwater at concentrations exceeding acceptable human health risk values.

The four VOCs that make up COCs in groundwater at CSSA and their respective remediation goals (i.e., MCLs) are shown in Table 1.1.

Table 1.1
Contaminants of Concern in Groundwater at CSSA

VOCs	
Compound	MCL (µg/L)
PCE	5
TCE	5
<i>cis</i> -1,2-DCE	70
<i>trans</i> -1,2-DCE	100
Vinyl chloride (VC)	2

Continued use of bioremediation (bioreactor) will treat the source area at SWMU B-3; and continued use of *in situ* chemical oxidation (ISCO) will treat source area contamination at AOC-65. Institutional and engineering LUCs will be implemented to prevent contact with contaminated media. Current off-post granular activated carbon (GAC) units installed on private drinking water wells will continue to be operated and monitored. New GAC units focused to treat COCs will be installed at additional off-post drinking water wells if COC concentrations exceeding the MCLs are detected during the LTM program. This approach is consistent with USEPA guidance on final cleanup goals for RCRA corrective action (USEPA, 2004).

Corrective measures have been in place to monitor and treat groundwater contamination for several years. Groundwater sampling has been conducted at CSSA since 1991 to identify, delineate, and monitor groundwater plumes. A bioreactor has been treating groundwater contamination via monitored bioremediation at SWMU B-3 since 2007. Groundwater contamination at AOC-65 was treated using soil vapor extraction (SVE) from 2002 through 2012, and since then has been addressed using ISCO applications.

1.3 REPORT ORGANIZATION

The implementation of corrective measures at CSSA is presented in the following sections and addresses the CMI Report content requirements of the Order:

- Section 2 details the site history, physiology, hydrogeology, and previous investigations;
- Section 3 outlines the CAOs for the corrective measures at CSSA;
- Section 4 describes the CMI activities performed at CSSA, as well as design plans and specifications for the SWMU B-3 bioreactor, AOC-65 ISCO application, and groundwater monitoring program;
- Section 5 presents the results of the corrective measures since the publication the USEPA Decision Document in July 2015;
- Section 6 details the practices that are followed by CSSA and its contracted analytical laboratories to verify the quality of all data collected in support of the corrective measures;
- Section 7 presents the conclusions of the corrective measures thus far; and
- Section 8 presents the references used in this CMI Report.

1.4 REFERENCE DOCUMENTS

Due to the long history of remediation efforts at CSSA, numerous documents have been prepared related to:

- SWMU investigations and closures;
- Quarterly groundwater monitoring;
- Hydrogeological conceptual site model (HCSM); and
- Treatability studies.

All the above documents have been used extensively in preparation of this report and are available on the CSSA Environmental Encyclopedia (<http://www.stanley.army.mil/>). Previous Order-related documents include:

- RFI Work Plan (April 2016);
- Baseline Risk Assessment (January 2014);
- RFI Report (December 2014);
- Corrective Measures Study (CMS, October 2014);
- USEPA Statement of Basis (March 2015);
- USEPA Decision Document (July 2015);
- Corrective Measures Implementation Program Plan (November 2015);
- Corrective Measures Design Report (November 2015);
- Construction Quality Assurance Plan (CQAP, August 2016); and
- Quarterly and Semi-Annual USEPA Progress Reports (1999 to present).

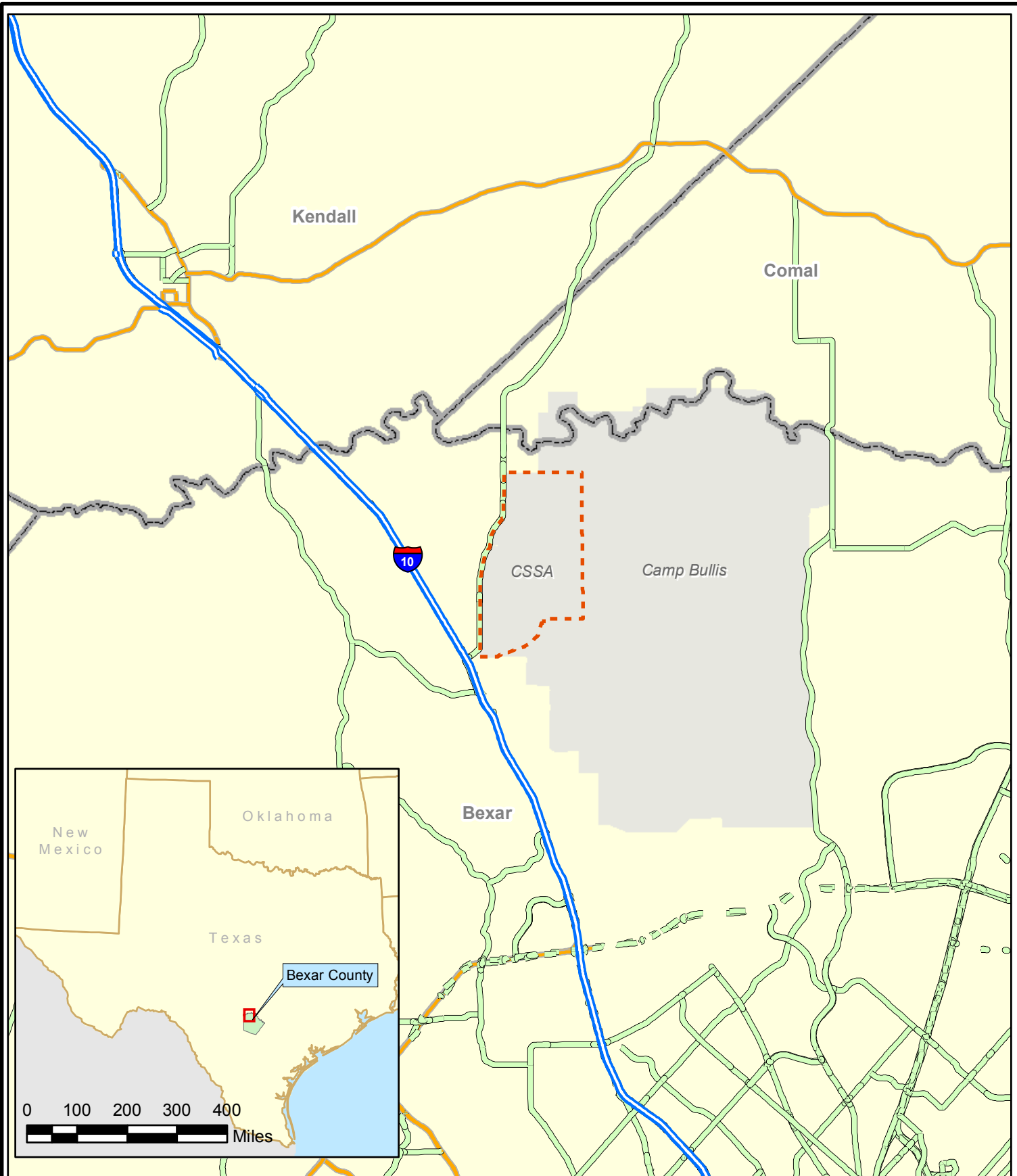
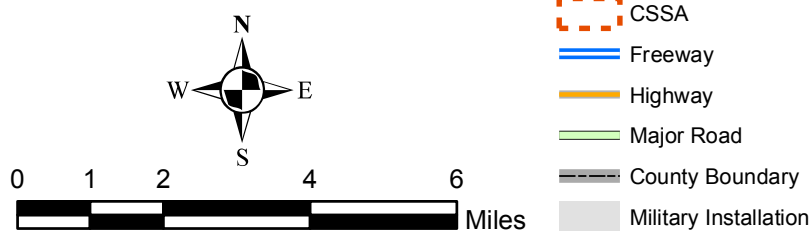


Figure 1.1

CSSA Location Map
Camp Stanley Storage Activity

PARSONS



- CSSA
- Freeway
- Highway
- Major Road
- County Boundary
- Military Installation

SECTION 2

SITE DESCRIPTION AND BACKGROUND

2.1 SITE HISTORY AND DESCRIPTION

2.1.1 Site History

CSSA is located in northwestern Bexar County, about 19 miles northwest of downtown San Antonio. The installation consists of 4,004 acres immediately east of Ralph Fair Road, and approximately 0.5 mile east of Interstate Highway (IH) 10 (**Figure 1.1**). Camp Bullis borders CSSA completely on the east, and partially on the north and south.

The land where CSSA is located was used for ranching and agriculture until the early 1900s. During 1906 and 1907, six tracts of land were purchased by the U.S. Government and designated the Leon Springs Military Reservation. The land included military campgrounds and cavalry shelters.

In October 1917, the installation was re-designated Camp Stanley. Extensive construction started during World War I to provide temporary cantonments and support facilities. In 1931, the installation was selected as an ammunition depot, and construction of standard magazines and igloo magazines began in 1938. Land was also used to test, fire, and overhaul ammunition components. As a result of these historic activities, CSSA has a number of historical waste sites, including SWMUs and AOCs.

Since the Order was issued in 1999, CSSA has been closing sites under State of Texas regulations, with both TCEQ and USEPA oversight. A total of 85 sites, including 39 SWMUs, 41 AOCs, and 5 RMUs, were identified at CSSA and investigations have been conducted at a total of 83 of those sites (**Table 2.1** and **Figure 2.1**). In 2012, four SWMUs (B-2, B-8, B-20/21, and B-24) were combined with RMU-1 as they are part of the active firing range. This range will be closed in the future when it is no longer active. As of June 2017, 77 sites have been either delisted or closed to UU/UE in accordance with TCEQ requirements, and comprehensive corrective measures are underway at two sites. The first site was closed in 1995, and the most recent closure (SWMU B-34) was approved by TCEQ in May 2014. Five sites are in CSSA's active range fan and will be closed when the range fan becomes inactive. In total, seven sites are still open (five sites in RMU-1) or undergoing active remediation (AOC-65 and SWMU B-3). Cleanup and closures were conducted in accordance with the State of Texas RCRA requirements.

The present mission of CSSA is the receipt, storage, issue, and maintenance of ordnance as well as quality assurance testing and maintenance of military weapons and ammunition. Because of its mission, CSSA has been designated a restricted access facility. No changes to the CSSA mission and/or military activities are expected in the future.

Table 2.1
Status of Waste Sites at Camp Stanley Storage Activity as of August 2014

	Site Status		
	Closed or Delisted	Part of Active Range Complex	Remediation Currently Underway
Solid Waste Management Units			
SWMU B-1	✓		
SWMU B-2		✓	
SWMU B-3			✓
SWMU B-4	✓		
SWMU B-5	✓		
SWMU B-6	✓		
SWMU B-7	✓		
SWMU B-8		✓	
SWMU B-9	✓		
SWMU B-10	✓		
SWMU B-11	✓		
SWMU B-12	✓		
SWMU B-13	✓		
SWMU B-14	✓		
SWMU B-15/16	✓		
SWMU B-19	✓		
SWMU B-20/21		✓	
SWMU B-22	✓		
SWMU B-23	✓		
SWMU B-23A	✓		
SWMU B-24		✓	
SWMU B-25	✓		
SWMU B-26	✓		
SWMU B-27	✓		
SWMU B-28	✓		
SWMU B-29	✓		
SWMU B-30	✓		
SWMU B-31	✓		
SWMU B-32	✓		
SWMU B-33	✓		
SWMU B-34	✓		
SWMU B-71	✓		
Bldg 40	✓		
Bldg 43	✓		
DD	✓		
F-14	✓		
I-1	✓		
O-1	✓		
Coal Bins	✓		
Areas of Concern			
AOC-35	✓		
AOC-36	✓		
AOC-37	✓		
AOC-38	✓		
AOC-39	✓		
AOC-40	✓		

Table 2.1
Status of Waste Sites at Camp Stanley Storage Activity as of August 2014

	Site Status		
	Closed or Delisted	Part of Active Range Complex	Remediation Currently Underway
AOC-41	✓		
AOC-42	✓		
AOC-43	✓		
AOC-44	✓		
AOC-45			
AOC-46	✓		
AOC-47	✓		
AOC-48	✓		
AOC-49	✓		
AOC-50	✓		
AOC-51	✓		
AOC-52	✓		
AOC-53	✓		
AOC-54	✓		
AOC-55	✓		
AOC-56	✓		
AOC-57	✓		
AOC-58	✓		
AOC-59	✓		
AOC-60	✓		
AOC-61	✓		
AOC-62	✓		
AOC-63	✓		
AOC-64	✓		
AOC-65			✓
AOC-66	✓		
AOC-67	✓		
AOC-68	✓		
AOC-69	✓		
AOC-70	✓		
AOC-72	✓		
AOC-73	✓		
AOC-74	✓		
AOC-75	✓		
Range Management Units			
RMU-1		✓	
RMU-2	✓		
RMU-3	✓		
RMU-4	✓		
RMU-5	✓		

2.1.2 Volatile Organic Compound Contamination at CSSA

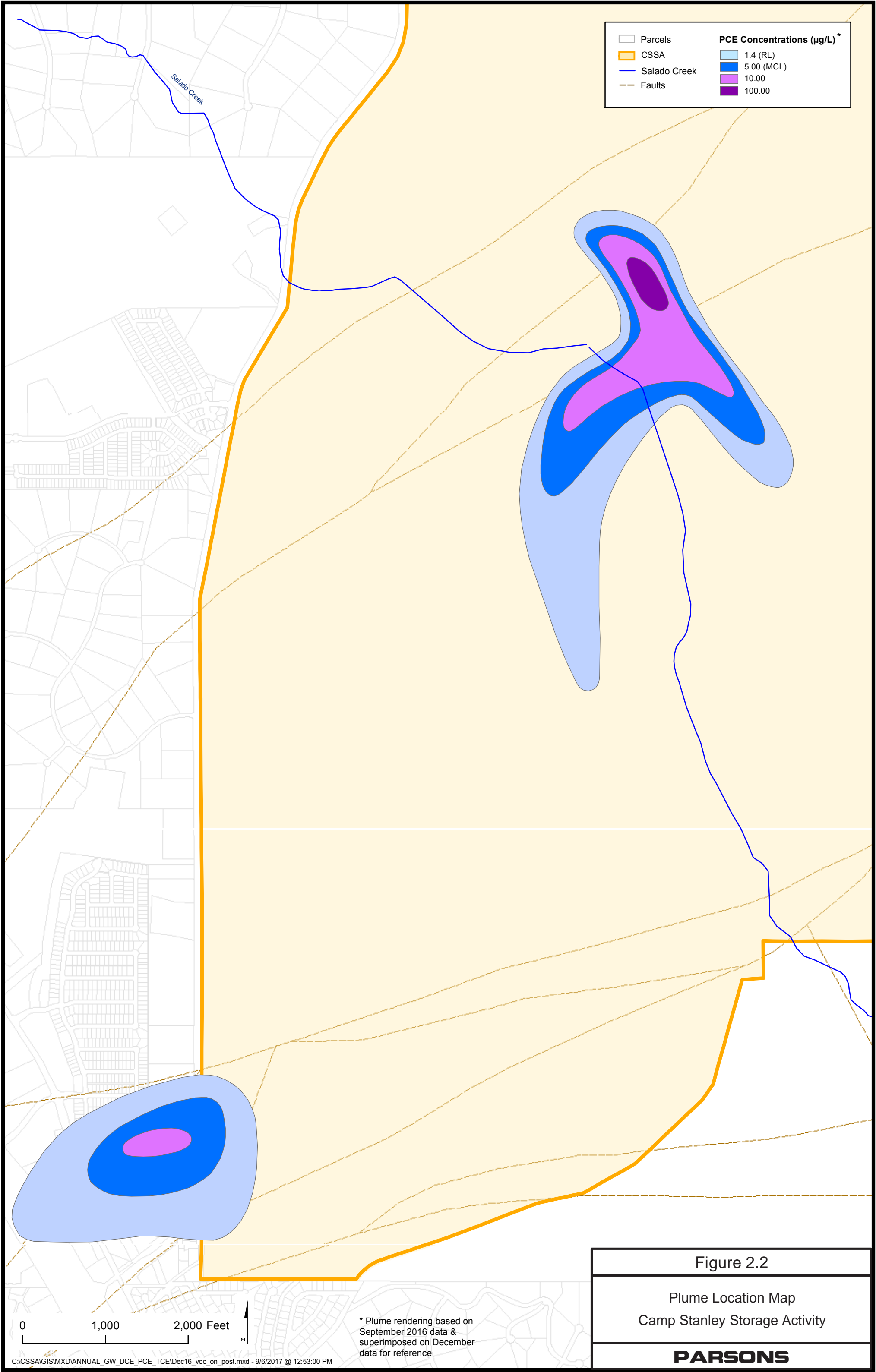
In 1991, routine water well testing by the Texas Department of Health detected the presence of dissolved PCE, TCE, and *cis*-1,2-DCE in a CSSA water supply well (Well 16 [CS-16]) above MCLs and the well was taken out of service. Subsequent sampling showed VOC contaminant concentrations greater than MCLs in several other wells. The potential sources of the waste constituents were believed to be the former oxidation pond (SWMU O-1) and Burn Area 3 (later renamed SWMU B-3); this is referred to as Plume 1 (**Figure 2.2**). Later, AOC-65 was identified as another source of groundwater contamination, referred to as Plume 2 (**Figure 2.2**). By 1999, VOCs had been detected in privately owned wells off-post. A synopsis of historical use and the nature and extent of contamination at each of these sites is detailed below.

SWMU O-1 and SWMU B-3

The oxidation pond, also referred to as SWMU O-1, was reportedly constructed in 1975 to receive fluids and sludge from Building 90-1, a gun bluing facility. The frequency of waste delivery to the pond varied upon the level of bluing activity. In 1982, an estimated 24,000 gallons were contained in the pond. The pond was abandoned and filled in 1985 after the liner was damaged during bulldozing activities. Several environmental investigations were conducted at the site, including soil gas surveys, geophysics, soil borings, and an electrokinetic treatability study. Eventually, the contents of the oxidation pond were excavated and backfilled with clean material.

SWMU B-3, which closely neighbors SWMU O-1, was a landfill area thought to have been used primarily for garbage disposal and trash burning, presumably during the 1980s. There was once a wide trench at the site where solid and liquid wastes were apparently burned. The trench was backfilled in the early 1990s. Subsequent source investigations identified an area of burn pits and disposal trenches containing PCE and its degradation products. The six trenches varied in depth from 5 to 15 feet, and were approximately 350 to 400 feet long and 12 to 20 feet wide. Groundwater beneath the landfill footprint occurs within a fractured bedrock aquifer composed of limestone and shales. The depth to the water table is typically 150 feet below ground surface (bgs), but can vary from 70 to 300 feet bgs depending on rainfall and recharge.

The results of geophysical surveys, soil gas sampling, soil borings, and soil and groundwater sampling continued at CSSA indicated that SWMU B-3 and O-1 contained significantly higher concentrations of VOC contaminants than other sites. Results showed PCE in SWMU O-1 soil samples and PCE, TCE, and *cis*-1,2-DCE in soil at SWMU B-3. Detailed results of these investigations are provided in the *Technical Memorandum on Soil Boring Investigations* (Parsons ES, 1995b), the *Technical Memorandum on Surface Geophysical Surveys at High Priority Sites* (Parsons ES, 1995c), and the *Technical Memorandum on Surface Geophysical Surveys, Well 16 Source Characterization* (Parsons ES, 1995a).



AOC-65

AOC-65, located along the southwestern side of CSSA, consists of Building 90 and potential source areas associated with Building 90 (Figure 2.2). Building 90 was used for weapons cleaning and maintenance. A metal vat, used for cleaning with chlorinated liquid solvents such as PCE and TCE, was installed in the western vault at Building 90 (main portion of AOC-65) prior to 1966 and removed in 1995. In 1995, after removal of the former solvent vat, a metal plate was welded over the concrete vault, and PCE and TCE solvents were replaced with a citrus-based cleaner system.

In 1999, CSSA identified PCE-impacted drinking water off-post near AOC-65. The fractured nature of the underlying bedrock aquifer provided multiple flow paths for contamination within the vadose zone at AOC-65 to migrate both laterally as well as vertically. Off-post VOC contamination in excess of the MCL was identified in both private and public water well systems. In response, CSSA implemented a proactive community relations plan to provide clean water, free of COCs, to the affected community, point-of-use GACs were installed on contaminated wells, and investigations and treatability studies were conducted for AOC-65. These studies included source area identifications, soil boring and well installations, and pilot scale treatability studies.

Groundwater Contamination

Based on the observed groundwater contamination described above, 119 monitoring wells were installed on-post between 1996 and 2013. Off-post contamination was first reported by CSSA in December 1999 at a private well adjacent to the facility. CSSA has identified and sampled more than 60 off-post private, commercial, and public supply wells surrounding the post. Since that time, solvent contamination has been detected above the laboratory's method detection limits (MDL) in over 30 off-post groundwater supplies.

Contamination is mostly within the Lower Glen Rose (LGR) water-bearing unit. Locally, the Bexar Shale (BS) serves as a confining unit between the water-bearing LGR and Cow Creek (CC) Limestone. Faults of the Balcones Fault Zone (BFZ) structurally influence and re-direct the groundwater flowpaths. Environmental studies demonstrate that most of the contamination resides within the LGR.

Plume 1 has advectively migrated primarily south-southeast toward Camp Bullis. A component of the plume has also migrated west-southwest toward CSSA well fields (CS-9, CS-10, and CS-11) and several off-post public and private wells. VOC concentrations over 500 µg/L are present in Middle Trinity aquifer wells near the source area. However, contaminant concentrations are below 1 µg/L over most of the Plume 1 area. In contrast, little to no contamination within the BS and CC Limestone has been consistently identified within Plume 1 except in association with open borehole completions.

Contamination at Plume 2 originated at AOC-65, and spread southward and westward from the post. The greatest concentrations of solvents are reported at the near subsurface adjacent to the source area. Deeper in the subsurface, concentrations in excess of 100 µg/L have been reported in perched intervals above the main aquifer body in the LGR. However, as evidenced by the multi-port wells, once the main aquifer body is penetrated, the concentrations are diluted to trace levels. Off-post, concentrations in excess of MCLs have been detected in private and

public wells with open borehole completions. All private groundwater wells with COC solvents present at concentrations greater than 90 percent of the MCL have been equipped with GAC units and wells in the area are sampled quarterly. Only sporadic, trace concentrations of solvents have been detected in BS and CC Limestone wells within Plume 2.

2.1.3 Hydrology

Approximately 32,250 linear feet of ephemeral stream drainages on CSSA have defined channels. In particular, Salado Creek bisects CSSA, flowing east-southeast. These streams are ephemeral (run few days per year) and have no direct or indirect ties to permanently flowing surface waters.

2.1.4 Geology

CSSA is characterized by a rolling terrain of hills and valleys in which nearly flat-lying limestone formations have been eroded and dissected by streams draining to the east and southeast. CSSA is sited over Cretaceous-age deposits of the Travis Peak and Glen Rose Formations of the Trinity Group. The predominant structural feature in the area is the BFZ escarpment. Normal faulting has occurred near the central area and the southern boundary of the installation. Faulting in the limestone units has juxtaposed strata of different ages, but fault scarps and traces are almost absent because many of the various calcareous lithologies weather similarly. The faults are northeast-southwest trending, but most are not as continuous as the fractures. Soil cover is relatively thin, and bedrock is frequently exposed in most areas other than stream valleys.

River and stream dissection of limestone is the major surface feature at CSSA. Most major rivers and streams originating in the Edwards Plateau northwest of CSSA tend to follow the NW-SE regional fracture patterns. Resistive limestone beds crop out as topographic highs across the landscape, resulting in the predominant physiography of hills and “saddles” which lead to stream valleys. Topographic relief across the area ranges from about 1,100 to 1,500 feet above sea level.

Stratigraphy

The oldest and deepest known rocks in the area are Paleozoic age (225 to 570 million years ago) schists of the Ouachita structural belt. They underlie the predominant Cretaceous-age carbonate lithology of the Edwards Plateau. At CSSA, the near-surface geology and aquifer are composed of Trinity Group carbonate bedrock, which includes the Glen Rose and Travis Peak Formations. In particular, for CSSA, the units of interest are the Glen Rose Limestone, BS, and CC Limestone that form the Middle Trinity aquifer.

The upper member of the Trinity Group is the Glen Rose Limestone. The Glen Rose represents a thick sequence of shallow water marine shelf deposits. This formation is divided into upper and lower members. At CSSA, the Glen Rose is exposed at the surface and in stream valleys. The Upper Glen Rose (UGR) consists of beds of blue shale, limestone, and marly limestone with occasional gypsum beds (Hammond 1984). Based on well log information, the thickness of the upper member reaches 500 feet in Bexar County. The thickness of this member at CSSA is estimated from well logs to be between 20 and 150 feet. The LGR, underlying the UGR, consists of a massive fossiliferous limestone, grading upward into thin beds of limestone,

marl, and shale (Ashworth, 1983). The lower member, according to area well logs, is approximately 300 feet thick at CSSA.

Underlying the Glen Rose Limestone is the Travis Peak Formation (and its downdip lateral equivalent, the Pearsall Formation), which attains a maximum thickness of about 940 feet and is divided into five members, in descending order: the Hensell Sand (and BS facies), the CC Limestone, the Hammett Shale (HS), the Sligo Limestone, and the Hosston Sand.

The youngest member of the Travis Peak Formation is the Hensell Sand, locally known as the BS. The shale thickness averages 60-80 feet, and is composed of silty dolomite, marl, calcareous shale, and shaley limestone, and thins by interfingering into the Glen Rose Formation. The underlying CC Limestone is a massive fossiliferous, white to gray, shaley to dolomitic limestone that attains a maximum thickness of 90 feet down dip in the area. At CSSA, groundwater is produced from the LGR and CC intervals of the Middle Trinity Aquifer. The stratigraphically oldest rocks (Hammett Shale, Sligo Limestone, and Hosston Sand) comprise the Lower Trinity Aquifer, but are not developed at CSSA.

Structure

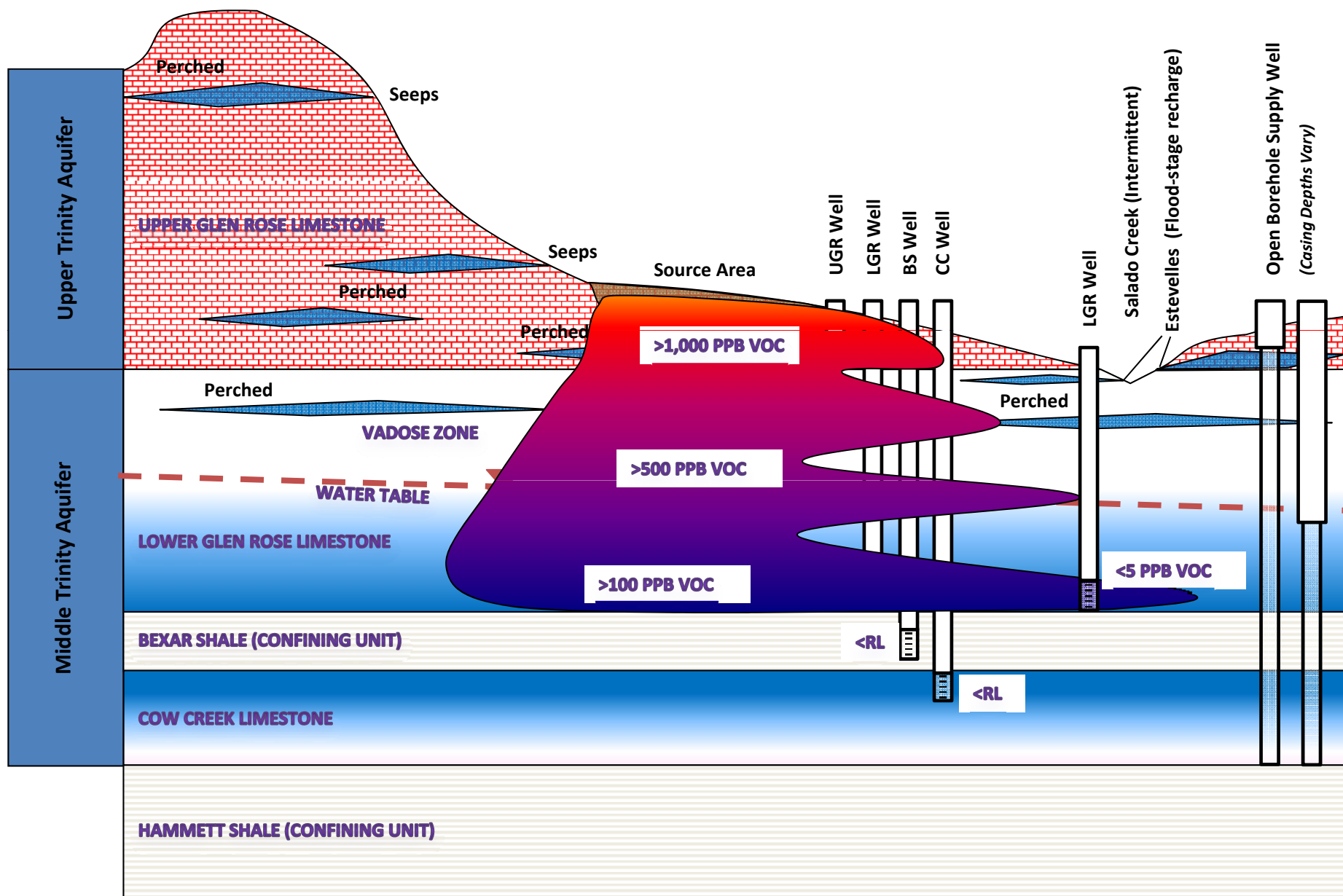
The predominant structural geologic features in the area are regional vertical fractures, the regional dip, and the BFZ escarpment. Regional fractures are the result of faulting in the Cretaceous sediments and in the deeper Paleozoic rocks. The two sets of fracture patterns trend northwest-southeast and northeast-southwest across the region. The regional dip is to the east and southeast at a grade of about 100 feet per mile near the fault zone in Bexar and Comal Counties, decreasing 10-15 feet per mile northwest of CSSA.

The BFZ is a series of high-angle normal faults that generally trend NE and SW. Total displacement in northwest Bexar County is approximately 1,200 feet. The faulting is a result of structural weakness in the underlying Paleozoic rocks and subsidence in the Gulf of Mexico basin to the southeast. The down drop blocks outcrop as progressively younger strata from northwest-southeast across the fault zone.

2.1.5 Hydrogeology

Groundwater occurrence and movement is highly variable due to the complex geologic environment. Three aquifers are present in the area of CSSA: the Upper, Middle, and Lower Trinity aquifers. These divisions are based on hydraulic continuity. The Glen Rose Formation and the Travis Peak and Pearsall Formations are the principle water-bearing units. As depicted on **Figure 2.3**, the Upper Member of the Glen Rose Formation composes the Upper Trinity Aquifer, and the Lower Member, a portion of the Middle Trinity Aquifer. The Pearsall Formation and its Travis Peak equivalent include a portion of the Middle Trinity Aquifer and the full Lower Trinity Aquifer. The Travis Peak Formation transitions into the Pearsall Formation in downdip locations very near, or just south of CSSA. Beneath these are metamorphosed Paleozoic rocks, which act as a lower hydrologic barrier. Only the Middle and Upper Trinity aquifers are typically addressed at CSSA.

Figure 2.3 CSSA Hydrogeologic Conceptual Site Model



Middle Trinity Aquifer

The primary groundwater source at CSSA and surrounding areas is the Middle Trinity aquifer, consisting of the LGR Limestone, the BS, and the CC Limestone. The average combined thickness of the aquifer members is approximately 460 feet. In the vicinity of CSSA, the LGR portion of the Middle Trinity aquifer is recharged by direct precipitation on the outcrop and stream flow infiltration. Likewise, over the same area, the BS acts as a hydrologic barrier to vertical leakage except where faulted; therefore, most recharge to the CC Limestone comes from overlying updip formations. The bottom of the CC Limestone forms the base of the Middle Trinity aquifer.

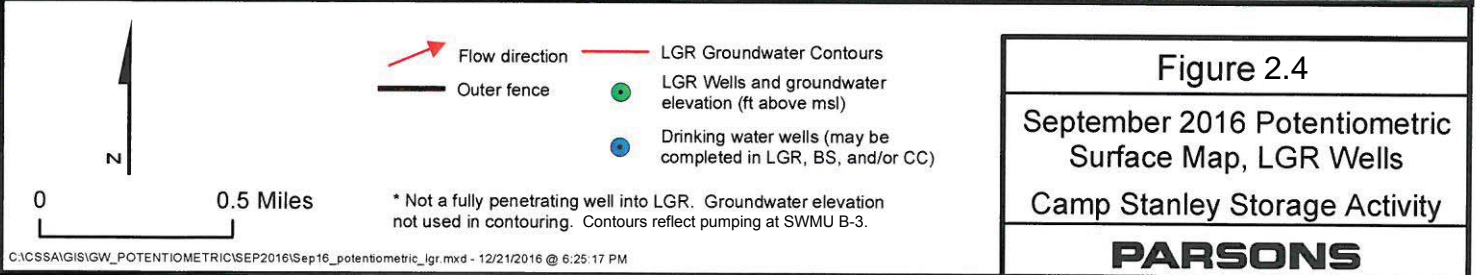
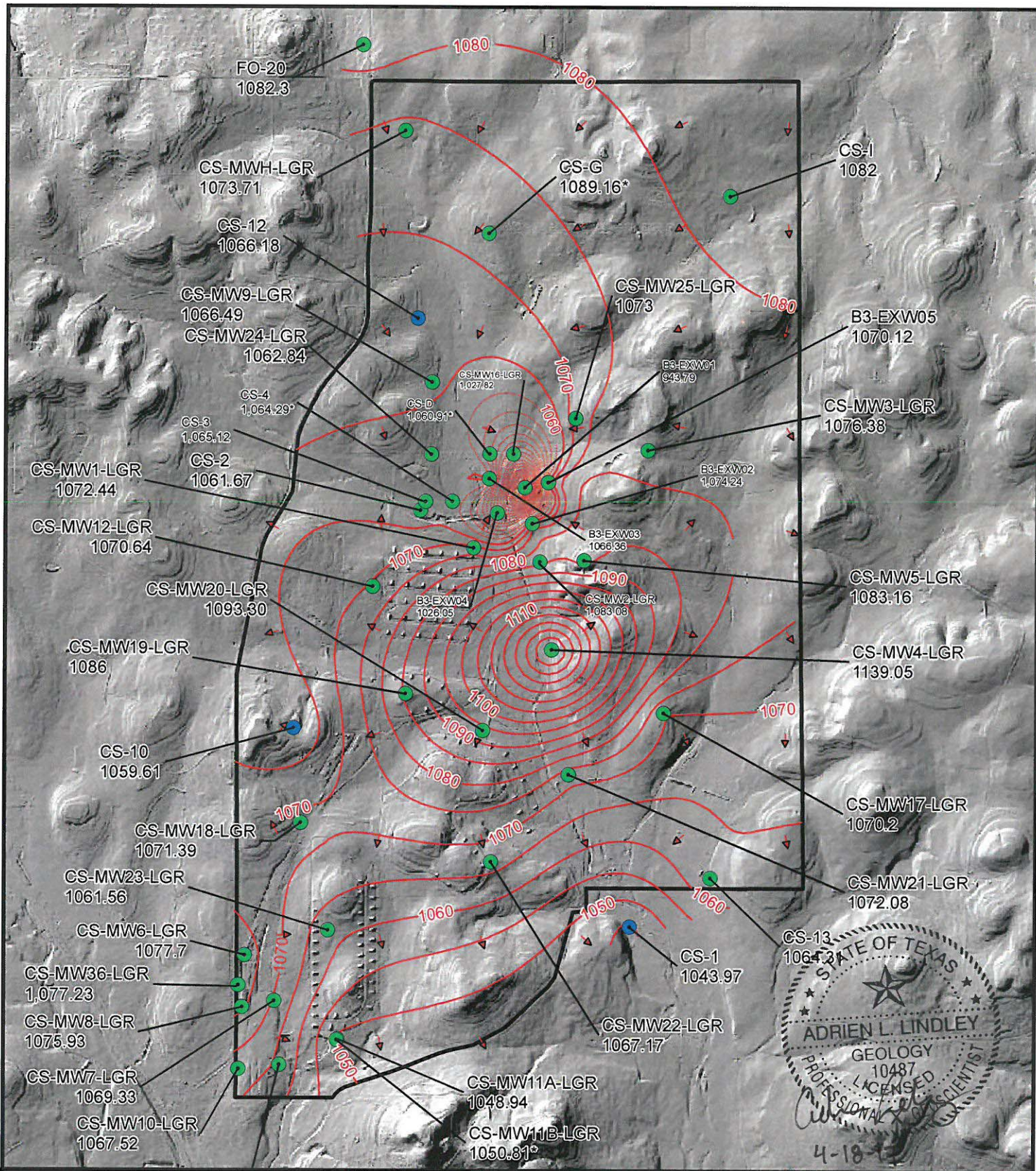
Information regarding the subsurface at CSSA was compiled from borehole data, geophysics, and surface mapping to create a conceptual stratigraphic model. Nearly 90 percent of the land surface at CSSA is composed of the basal section of the UGR limestone, comprising the upper confining layer of the Middle Trinity aquifer. Data indicate that the underlying LGR is typically an average thickness of 320 feet. The BS is normally 60 feet thick, whereas the underlying CC Limestone unit is typically 75 feet thick.

The bulk of the main groundwater body occurs within the basal portion of the LGR and the upper portion of the CC Limestone. The occurrence of groundwater within these units was implicitly related to the massive moldic porosity and karstic features associated with reef-building events and fossiliferous biostromes capable of storing large quantities of water. Occasionally, large volumes of groundwater can also be produced from well-developed reefs above the basal unit, or from significant perched fracture or karstic features. Otherwise, groundwater yields in the UGR and the top 250 feet of the LGR are minimal. Likewise, groundwater production from the BS is negligible.

Based on observation well measurements, regional groundwater flow is generally to the south-southeast (**Figure 2.4**). The LGR typically has a southward gradient that deviates around mounding that occurs at CSSA near the central and northern portions of the facility (CS-MW4-LGR).

Long-term monitoring shows that groundwater response to precipitation events can be swift and dramatic. Depending on the severity of a precipitation event, the groundwater response will occur within several days, or even hours. As an example, the BS exhibits the potential for either northward or southward flow, depending on the season. Likewise, the CC limestone exhibits erratic flow paths, with seasonally radial flows from mounded areas.

Significant precipitation events can result in dramatic aquifer response with regard to water levels. More than 80 feet of recharge has been measured in a well after a 4.5-inch precipitation event. Data obtained from the on-post well clusters indicate that for most of the year, a downward vertical gradient exists within the Middle Trinity aquifer. Differences in drainage rates often leave the head of the BS well above the head of the LGR and CC Limestone. The large differences in head suggest the BS reacts locally as a confining barrier between the LGR and CC Limestone.



Upper Trinity Aquifer

The Upper Trinity aquifer consists of the UGR Limestone. Recharge to the Upper Trinity aquifer is from direct precipitation to UGR Limestone outcrop and from stream flow infiltration. Movement of groundwater in the Upper Trinity is restricted to lateral flow along bedding planes between marl and limestone, where solution has enhanced permeability.

Static water levels in adjacent wells completed in different beds within the UGR are often different, demonstrating the possibility that beds are not hydraulically connected by avenues of vertical permeability. The only place where extreme development of solution channels is reported is in evaporite layers in or near the outcrop of the UGR Limestone.

Discharge from the Upper Trinity aquifer is predominantly from natural flow through seeps and springs and from pumping. The Upper Trinity aquifer is, in general, unconfined. Fluctuations in water levels in the Upper Trinity are predominantly a result of seasonal rainfalls and, in some areas, may be impacted by pumping from domestic and public wells. Upper Trinity water is generally of poor quality and most wells achieve only low production. Evaporite beds in the Upper Trinity introduces excessive sulfate into the water. Few wells obtain water solely from the Upper Trinity aquifer.

To the northwest of CSSA where the full thickness of the UGR exists, the aquifer is utilized as a primary drinking water supply. However, because the unit is so thin at CSSA, it normally does not store appreciable quantities of water. Therefore, it is not used for water supply in the vicinity of CSSA. But in some instances, off-post wells with minimal surface casing can receive contributing UGR groundwater into the open borehole well. The UGR isn't typically used due to its seasonal availability and poor natural water quality, but it is used as an indicator of environmental contamination source locations at CSSA.

2.1.6 Surface Water and Groundwater Use

There are ephemeral streams at CSSA that flow after significant rainfall but, there are no perennial surface water sources at CSSA. Therefore, surface water is not a source of potable water at CSSA.

Both CSSA and the immediate surrounding areas use the Middle Trinity aquifer as a potable water source. This includes CSSA, commercial developments, private landowners, and until recently, several nearby public water systems. As of July 2017, there are three supply wells in use on-post (CS-1, CS-10, and CS-12), one planned for future use (CS-13), and approximately 55 private wells within one-quarter mile of the post boundary.

Several new housing developments neighboring CSSA are supplied by San Antonio Water System (SAWS). SAWS obtains its water primarily from the Edwards aquifer to the southeast. In addition, the neighboring City of Fair Oaks obtains its drinking water from both the Trinity aquifer and Canyon Lake, which the Guadalupe Blanco River Authority (GBRA) extracts and treats at the Western Canyon Water Treatment Plant.

2.2 PREVIOUS INVESTIGATIONS

This section describes groundwater and source area investigations prior to the issuance of the Decision Document in July 2015.

2.2.1 Initial CSSA Groundwater Investigation

Contaminants were initially detected in CSSA Well CS-16 during routine water supply testing in April 1991. Drinking water withdrawals at CS-16 ceased immediately. Follow-up sampling confirmed concentrations of TCE and PCE above drinking water MCLs and the well was permanently taken out of service. Comprehensive investigation of groundwater contamination at CSSA began in 1992. The effort started with preliminary evaluations to establish the extent of the problem without invasive field techniques, namely analyzing groundwater samples from existing CSSA wells and geophysical surveys to identify potential contamination source areas. Samples from Well CS-D, located west of Well CS-16, also exhibited concentrations of PCE and TCE that exceeded MCLs. Camera surveys were also performed at CSSA wells to inspect the integrity of existing casings and to document general conditions inside the wells. Following this effort, the *Hydrogeologic Report for Evaluation of Groundwater Contamination* (ES, 1993) was submitted to the appropriate regulatory agencies for comment and approval.

A groundwater monitoring and reporting program was initiated in 1994 and established that groundwater flow gradients generally varied from south-southwest to south-southeast. The monitoring continued to show above-MCL VOC contamination in Wells CS-16 and CS-D. Attempts to identify specific contaminated zones in several CSSA wells through discrete groundwater sampling proved inconclusive. Nevertheless, after review of geophysical and video logs, additional surface casing was installed to 200 ft bgs in Wells CS-2, CS-3, CS-4, CS-16, and CS-D to seal off shallow water-bearing zones that could have been contributing to migration of VOC contamination through open boreholes. Investigation activities continued in 1995, including additional downhole geophysical logging, discrete interval sampling, and well upgrades. In addition, periodic monitoring of several off-post domestic water supply wells was eventually initiated. At that time, sampling of these offsite wells showed no evidence of contamination.

2.2.2 Source Area Characterization

Other work in 1995 relating to groundwater contamination issues focused on source characterization. To help identify potential sites, historical records were examined and interviews with CSSA employees were conducted to locate potential SWMUs and other AOCs. Sites were examined throughout CSSA where waste had been dumped and/or burned during past disposal activities. Areas showing unusual topography were also considered possible waste burial locations. Electromagnetic (EM) and ground penetrating radar (GPR) surveys were conducted at some of these sites in early 1995, followed by soil-gas surveys in areas where anomalies were identified.

SWMU O-1

Excavation of subsurface soil from the known extent of contamination within SWMU O-1 began in July 2000. Excavation and removal of approximately 1,515 cubic yards (CY) of contaminated soil was completed with soil material transported and disposed of at a permitted disposal facility. The area of excavation encompassed approximately 7,000 square feet. Excavation continued to a depth where bedrock was encountered until the soil was removed within and slightly beyond the lateral extent of contamination to a depth where bedrock was encountered. The resulting excavation was approximately 5 feet deep.

After confirmation samples had been collected, the excavation was backfilled and a low-permeability clay liner was constructed over the site. Six inches of topsoil were placed on top of the clay liner, and a vegetative surface was established on the topsoil. CSSA sought a partial facility closure of the surface soil zone located within the boundaries of SWMU O-1. The cover serves to prevent infiltration of precipitation into and through the bedrock and remaining contaminated groundwater, thereby serving to mitigate, control, abate, and minimize spread of contamination in the groundwater below. The partial facility closure was approved by the TCEQ in April 2002.

The underlying limestone and the groundwater-bearing zones were not included in the partial facility closure. The limestone/groundwater zone is being addressed as part of the closely neighboring SWMU B-3 bioreactor system, described further below. A groundwater extraction well (B3-EXW02-LGR) has been drilled at the site, and is actively capturing contaminated groundwater for the SMWU B-3 bioreactor system.

SWMU B-3

Numerous environmental investigations have occurred at SWMU B-3, including soil gas surveys, geophysical surveys, soil boring and groundwater well installations, and an SVE pilot study. To remediate contaminated groundwater, an *in situ* “bioreactor” was created in 2007 by removing the waste in the disposal trenches, backfilling with a gravel/mulch mixture, and infiltrating contaminated groundwater (Figure 2.5).

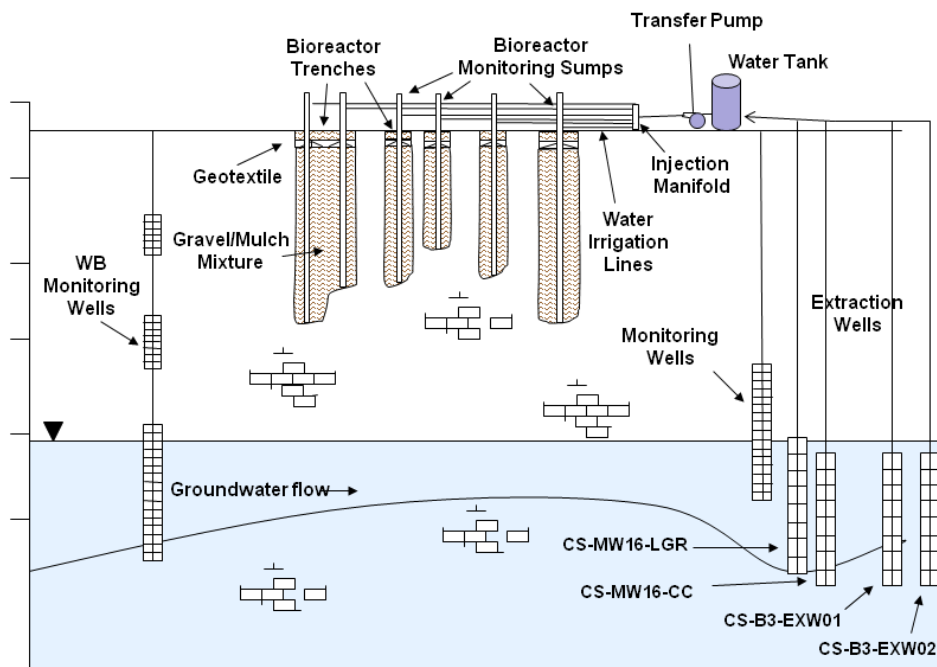


Figure 2.5 Conceptual Drawing of SWMU B-3 Bioreactor

Microbial activity was augmented with addition of the KB-1 commercial culture of *dehalococcoides*. The general design criteria for the bioreactor included placement of a 1:1 mixture by volume of gravel to deciduous tree mulch into the six excavated trenches at SWMU

B-3. A water irrigation system was installed near the gravel/tree mulch in which water could be pumped from nearby wells and delivered into each trench.

In 2011-2012, several system updates were incorporated at the SWMU B-3 bioreactor. Three new extraction wells were installed between May 2011 and June 2012. The current system distributes contaminated groundwater collected from seven extraction wells located around the perimeter of the site into the bioreactor trenches where the water encounters microbial activity which degrades the organic contaminants. Also during this time period, Building 260 was constructed on the northeast side of the bioreactor to house system controls, storage tanks, the transfer pump, and bag filter. The repositioning of the injection equipment in this new building required the rerouting of water lines from extraction wells and utilities, and moving supervisory control and data acquisition (SCADA) controls. Two 10,000-gallon polyethylene storage tanks were installed in the new building, and they replace the 6,000-gallon trailer-mounted tank previously used. Following the addition of Building 260, bioreactor trenches were recharged with deciduous tree mulch and gravel. New injection piping was installed approximately 18 inches below the surface within each trench and covered with new geotextile fabric.

AOC-65

Source characterization of the Building 90 vicinity included a 2001 soil gas survey that involved the collection and analysis of 319 soil gas samples. PCE, TCE, *cis*-1,2-DCE and *trans*-1,2-DCE were detected around and inside Building 90. An RFI report for AOC-65 was completed in September 2002 followed by an interim removal action including excavation of soils underlying the pavement and drainage swale on the west side of the building, and removal of lead-contaminated sand pipe bedding.

Additional investigations performed at AOC-65 included soil borings, soil-gas surveys, multiple geophysical sensing techniques, and shear-wave seismic surveys. The objectives of those investigations were to identify pathways for migration specifically related to stratigraphic and structural features. Results of these investigations culminated with the installation of two pilot study vapor extraction systems. A weather station and transducers were installed at the site to aid in a groundwater recharge study.

Pilot testing was initiated at AOC-65 to evaluate the effectiveness of SVE for the removal of VOC contamination from the vadose zone. SVE was demonstrated to be an effective method for source removal in surface formations at CSSA during the earlier pilot and treatability study at SWMU B-3. Two SVE systems were installed at AOC-65 in late 2002. SVE proved ineffective after 10 years of operations due to large fluctuations in water levels within the aquifer. Extraction well screens and flow paths (fractures) were flooded during periods of higher groundwater elevations.

An interim removal action was conducted in July 2002 to remove or significantly reduce the levels of VOCs present in the shallow soil material in and around Building 90. The removal activities included the characterization of contaminants present in the soil zone and removal of impacted soil material from specific areas west of the building. This removal included impacted soils along a drain line and a drainage ditch west of Building 90 which exhibited high levels of VOCs. The SVE system was installed inside Building 90 to evaluate subslab ventilation as a removal option for contaminants underlying the building and that is, inaccessible to excavation.

The 2002 interim removal action is further documented in the *Final AOC-65 Interim Removal Action Report* (Parsons, 2003).

An interim removal action in 2012 included the excavation and removal of contaminated media beneath the concrete lined drainage ditch west of Building 90. Approximately 1,000 CY of material was removed. The material met Class 3 waste characteristics and was reused on-site as construction fill for road maintenance. The completion of the interim removal action allowed for evaluation of other treatment technologies. Infiltration galleries were installed within the excavation for an ISCO treatability study, and a UIC permit was obtained from TCEQ.

An approach was designed for application of ISCO within AOC-65 by taking advantage of lessons learned from successful operation of the SMWU B-3 bioreactor. In 2012, the approach was designed for application of ISCO material at AOC-65 included the creation of a trench within a suspected point of release (i.e., drainage ditch) and backfilling this trench with alternating layers of ½-inch-sized gravel and compacted clay. Irrigation lines were installed within each of the gravel layers creating three separate infiltration galleries within the 15-foot-deep, 4.5-foot-wide, 320-foot-long trench (**Figure 2.6**).

The infiltration galleries were configured to target injection in multiple fractures, some solutionally enlarged, that had been identified on the exposed trench walls. ISCO solution were also delivered to the subsurface using existing steam injection wells (SIWs) modified for ISCO injection and ISCO Injection Wells (IIWs). Two 13-foot-long, 2-foot-wide, 2-foot-deep surficial excavations were later created within a concrete vault located inside Building 90 for additional ISCO applications within the suspected source area (**Figure 2.7**).

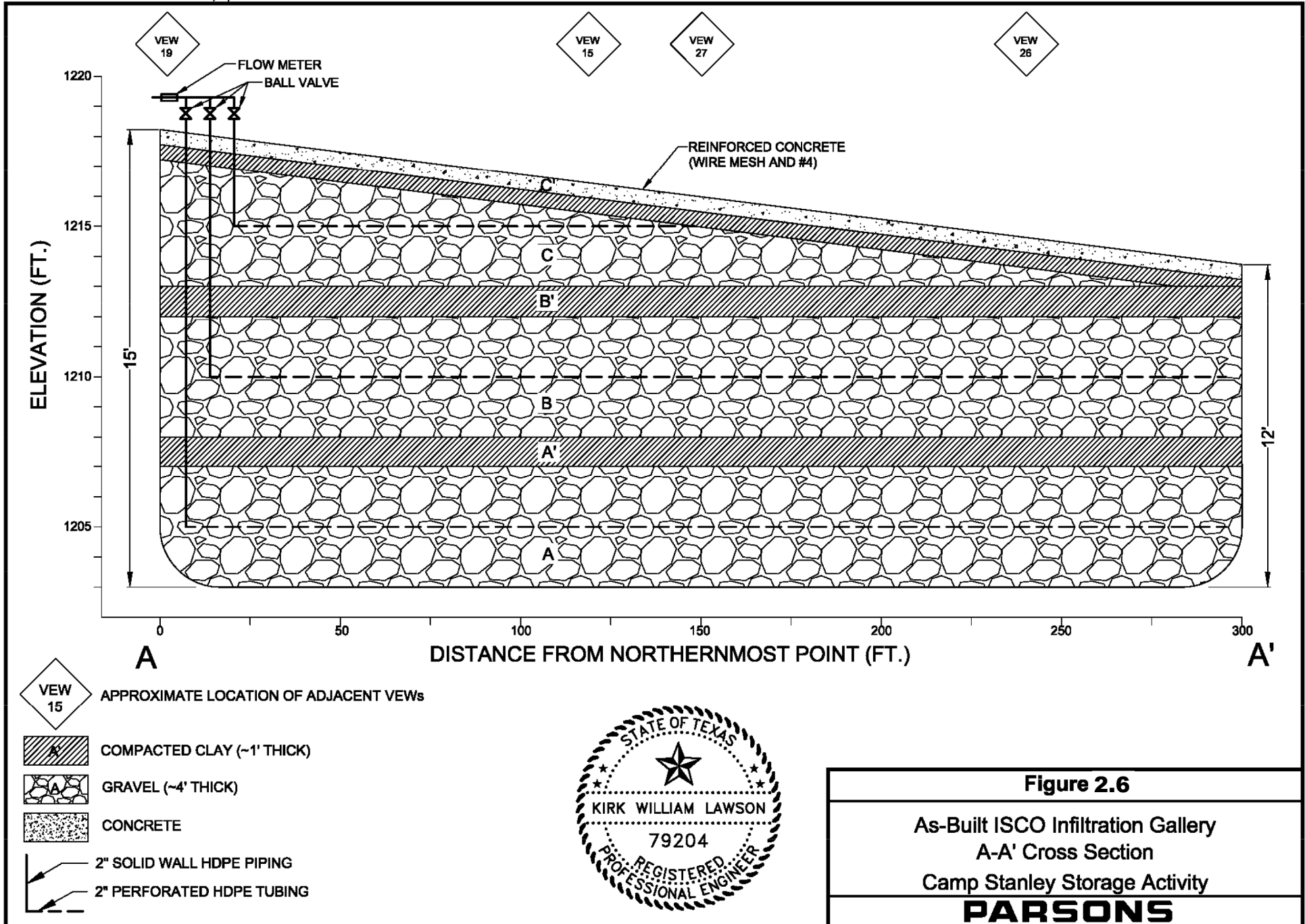
Pilot and field-scale treatability studies were performed using sodium persulfate applied to the infiltration galleries constructed within the 320-foot-long trench in 2012, 2013, and 2014 as follows:

- 2012: 15,000 gallons of alkaline-activated 20% sodium persulfate solution;
- 2013: 33,000 gallons of alkaline-activated 20% sodium persulfate solution; and
- 2014: 103,000 gallons of alkaline-activated 20% sodium persulfate solution.

2.2.3 Groundwater Contamination

CSSA began groundwater monitoring using a low-flow system in early 1997. Camera surveys were completed in CS-1, CS-9, and CS-11, followed by upgrading that included carbon dioxide (CO₂) rehabilitation treatments. Ongoing work for SWMU and AOC site characterizations did not reveal additional potential sources contributing to the CS-16 area plume. However, past use of solvents in CSSA Building 90 was suspected as a potential source of contamination in the SW corner of the post. From 1998 through January 2004, CSSA continued monitoring water levels and conducting groundwater sampling on a quarterly schedule. Groundwater monitoring reports are included in Volume 5 of the CSSA Environmental Encyclopedia.

In 1998, planning for the installation of several clustered monitoring wells throughout CSSA was also initiated. The intention of the well clusters was to assist in the ongoing characterization



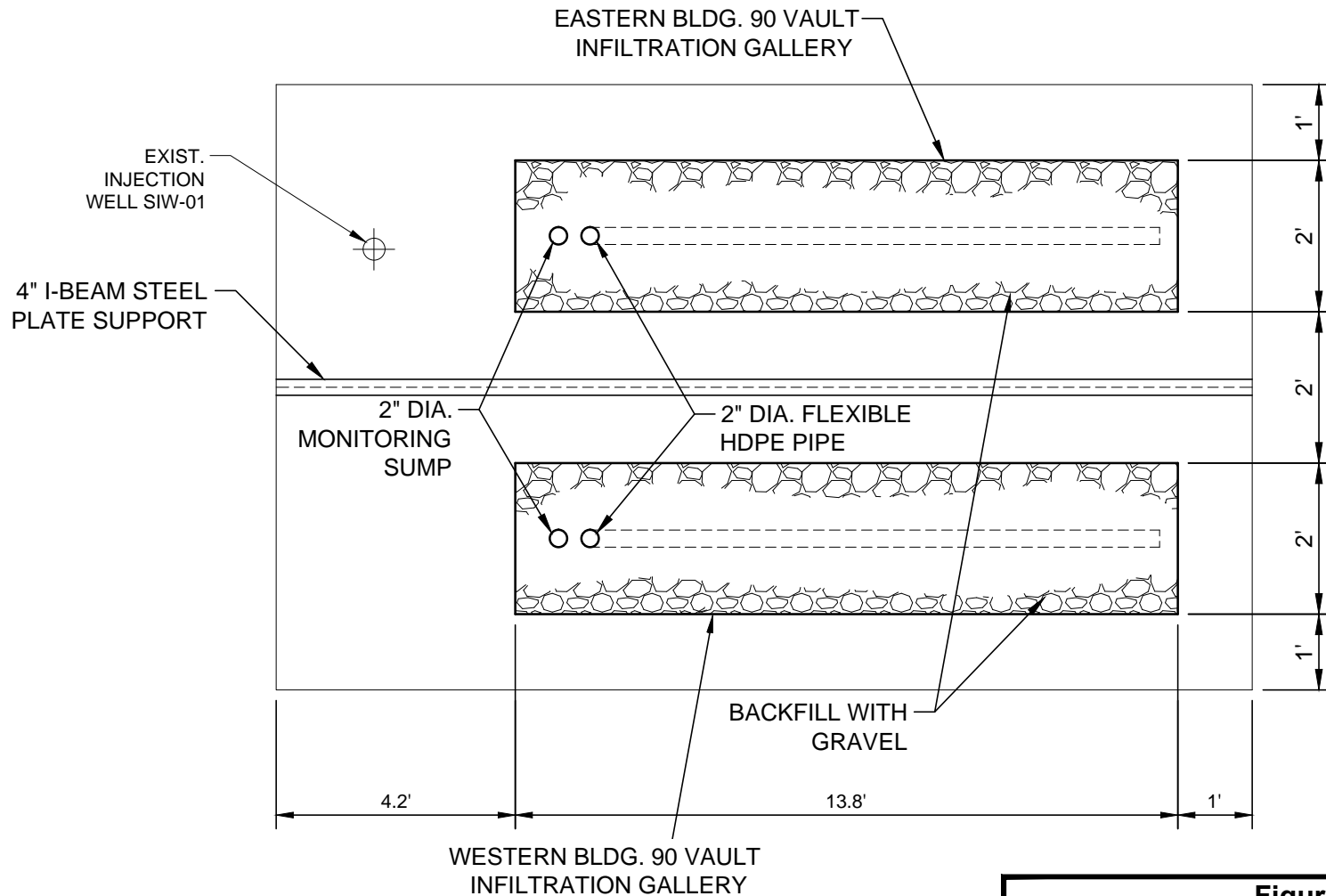


Figure 2.7

ISCO Building 90
Vault Infiltration Gallery Plan
Camp Stanley Storage Activity, Texas

PARSONS

of groundwater contamination at CSSA. The wells provided for monitoring of the major water-bearing zones in the LGR, BS, and CC portions of the Middle Trinity aquifer.

In 1999, an offsite well survey was conducted in the areas surrounding the CSSA facility. As many as 130 private or public supply wells were tentatively identified within one mile of CSSA. Of these, nearly 100 wells were positively identified and mapped. Most wells in the locality developed their water resources from the Middle Trinity aquifer.

The typical well construction for the area includes an open borehole completion through the LGR, BS, and CC portions of the aquifer with minimal surface casing. This methodology ensured adequate yield, but could enhance the likelihood of cross-contamination between water-bearing units. As part of the quarterly monitoring program, select offsite wells were sampled for the presence of target contaminant analytes.

As a result of the 1999 well survey, CSSA initiated an offsite well sampling program in December 1999. Based on this sampling, it was discovered that PCE and/or TCE was present in both public and private drinking water wells to the west and SW of the facility. These events lead to the search for another area of contaminant release, which ultimately lead to AOC-65, a solvent vat area in Building 90 where solvent had been used in the past.

In July and August 2001, two pumping tests were performed on CSSA wells CS-10 and CS-16. The tests were conducted to get a better sense of the hydraulic character of the Middle Trinity aquifer. The tests were conducted in wells that were open to both producing intervals of the aquifer: the Glen Rose Limestone and the CC Limestone. The resultant hydraulic conductivity ranged between 8.9 and 9.96 gpd/ft² (0.363 and 0.406 m/day).

In 2004, CSSA performed a Long-Term Monitoring Optimization (LTMO) study to evaluate the groundwater program in terms of both effectiveness and costs. The revised sampling program was implemented in December 2005. LTMO study sampling frequencies were initially implemented on-post in December 2005, as approved by TCEQ and USEPA. The LTMO evaluation was updated in 2010 using groundwater data from monitoring conducted between 2005 and 2009. It was approved by the TCEQ and USEPA and was implemented on- and off-post in June 2011. The current versions of the LTMO and Data Quality Objectives (DQOs) were updated with monitoring data collected between 2010 and 2014 and subsequently approved by the regulators for incorporation in the groundwater monitoring program in April and May 2016, respectively.

The CSSA groundwater monitoring program contains 196 sampling locations (**Figure 2.8**). The sampling locations include 64 on-post wells, 59 off-post wells, and eight Westbay wells totaling 73 distinct sampling locations throughout the eight wells. Detailed descriptions of the different well designs are included in the *Corrective Measures Design Report* (Parsons, 2016b).

As described above, a wellhead treatment system is installed on a private or public drinking water well if a COC concentration \geq 90% of the MCL threshold is identified during off-post monitoring. Off-post monitoring has identified six of these wells. Each of these six wells has a GAC treatment system installed to treat extracted water prior to distribution, storage, and use.

GAC systems typically consist of a treatment unit composed of two sequential carbon filters (carbon vessels) that receives water pumped directly from the well (**Figure 2.9**). As pumped water passes through the unit, VOCs are removed and treated water is then distributed to a

residence. The sequential carbon filter setup provides redundant treatment of water prior to distribution. Some GAC treatment systems are composed of dual treatment units, in which a total of four carbon filters are employed. In a dual system, GAC treatment units are installed in parallel to each other and water is pumped from the well, divided between the two units, treated, and then recombined before residential distribution.

Maintenance of the GAC carbon filters is performed by a service provider and is conducted on a semi-annual basis (February and August of each year). These maintenance activities typically do not coincide with scheduled sampling for the off-post groundwater monitoring program. Maintenance activities include exchanging each of the carbon filters semi-annually, as well as replacing the particulate pre-filters that remove solids from the extracted groundwater prior to entry into the carbon filters (every 3 weeks). Carbon filters are arranged in either a “lead” or “lag” position. During maintenance, the lead filter is exchanged with the lag filter and a new carbon vessel is installed into the lag position.

Inset Map B-3 Bioreactor

CS-D

CS-B3-MW01

B3-MW26-UGR

CS-WB07

B3-EXW03

B3-MW27-UGR

CS-4

B3-EXW04

CS-MW1-LGR

CS-MW1-CC

CS-MW1-BS

CS-MW16-CC

CS-MW16-LGR

CS-WB05

B3-MW34-UGR

B3-MW33-UGR

CS-WB08

B3-EXW05

B3-EXW01

B3-MW31-UGR

CS-WB06

B3-MW29-UGR

B3-MW30-UGR

B3-EXW02

CS-MW5-LGR

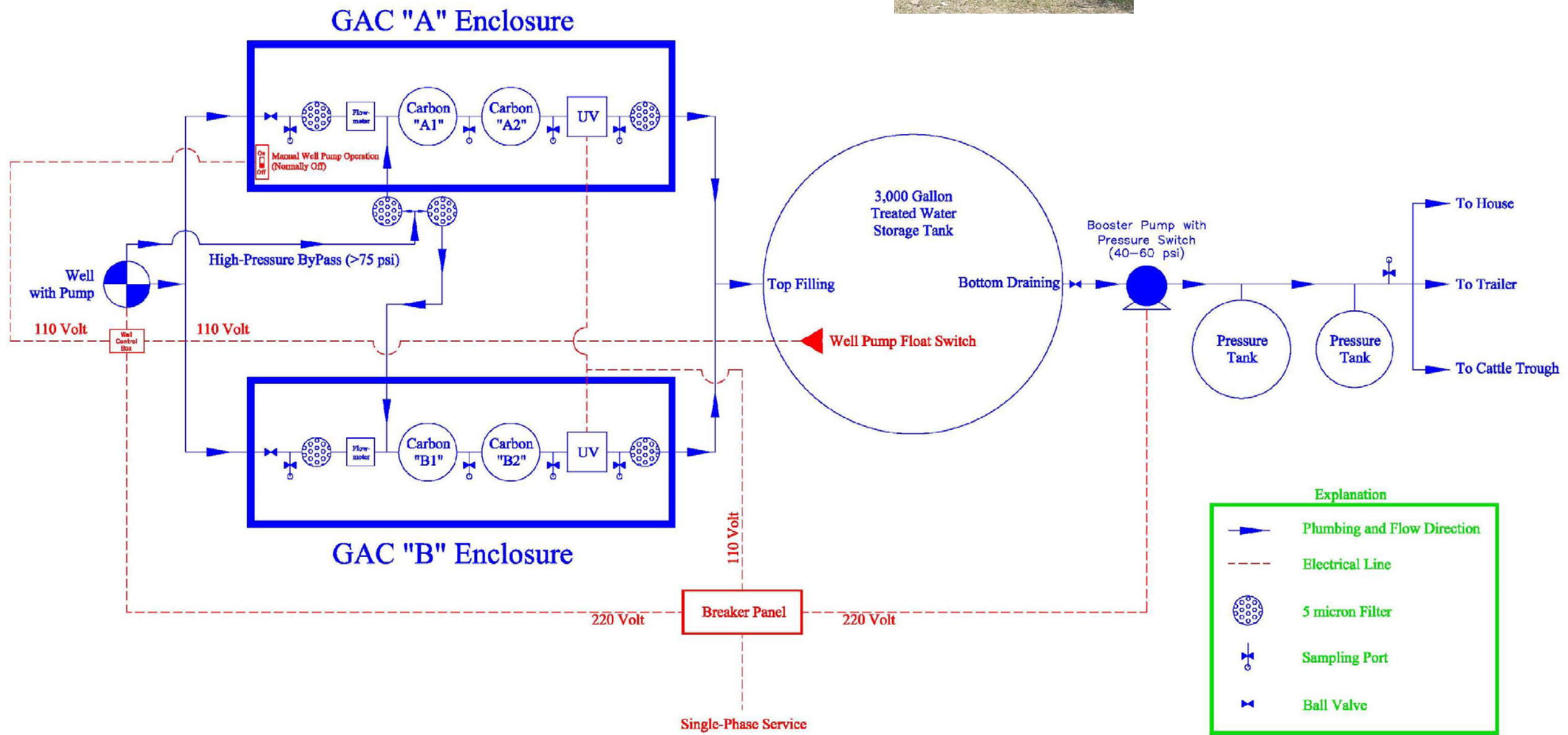
AOC65-VIEW20
AOC65-VIEW21
AOC65-PZ06-LGR
AOC65-PZ01-LGR
AOC65-VIEW19-UGR
AOC65-VIEW23
CS-MW36-LGR
AOC65-TSW-02
AOC65-VIEW25
AOC65-MW2A
AOC65-TSW-03
AOC65-TSW-04
AOC65-TSW-07
AOC65-PZ02-LGR
AOC65-PZ05-LGR
AOC65-MW1
AOC65-VIEW29
AOC65-VIEW15-UGR
AOC65-VIEW16-LGR
AOC65-VIEW31
AOC65-VIEW28A
AOC65-VIEW32
AOC65-TSW-05
AOC65-VIEW13-LGR
CS-WB03
AOC65-TSW-01
AOC65-VIEW27
AOC65-VIEW17-LGR
AOC65-VIEW18-LGR
AOC65-VIEW14-LGR
AOC65-VIEW26
CS-WB0
AOC65-TSW-06

**Inset Map
Building 90**

Notes: Wells shown in *italics* are not part of the current or proposed long-term monitoring program.
AOC65 wells are monitored as part of remediation efforts at the site.

Groundwater Monitoring Well
Locations
Camp Stanley Storage Activity

2-22



SECTION 3

SCOPE OF CMI

The purpose of CMI at CSSA was to achieve the CAOs developed in the CMS (Parsons, 2014) to identify goals for reducing hazards to ensure protection of human health, safety, and the environment. CAOs are intended to be as specific as possible, without limiting the range of alternatives that can be developed or to prescribe a particular alternative. Typically, these objectives are identified for hazardous substances at a site and for a specific medium, such as soil or groundwater, by which humans and the environment can become exposed. Regulations often require that CAOs achieve certain mandated criteria (e.g., drinking water maximum contaminant level regulations). CAOs specify:

- Contaminant(s) and media of concern;
- Exposure route(s) and receptor(s); and
- Remediation goal(s) for each exposure route.

The typical method for developing CAOs at waste sites involves considering the nature and extent of contamination, the potential exposure pathways, current and future receptors, and current and future land use.

3.1 SOIL

The CAO for soil at CSSA was to clean up contaminated soil at each site to Tier 1 or Tier 2 Residential Protective Concentration Limits (PCLs). All soil at identified SWMUs, AOCs, and RMUs at CSSA was remediated to residential PCLs with the exception of RMU-1 and the SWMUs included therein. RMU-1 will be remediated and closed when the range is no longer active.

3.2 GROUNDWATER

CAOs for groundwater at CSSA include:

1. Control migration of contaminated groundwater through source area treatment so COCs above MCLs do not migrate to groundwater in adjacent areas where concentrations are below MCLs.
2. Prevent human exposure to groundwater containing COCs at concentrations that exceed MCLs.
3. Control and monitor on-site worker dermal contact with, or ingestion of, COCs in shallow groundwater.

This approach is consistent with USEPA guidance on final cleanup goals for RCRA corrective action (USEPA, 2004). The corrective measure put in place to achieve each CAO is summarized in **Table 3.1**.

Table 3.1 Corrective Measures at CSSA

CAO	SWMU B-3	AOC-65	Groundwater
1	Bioreactor	ISCO	LUCs
2	LUCs	LUCs	GAC
3	LTM, LUCs	LTM, LUCs	LTM, LUCs

SECTION 4

CMI ACTIVITIES

This section presents the results of the corrective measures at CSSA since the publication of the USEPA Decision Document in July 2015. Ongoing activities include operations, maintenance, and monitoring of the SWMU B-3 bioreactor; continued ISCO applications and monitoring at AOC-65; and on- and off-post long-term groundwater monitoring.

4.1 SWMU B-3 BIOREACTOR

The bioreactor was selected as the final remedy for SWMU B-3 in July 2015, and ongoing operations and monitoring activities are expected to continue until the contamination in groundwater is reduced to below MCLs. Between February and May 2017, lactate and vegetable oil were applied at SWMU B-3 via three injection wells to enhance the bioremediation mechanisms already in place at the site. Lactate was also applied directly to the bioreactor trenches. Groundwater contaminant concentrations are monitored at surrounding monitoring wells including four Westbay multi-port wells, nine UGR wells, and four LGR wells, as shown on **Figure 4.1**.

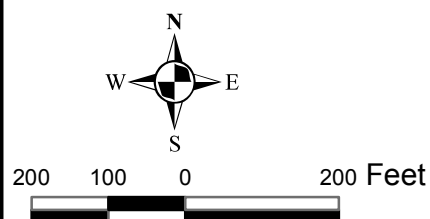
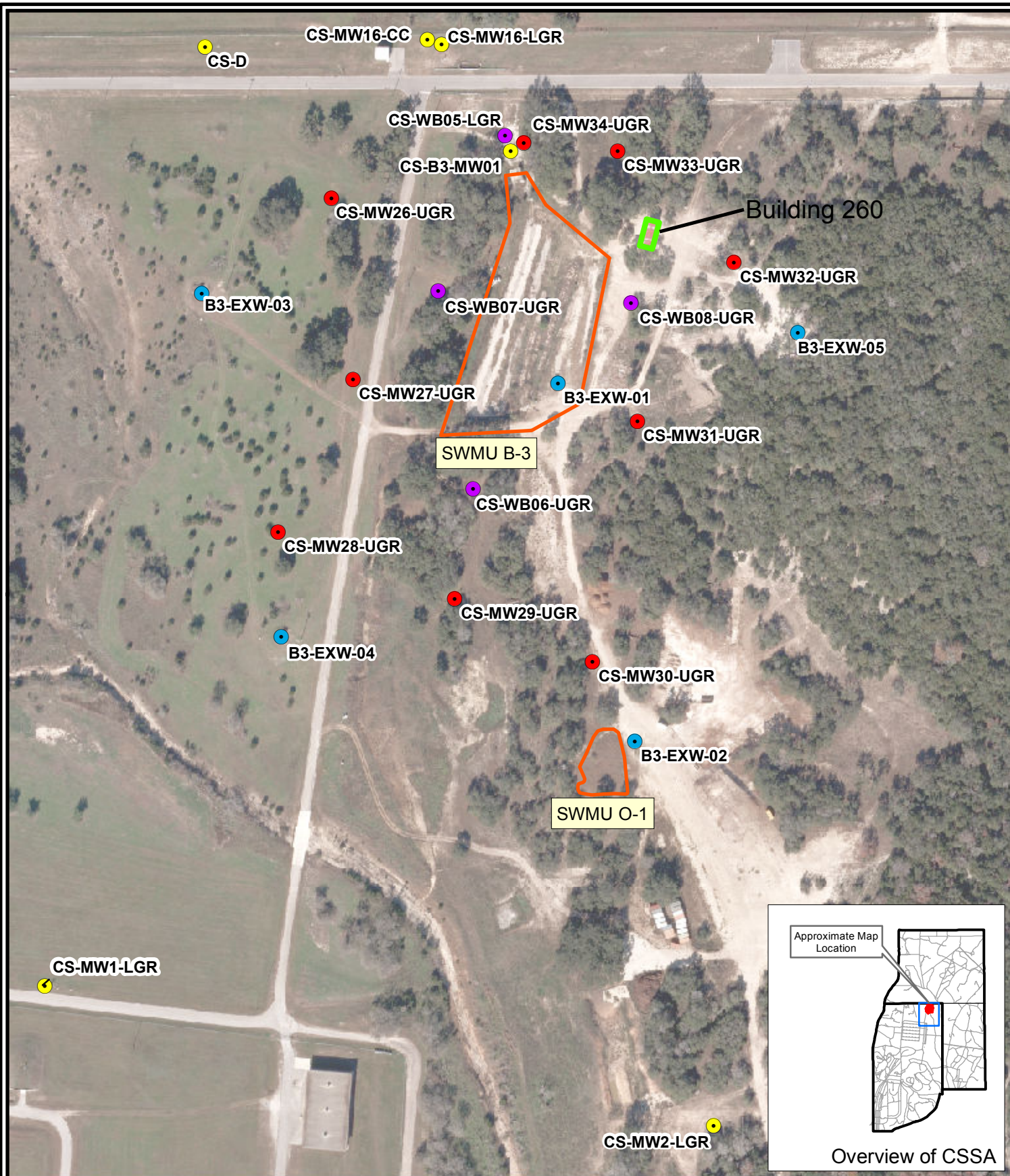
4.2 AOC-65

In July 2015, USEPA approved ISCO as the final remedy for groundwater contamination at AOC-65. Prior to this, four ISCO injections had been performed at AOC-65 as described in Section 2.2.2.3. In August and November 2015, two additional injections were performed which focused on the area between Bldg. 90 and the infiltration trench:

- August 2015: 3,500 gallons of 0.45% sodium permanganate solution; and
- November 2015: 7,000 gallons of 0.9% sodium permanganate solution

The change from sodium persulfate to sodium permanganate was intended to reduce total volumes injected, and thereby reduce artificial mounding, and changes to the groundwater gradients and flow directions locally. Results from the permanganate injections revealed distribution of ISCO solution was more widespread than anticipated given injection volumes were much smaller than persulfate applications. Variability in flow directions from ISCO injections, however, make it difficult to pinpoint application locations that provide the best distribution.

Groundwater samples collected at AOC-65 indicate the ISCO solution follows preferential flow paths. This was inferred by the positive field identification of persulfate (oxidant) and elevated pH (activator), and the presence of reaction by-products within the monitoring well network.



- UGR Monitoring Well Location
- Westbay Multi-port Well
- Supply/Monitoring Well
- Extraction Well
- SWMU Boundary

Figure 4.1

SWMU B-3
Monitoring Locations
Camp Stanley Storage Activity

PARSONS

4.3 GROUNDWATER MONITORING

The design of the groundwater monitoring program is based on the *Data Quality Objectives for the Groundwater Monitoring Program* (Parsons, 2016a), the *Three-Tiered Long-Term Monitoring Network Optimization Evaluation* (Parsons, 2016b); and the *CSSA Off-Post Monitoring Program Response Plan* (Parsons, 2002).

The DQO Report outlines the process for determining the frequency, locations, and methods of groundwater sample collection and analysis following USEPA's seven-step DQO process (**Figure 4.1**). In conjunction with the DQO Report, the LTMO Report summarizes the effectiveness of the CSSA monitoring network, and develops a site-specific strategy for groundwater sampling and analysis to maximize the amount of relevant information that can be obtained while minimizing incremental costs.

The purposes of the *CSSA Off-Post Monitoring Program Response Plan* are to (1) confirm area drinking water meets USEPA and TCEQ standards, (2) determine the lateral and vertical extent of VOC contamination, (3) determine if there are any potential off-post VOC source areas, (4) provide the framework to monitor off-post water wells that are located downgradient of known VOC source areas and within close proximity of CSSA, and (5) provide action levels and Army response guidance if additional off-post groundwater contamination is encountered.

4.4 POINT-OF-USE TREATMENT

The use of GAC treatment systems is the USEPA-approved Final Remedy for dissolved-phase VOC treatment in off-post groundwater per the CSSA Statement of Basis and Decision Documents (USEPA, 2015). The previous Response Plan (2002) did not address the use, maintenance, and monitoring aspects of the GAC wellhead treatment systems. This addendum describes the configuration of these systems and the frequency of maintenance and monitoring requirements.

CSSA has installed GAC treatment systems at six private off-post wells in which COC concentrations reached 90% or greater of the MCL for PCE and TCE (i.e., ≥ 4.5 milligrams per liter [mg/L]). Well locations that routinely exceed the MCL for PCE and/or TCE and are used for consumption include:

- Three private residences (LS-5, LS-7 and RFR-10 [2 GAC units]);
- Two businesses (OFR-3 and RFR-11); and
- One church (LS-6).

These wells are all located southwest of CSSA, within the extent of Plume 2 (**Figure 4.2**). Prior to 2008, two public supply wells (LS-2 and LS-3) for the Leon Springs Villas were also treated by a centralized high-capacity GAC unit. However, this PWS system no longer derives its groundwater from the Middle Trinity aquifer, and therefore the system was dismantled. This method of groundwater treatment employs activated carbon to remove organic contaminants from the groundwater. The entire system is self-contained within a small shed at each well location (Figure 2.9). There are multiple configurations of treatment dependent upon the well and water supply equipment that each well owner operates.

As described above, a wellhead treatment system is installed on a private or public drinking water well if a COC concentration $\geq 90\%$ of the MCL threshold is identified during off-post monitoring. Off-post monitoring has identified six of these wells. Each of these six wells has a GAC treatment system installed to treat extracted water prior to distribution, storage, and use.

GAC systems typically consist of a treatment unit composed of two sequential carbon filters (carbon vessels) that receives water pumped directly from the well. As pumped water passes through the unit, VOCs are removed and treated water is then distributed to a residence. The sequential carbon filter setup provides redundant treatment of water prior to distribution. Some GAC treatment systems are composed of dual treatment units, in which a total of four carbon filters are employed. In a dual system, GAC treatment units are installed in parallel to each other and water is pumped from the well, divided between the two units, treated, and then recombined before residential distribution. Off-post wells with GAC units are sampled for VOC COCs on a quarterly basis.

Maintenance of the GAC carbon filters is performed by a service provider and is conducted on a semi-annual basis (February and August of each year). These maintenance activities typically do not coincide with scheduled sampling for the off-post groundwater monitoring program. Maintenance activities include exchanging each of the carbon filters semi-annually, as well as replacing the particulate pre-filters that remove solids from the extracted groundwater prior to entry into the carbon filters (every 3 weeks). Carbon filters are arranged in either a “lead” or “lag” position. During maintenance, the lead filter is exchanged with the lag filter and a new carbon vessel is installed into the lag position.

4.5 SITE SPECIFIC DOCUMENTATION

Documentation for the SWMU B-3 bioreactor, AOC-65 ISCO, and groundwater monitoring operations and sampling results are described below.

4.5.1 SWMU B-3 Annual UIC Permit Letter

The annual UIC permit letter report provides TCEQ with the information needed to maintain the UIC permit required for bioreactor operations. The report documents the volume of extracted groundwater from the seven bioreactor extraction wells, the volume of recovered water injected into bioreactor trenches, system pressures, and water quality information including pH, VOCs, and TDS concentration data from quarterly samples collected from the system prior to injection. This letter report is submitted to the TCEQ UIC Permits Section, Radioactive Materials Division and the CSSA Environmental Program Manager within 45 days after Parsons receives the April bioreactor monitoring data (i.e., typically late June or July).

4.5.2 SWMU B-3 Annual Bioreactor Report

The Bioreactor Operations Annual Performance Status Report provides a summary of bioreactor operations and effectiveness throughout the year. A summary of operational parameters including extraction and injection volumes, precipitation, analytical results from semi-annual sampling events at all wells and sumps within the bioreactor monitoring network, field parameters and weekly system inspection results, and status of system maintenance issues. Additionally, planned activities for the following year are noted. This report is submitted to the CSSA Environmental Program Manager in July or August.

4.5.3 AOC-65 Annual UIC Permit Letter

The annual ISCO UIC Permit Letter Report provides the state regulator (TCEQ) information required to maintain the Underground Injection Control permit required for ISCO injection operations at AOC-65. The report documents any injections that have occurred including the location of injection, type and concentration of oxidant used, volumes injected, and the status of injection operations over the past year. This letter report is submitted to the TCEQ UIC Permits Section, Radioactive Materials Division and the CSSA Environmental Program Manager each June.

4.5.4 AOC-65 ISCO Assessment Reports

The ISCO Assessment Reports provide a summary of ISCO operations at AOC-65 and injection effectiveness following one or more injection events. These reports document any injections that have occurred during the reporting period and include information on the volume, oxidant type used, oxidant concentration, and injection location(s) as well as providing a summary of analytical data from quarterly sampling events at wells within the ISCO monitoring network. Additionally, planned injection activities for the following year are noted. This report is submitted to the CSSA Environmental Program Manager after each injection once adequate monitoring has been conducted.

4.5.5 Groundwater Monitoring Reports

The Quarterly and Annual Groundwater Reports provide an evaluation of results from groundwater monitoring conducted throughout the year at CSSA. Groundwater monitoring is performed on-post and off-post during the months of March, June, September, and December. The reports evaluate groundwater flow direction and elevations, groundwater contaminant concentrations for characterization purposes, and meteorological and seasonal variations in physical and chemical properties. The reports describe the physical and chemical characteristics of the groundwater monitoring results and change any occurring to the program each year.

SECTION 5

QUALITY ASSURANCE

5.1 QUALITY CONTROL PROCEDURES

Data verification, laboratory QC, and field QC samples used for this project are identified below.

5.1.2 Data Verification

Data collected were subjected to the data verification process outlined in the Quality Assurance Project Plan (QAPP) (Parsons, 2003) to assure that data correctly represent analytical measurements. In general, verification identifies non-technical errors in the data package that can be corrected (e.g., typographical errors). Data verification also includes verifying that the sample identifiers on laboratory reports match those on the COC record.

5.1.3 Laboratory QC Samples

Analytical laboratories follow QC requirements are followed during all analytical activities to produce data of known quality that satisfy the project objectives. Laboratory QC samples verify that sample handling procedures uphold the validity of the samples, and assess sample quality in terms of precision and accuracy. Laboratory QC samples monitor all phases of the analytical process.

- **Method Blanks:** One method blank is analyzed per batch of samples following the same analytical procedures as the field-collected samples. It is used to detect the presence and magnitude of contaminants or other anomalies resulting from sample preparation and analytical procedures.
- **Matrix Spikes/Matrix Spike Duplicates:** One matrix spike (MS)/matrix spike duplicate (MSD) pair is prepared and analyzed for every 20 VOC samples. The MS/MSD samples are prepared by spiking a known amount of an analyte for each method into a sample of the matrix. The spiked samples are then carried through the same procedures as the regular field-collected samples. The percent recoveries of the spiked compounds are used as an indication of the accuracy and appropriateness of the methods for the matrix. The precision of the method is also assessed by calculating and evaluating the relative percent difference (RPD) between the results of the MS and MSD.
- **Surrogates:** Surrogate compounds (artificial compounds with similar chemical properties and behavior as the compounds of interest) are added to each sample analyzed for applicable organic analytical methods. The percent recoveries of these spiked surrogate compounds are used to assess the accuracy of sample preparation and analytical procedures.

5.1.4 Field QC Samples

Field QC samples were collected in accordance with the QAPP (Parsons, 2003) to evaluate the reproducibility of the field sampling techniques.

- **Field Duplicates:** Field duplicate samples are collected at the same location as the original sample from either known or suspected contaminated areas of a site. Duplicate samples are collected in immediate succession, using identical recovery techniques, and treated in an identical manner during storage, transportation, and analysis. Results from the field duplicates are used to assess Total Precision (both sampling and analysis). Field duplicates are identified as duplicates but given different identification numbers on the containers and on the chain-of-custody forms. The chain-of-custody form must request all the specified analyses for both the samples.

If Total Precision exceeds the DQO limits for precision for a given matrix, the results of field samples may be used as estimated values. If the Total Precision for a set of duplicates could not be calculated because both samples are non-detects, the data do not require an R flag. The case narrative should state that the duplicates were analyzed and a numerical precision value could not be determined through no fault of the sampling or laboratory staff.

- **Trip Blank:** The trip blank consists of VOC sample vials filled in the laboratory with ASTM Type II reagent grade water, transported to the sampling site, handled like an environmental sample and returned to the laboratory for analysis. Trip blanks are used to assess the potential introduction of contaminants from sample containers or during the transportation and storage procedures.

Trip blanks are not opened in the field. Trip blanks are prepared only when VOC samples are taken and are analyzed only for VOC analytes. A trip blank is included when two or more samples are shipped in a cooler. The number of trip blanks needed should be discussed at the time of establishing the DQOs. When an analyte is detected in the trip blank, the appropriate validation flag, as described in the QAPP (Parsons, 2003) is applied to all the positive results for the samples shipped in the same cooler.

SECTION 6 RESULTS

This section presents data collected as part of the final remedial programs in place for SWMU B-3, AOC-65, and groundwater at CSSA since the Decision Document was signed in 2015.

6.1 SWMU B-3 BIOREACTOR

In the ten years the bioreactor has been operating at SWMU B-3, approximately 185,500,000 gallons of groundwater were extracted from CS-MW16-LGR, CS-MW16-CC, B3-EXW01, B3-EXW02, B3-EXW03, B3-EXW04, and B3-EXW05 and injected into bioreactor trenches 1 – 6 (**Figure 6.1**). Data from monitoring efforts indicate that the B-3 bioreactor has continued to maintain appropriate geochemical conditions for effective anaerobic dechlorination of chlorinated aliphatic hydrocarbons (CAHs) (including the maintenance of reducing conditions, neutral pH, and low dissolved oxygen concentrations).

Analytical results for samples collected in bioreactor trench sumps indicate reductive dechlorination is occurring resulting in the production of *cis*-1,2-DCE, VC, and ethene and low (~5 ppb) to non-detect concentrations of PCE and TCE. The decrease in VOC concentrations within the vadose zone beneath the bioreactor indicates the source material is being transformed within the bioreactor. Additionally, the injected waters conditioned to promote reductive dechlorination in the bioreactor have migrated from the vadose zone along fractures and preferred pathways into saturated portions of the aquifer resulting in an increase in VC and ethene concentrations.

In addition to a lateral bioreactor influence, as evidenced in VOC concentrations in shallow monitoring wells around the site, the development of a more vertical component of bioreactor influence is evident with an increase in observed concentrations of reductive dechlorination products at depth. Large increases in the reductive dechlorination product concentrations have been observed within samples originating as much as 300 feet bgs that prior to bioreactor operation had no detections of these components.

The best supporting evidence of reductive dechlorination is the presence of daughter products VC and ethene within the trench sumps and in deeper portions of the aquifer. Secondary lines of evidence include the production of ferrous iron (Fe^{2+}), which indicates groundwater conditions are sufficiently reducing for anaerobic dechlorination to occur; methane, which indicates that fermentation is occurring and that the potential for complete anaerobic dechlorination exists, and hydrogen concentrations above 1.0 nmol/L which indicate sufficient primary electron donor is present to sustain anaerobic dechlorination of CAHs.

Representative groundwater monitoring data collected at SWMU B-3 since the Decision Document was issued in July 2015 are presented in **Table 6.1**. Groundwater monitoring at SWMU B-3 will continue as described in the *SWMU B-3 Operations and Maintenance Manual* (Parsons, 2015a), and those data will be presented in a 5-year review report in 2020.

Table 6.1 Analytical Results from Bioreactor Trenches 1, 2, and 6

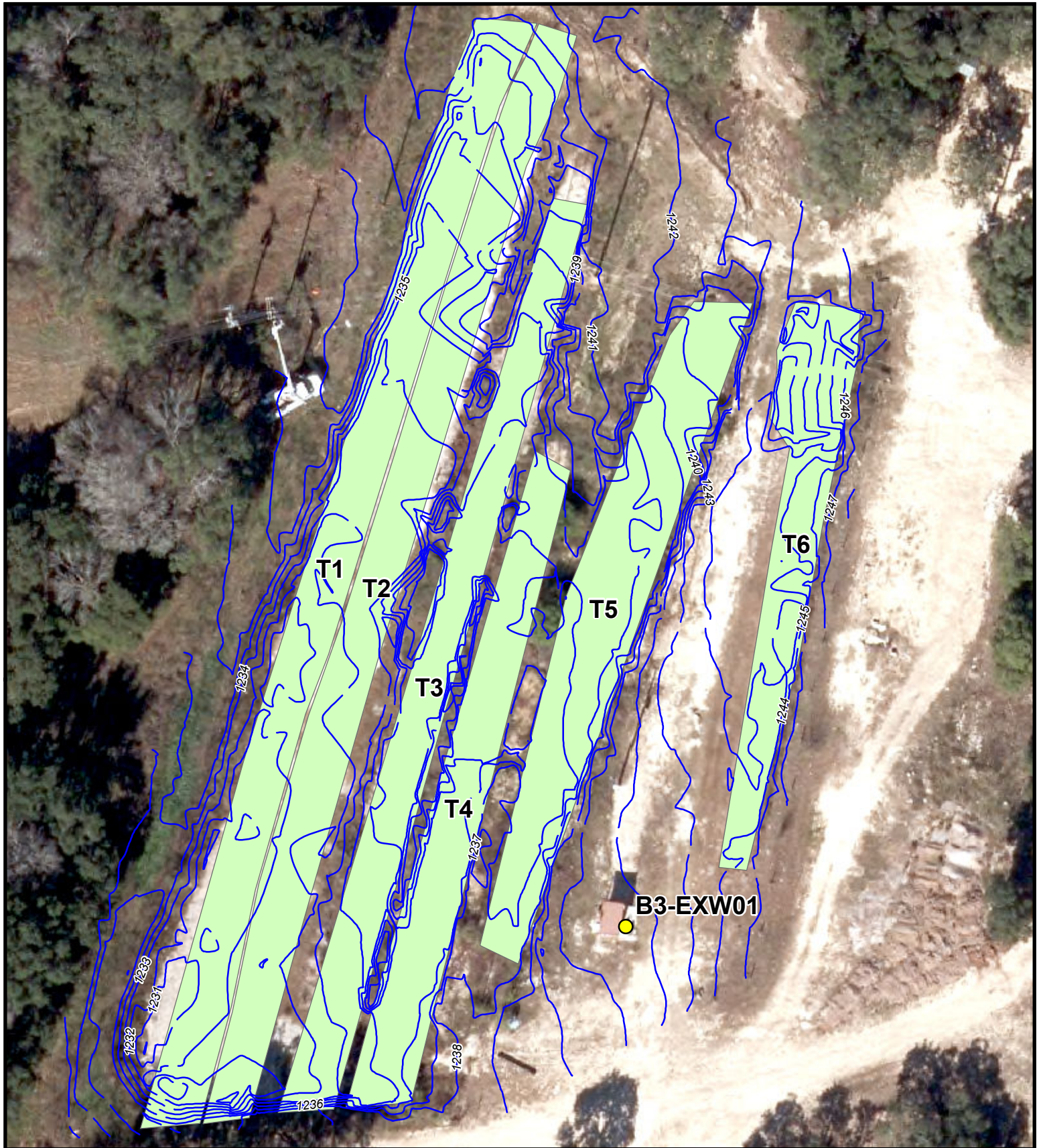
Trench 1 Sumps:	T1-1		T1-2		T1-3	
Date:	4/21/2016	3/9/2017	4/21/2016	3/9/2017	4/22/2016	3/9/2017
PCE (µg/L)	ND	ND	ND	ND	ND	ND
TCE (µg/L)	ND	0.61	ND	ND	ND	ND
cis-1,2-DCE (µg/L)	15	2.7	34	1.1	0.34	0.32
trans-1,2-DCE (µg/L)	0.99	ND	5.2	1.3	0.51	ND
VC (µg/L)	6.2	0.54	21	2.3	ND	0.49
Ethene (µg/L)	ND	ND	ND	ND	ND	ND

6.2 AOC-65

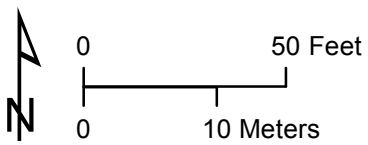
In the five years of ISCO operations at AOC-65, three separate persulfate solution injections and two permanganate solution injections have been performed. Additionally, one application of oxidant infused in a paraffin wax matrix has also been performed. Data from these injections indicate that a significant amount of contaminant mass remains in the unsaturated zone within AOC-65. While persulfate injections reduced contaminant concentrations at several wells within AOC-65, the increasing volumes of oxidant solution applied resulted in the mobilization of contaminants in directions contrary to typical groundwater flow direction. Additionally, auto-decomposition of persulfate restricts contact time with contaminants and therefore reduced effectiveness. Permanganate injection volumes on the other hand were much smaller, utilized smaller injection galleries, and therefore were more targeted to suspected contaminant source areas. Permanganate also does not auto decompose, therefore, maximizing contact time with any contaminants encountered.

Analytical results from shallow monitoring wells within AOC-65 indicate that both persulfate and permanganate injections oxidized contaminants. None of the oxidant injections provided complete coverage of the area due to the fractured nature of the bedrock shallow and at depth, and in some cases the artificial mounding caused by the injections resulted in unanticipated contaminant concentrations in wells deep and shallow and near to and far from injection sites. Rather than flooding the subsurface with oxidant, a more passive approach to oxidant application was devised in which oxidant infused wax cylinders were installed within six wells around the site. The cylinders release oxidant to groundwater flowing through the well. These wells were selected based on historic contaminant concentrations and proximity to the suspected source areas.

Groundwater monitoring data collected at AOC-65 since July 2015 are presented in **Table 6.2**. Groundwater monitoring at AOC-65 will continue as described in the *AOC-65 In-Situ Chemical Oxidation Operations and Monitoring Plan* (Parsons, 2013) and the *Three-Tiered Long Term Monitoring Network Optimization Evaluation* (Parsons, 2016b), and those data will be presented in a 5-year review report in 2020.



Aerial Photo Date: 2013



- Extraction Well
- ~ Elevation Contour (1 ft)
- Trench

Figure 6.1

SWMU B-3
Trench Locations
Camp Stanley Storage Activity

PARSONS

6.3 GROUNDWATER MONITORING

The CSSA groundwater monitoring program follows the provisions of the groundwater monitoring program *Final Data Quality Objectives for the Groundwater Monitoring Program* (Parsons 2016a), as well as the recommendations of the *Three-Tiered Long Term Monitoring Network Optimization Evaluation* (Parsons 2016b) which provided recommendations for sampling based on an LTMO study performed for the CSSA groundwater monitoring program.

Both on- and off-post groundwater samples were collected quarterly in 2016 (March, June, September, and December) in accordance with the approved CSSA LTMO program. The updated sampling schedule was implemented in September 2016 with most wells scheduled for sampling on a quarterly, 15-month, or 30-month interval. Groundwater data collected on-post and off-post in 2016 are presented in **Tables 6.3 through 6.5**.

In 2016, a total of 55 samples were collected from 34 on-post wells (Table 6.3). Contaminant concentrations above drinking water standards were detected at 4 on-post wells. Wells (CS-D, CS-MW1-LGR, CS-MW5-LGR, and CS-MW36-LGR) exceeded drinking water standards for VOCs. No wells exceeded drinking water standards for metals in 2016.

A total of 66 samples were collected from 37 Westbay zones in 2016. VOC concentrations above drinking water standards were detected in a total of 15 zones at all four Westbay locations (Table 6.4).

In 2016, a total of 52 samples were collected from 20 off-post wells and 6 GAC wellhead treatment locations (Table 6.5). VOC concentrations above drinking water standards were detected at two off-post wells (OFR-3 and RFR-10). OFR-3 and RFR 10 had GAC units installed at the wellheads in 2002 and 2001, respectively. These GAC filtration units remove VOC contamination prior to use. One post-GAC sample from RFR-10 broke the MCL in March 2016. This unit was immediately taken offline and the carbon canisters were replaced. Additional samples were collected to ensure the unit was working properly before it was placed back into service. Samples collected after the treatment system at OFR-3 (post-GAC samples) continue to show that all VOC are being removed from the well, and the treatment is effective.

On- and off-post groundwater at CSSA will continue to be monitored as described in the *Final Data Quality Objectives for the Groundwater Monitoring Program* (Parsons 2016a) and the *Three-Tiered Long Term Monitoring Network Optimization Evaluation* (Parsons 2016b), and those results will be presented in a 5-year review report in 2020.

Table 6.2
VOC COCs for Selected Samples
Collected August 2015 - April 2017

SAMPLE ID: DATE SAMPLED: LAB SAMPLE ID:		AOC65-TSW-01 9/24/2015 AZ22286	AOC65-TSW-01 11/30/2015 AZ25727	AOC65-TSW-01 1/13/2016 AZ27467	AOC65-TSW-01 2/10/2016 AZ28835	AOC65-TSW-01 3/10/2016 AZ30452	AOC65-TSW-01 6/21/2016 AZ37613	AOC65-TSW-01 10/4/2016 AZ43917	AOC65-TSW-01 11/29/2016 AZ46478	AOC65-TSW-01 4/3/2017 AZ53112
Volatile Organics - SW8260B cis-1,2-Dichloroethene Tetrachloroethene (PCE) trans-1,2-Dichloroethene Trichloroethene (TCE) Vinyl chloride	Units									
	µg/L	1.8 U	0.070 U	0.70 U	1.4 U	3.5 U	2.32	3.67	1.68	1.03 F
	µg/L	822.41	713.12	1,702	1,288	838.43	4,609	5,264	3,134	926.32
	µg/L	2.0 U	0.080 U	0.80 U	1.6 U	4.0 U	0.080 U	0.080 U	0.080 U	0.080 U
	µg/L	1.2 U	0.75 F	2.99 F	1.0 U	2.5 U	5.06	6.1	5.02	1.42
	µg/L	2.0 U	0.080 U	0.80 U	1.6 U	4.0 U	0.080 U	0.080 U	0.080 U	0.080 U

SAMPLE ID: DATE SAMPLED: LAB SAMPLE ID:		AOC65-TSW-05 8/21/2015 AZ20592	AOC65-TSW-05 9/24/2015 AZ22282	AOC65-TSW-05 11/30/2015 AZ25724	AOC65-TSW-05 1/13/2016 AZ27473	AOC65-TSW-05 2/10/2016 AZ28842	AOC65-TSW-05 3/11/2016 AZ30465	AOC65-TSW-05 6/21/2016 AZ37617	AOC65-TSW-05 10/5/2016 AZ43923	AOC65-TSW-05 11/30/2016 AZ46490
Volatile Organics - SW8260B cis-1,2-Dichloroethene Tetrachloroethene (PCE) trans-1,2-Dichloroethene Trichloroethene (TCE) Vinyl chloride	Units									
	µg/L	0.070 U	0.14 U	0.070 U	0.070 U	0.070 U	0.070 U	0.070 U	0.070 U	0.070 U
	µg/L	243.92	174.23	105.12	124.27	98.6	157.5	626.49	224.14	136.73
	µg/L	0.080 U	0.16 U	0.080 U	0.080 U	0.080 U	0.080 U	0.080 U	0.080 U	0.080 U
	µg/L	0.27 F	0.10 U	0.22 F	0.37 F	0.37 F	0.43 F	0.51 F	0.37 F	0.050 U
	µg/L	0.080 U	0.16 U	0.080 U	0.080 U	0.080 U	0.080 U	0.080 U	0.080 U	0.080 U

SAMPLE ID: DATE SAMPLED: LAB SAMPLE ID:		AOC65-TSW-05 4/3/2017 AZ53114	AOC65-VEW27 8/21/2015 AZ20595	AOC65-VEW27 9/24/2015 AZ22269	AOC65-VEW27 11/30/2015 AZ25726	AOC65-VEW27 1/13/2016 AZ27469	AOC65-VEW27 2/10/2016 AZ28824	AOC65-VEW27 3/10/2016 AZ30453	AOC65-VEW27 6/21/2016 AZ37606	AOC65-VEW27 10/4/2016 AZ43927
Volatile Organics - SW8260B cis-1,2-Dichloroethene Tetrachloroethene (PCE) trans-1,2-Dichloroethene Trichloroethene (TCE) Vinyl chloride	Units									
	µg/L	0.070 U	0.14 U	0.28 F	0.070 U	0.25 F	0.070 U	0.35 U	0.070 U	0.070 U
	µg/L	178.39	21.32	59.35	0.91 F	144.48	246.5	384.89	95.97	10.7
	µg/L	0.080 U	0.16 U	0.080 U	0.080 U	0.080 U	0.080 U	0.40 U	0.080 U	0.080 U
	µg/L	0.31 F	0.10 U	0.77 F	0.050 U	2.81	8.89	4.74 F	1.74	0.050 U
	µg/L	0.080 U	0.16 U	0.080 U	0.080 U	0.080 U	0.080 U	0.40 U	0.080 U	0.080 U

SAMPLE ID: DATE SAMPLED: LAB SAMPLE ID:		AOC65-VEW27 11/30/2016 AZ46483	AOC65-VEW27 4/3/2017 AZ53106	AOC65-VEW32 8/21/2015 AZ20594	AOC65-VEW32 9/24/2015 AZ22275	AOC65-VEW32 12/1/2015 AZ25723	AOC65-VEW32 1/13/2016 AZ27466	AOC65-VEW32 2/10/2016 AZ28829	AOC65-VEW32 3/11/2016 AZ30457	AOC65-VEW32 6/21/2016 AZ37611
Volatile Organics - SW8260B cis-1,2-Dichloroethene Tetrachloroethene (PCE) trans-1,2-Dichloroethene Trichloroethene (TCE) Vinyl chloride	Units									
	µg/L	17.96	26.29	2.79	7.0 U	0.070 U	5.51 F	7.0 U	16.95 F	1.97
	µg/L	550.69	148.86	21,340	11,437	656.25	3,271	5,320	7,488	660.39
	µg/L	1.71	1.01	0.16 U	8.0 U	0.080 U	0.80 U	8.0 U	8.0 U	0.080 U
	µg/L	102.68	59.22	5.41	5.0 U	0.24 F	33.15	36.57 F	42.61 F	3.51
	µg/L	3.78	8.26	0.16 U	8.0 U	0.080 U	0.80 U	8.0 U	8.0 U	0.080 U

Table 6.2
VOC COCs for Selected Samples Collected
August 2015 - April 2017

SAMPLE ID: DATE SAMPLED: LAB SAMPLE ID:		AOC65-VEW32 10/4/2016 AZ43930	AOC65-VEW32 11/30/2016 AZ46488	AOC65-VEW32 4/3/2017 AZ53113	CS-MW36-LGR 9/11/2015 AZ21514	CS-MW36-LGR 12/9/2015 AZ26200	CS-MW36-LGR 3/8/2016 AZ30233	CS-MW36-LGR 6/7/2016 AZ36818	CS-MW36-LGR 9/12/2016 AZ42800
Volatile Organics - SW8260B	Units								
cis-1,2-Dichloroethene	µg/L	0.61 F	0.81 F	0.070 U	0.36 F	0.070 U	0.28 F	0.070 U	0.070 U
Tetrachloroethene (PCE)	µg/L	333.44	1,144	4,909	13.21	6.71	8.26	4.12	5.35
trans-1,2-Dichloroethene	µg/L	0.080 U	0.080 U	0.080 U	0.080 U	0.080 U	0.080 U	0.080 U	--
Trichloroethene (TCE)	µg/L	1.58	3.08	2.37	12.01	2.34	7.86	1.53	2.35
Vinyl chloride	µg/L	0.080 U	0.080 U	0.080 U	0.080 U	0.080 U	0.080 U	0.080 U	0.080 U

SAMPLE ID: DATE SAMPLED: LAB SAMPLE ID:		CS-MW36-LGR 12/12/2016 AZ47438	CS-MW36-LGR 3/6/2017 AZ51127	CS-WB01-LGR-09 9/16/2015 AZ21843	CS-WB01-LGR-09 12/2/2015 AZ25821	CS-WB01-LGR-09 3/9/2016 AZ30224	CS-WB01-LGR-09 6/8/2016 AZ36797	CS-WB01-LGR-09 9/14/2016 AZ43163	CS-WB01-LGR-09 12/14/2016 AZ47730
Volatile Organics - SW8260B	Units								
cis-1,2-Dichloroethene	µg/L	0.090 F	0.070 U	0.60 F	0.58 F	0.44 F	0.69 F	0.49 F	0.61 F
Tetrachloroethene (PCE)	µg/L	5.54	4.87	12.41	16.96	10.23	9.55	7.95	17.56
trans-1,2-Dichloroethene	µg/L	0.080 U	0.080 U	0.080 U	0.080 U	0.080 U	0.080 U	--	0.080 U
Trichloroethene (TCE)	µg/L	3.13	1.56	14.37	19.05	12.3	12.56	10.89	18.25
Vinyl chloride	µg/L	0.080 U	0.080 U	0.080 U	0.080 U	0.080 U	0.080 U	0.080 U	0.080 U

SAMPLE ID: DATE SAMPLED: LAB SAMPLE ID:		CS-WB01-LGR-09 3/15/2017 AZ52051	CS-WB02-LGR-09 9/23/2015 AZ22163	CS-WB02-LGR-09 12/2/2015 AZ25822	CS-WB02-LGR-09 3/14/2016 AZ30559	CS-WB02-LGR-09 6/14/2016 AZ37011	CS-WB02-LGR-09 9/15/2016 AZ43165	CS-WB02-LGR-09 12/15/2016 AZ47732	CS-WB02-LGR-09 3/15/2017 AZ52053
Volatile Organics - SW8260B	Units								
cis-1,2-Dichloroethene	µg/L	0.61 F	0.20 F	0.18 F	0.070 U	0.070 U	0.070 U	0.18 F	0.070 U
Tetrachloroethene (PCE)	µg/L	8.57	9.43	14.18	5.74	7.31	7.05	12.55	7.62
trans-1,2-Dichloroethene	µg/L	0.080 U	0.080 U	0.080 U	0.080 U	0.080 U	--	0.080 U	0.080 U
Trichloroethene (TCE)	µg/L	11.36	7.31	11.24	6.19	7.42	6.81	10.47	7.24
Vinyl chloride	µg/L	0.080 U	0.080 U	0.080 U	0.080 U	0.080 U	0.080 U	0.080 U	0.080 U

SAMPLE ID: DATE SAMPLED: LAB SAMPLE ID:		CS-WB03-LGR-09 9/17/2015 AZ21852	CS-WB03-LGR-09 12/2/2015 AZ25823	CS-WB03-LGR-09 3/14/2016 AZ30560	CS-WB03-LGR-09 6/15/2016 AZ37245	CS-WB03-LGR-09 9/19/2016 AZ43272	CS-WB03-LGR-09 12/15/2016 AZ47733	CS-WB03-LGR-09 3/15/2017 AZ52054	CS-WB03-UGR-01 9/21/2015 AZ21921
Volatile Organics - SW8260B	Units								
cis-1,2-Dichloroethene	µg/L	0.49 F	0.20 F	0.070 U	0.070 U	0.070 U	0.070 U	0.070 U	21.7 F
Tetrachloroethene (PCE)	µg/L	4.61	3.25	2.3	1.94	2.64	4.91	2.61	23,737
trans-1,2-Dichloroethene	µg/L	0.080 U	0.080 U	0.080 U	0.080 U	--	0.080 U	0.080 U	8.0 U
Trichloroethene (TCE)	µg/L	4.39	3.84	2.59	2.69	2.87	4.92	2.89	216.25
Vinyl chloride	µg/L	0.080 U	0.080 U	0.080 U	0.080 U	0.080 U	0.080 U	0.080 U	8.0 U

Table 6.2
VOC COCs for Selected Samples Collected
August 2015 - April 2017

SAMPLE ID: DATE SAMPLED: LAB SAMPLE ID:		CS-WB03-UGR-01 12/2/2015 AZ25814	CS-WB03-UGR-01 3/14/2016 AZ30562	CS-WB03-UGR-01 6/16/2016 AZ37254	CS-WB03-UGR-01 9/19/2016 AZ43280	CS-WB03-UGR-01 12/15/2016 AZ47735	CS-WB03-UGR-01 3/15/2017 AZ52056	CS-WB04-LGR-11 9/22/2015 AZ22154	CS-WB04-LGR-11 12/3/2015 AZ25824
Volatile Organics - SW8260B	Units								
cis-1,2-Dichloroethene	µg/L	22.09 F	20.94 F	7.94	16.67	12.65	7.8	0.070 U	0.070 U
Tetrachloroethene (PCE)	µg/L	28,943	9,873	7,444	9,817	18,548	6,503	1.5	22.11
trans-1,2-Dichloroethene	µg/L	20 U	8.0 U	0.95	--	2.51	1.42	0.080 U	0.080 U
Trichloroethene (TCE)	µg/L	250.91	101.51	73.39	129.76	114.43 F	64.64	0.050 U	0.12 F
Vinyl chloride	µg/L	20 U	8.0 U	0.080 U	0.080 U	0.080 U	0.080 U	0.080 U	0.080 U

SAMPLE ID: DATE SAMPLED: LAB SAMPLE ID:		CS-WB04-LGR-11 3/8/2016 AZ30222	CS-WB04-LGR-11 6/9/2016 AZ36807	CS-WB04-LGR-11 9/20/2016 AZ43281	CS-WB04-LGR-11 12/14/2016 AZ47728	CS-WB04-LGR-11 3/22/2017 AZ52301
Volatile Organics - SW8260B	Units					
cis-1,2-Dichloroethene	µg/L	0.070 U	0.070 U	0.14 U	0.070 U	0.070 U
Tetrachloroethene (PCE)	µg/L	0.060 U	0.060 U	1.41 F	0.64 F	0.62 F
trans-1,2-Dichloroethene	µg/L	0.080 U	0.080 U	--	0.080 U	0.080 U
Trichloroethene (TCE)	µg/L	0.050 U	0.050 U	0.10 U	0.050 U	0.050 U
Vinyl chloride	µg/L	0.080 U	0.080 U	0.16 U	0.080 U	0.080 U

QA NOTES AND DATA QUALIFIERS:
(NO CODE) - Confirmed identification.
U - Analyte was not detected above the indicated Method Detection Limit (MDL).
F - Analyte was positively identified, but the quantitation is an estimation above the MDL and below the Reporting Limit (RL).
Detections are bolded.
-- - Analyte was not tested.

Table 6.3
2016 On-post Groundwater COCs and Metals Analytical Results

Well ID	Laboratory	Analytical Method	Sample Date	Dichloro-ethene, 1,1 (ug/L)	Dichloro-ethene, <i>cis</i> - 1,2 (ug/L)	Dichloro-ethene, <i>trans</i> - 1,2 (ug/L)	Tetra-chloroethene (ug/L)	Tri-chloroethene (ug/L)	Vinyl chloride (ug/L)
CS-1	APPL	SW8260B	3/16/2016	--	--	--	--	--	--
	APPL	SW8260B	6/17/2016	--	--	--	0.27F	--	--
	APPL	SW8260B	7/21/2016	--	--	--	--	--	--
	APPL	SW8260B	9/27/2016	NA	--	NA	--	--	--
	APPL	SW8260B	12/13/2016	NA	--	NA	0.08F	--	--
CS-2	APPL	SW8260B	9/9/2016	NA	--	NA	--	--	--
CS-4	APPL	SW8260B	9/9/2016	NA	--	NA	0.68F	0.64F	--
	Duplicate	APPL	SW8260B	9/9/2016	NA	0.09F	0.66F	0.57F	--
CS-10	APPL	SW8260B	3/16/2016	--	--	--	--	--	--
	Duplicate	APPL	SW8260B	3/16/2016	--	--	--	--	--
	APPL	SW8260B	6/17/2016	--	--	--	0.16F	--	--
	APPL	SW8260B	7/21/2016	--	--	--	--	--	--
	APPL	SW8260B	9/27/2016	NA	--	NA	--	--	--
	Duplicate	APPL	SW8260B	9/27/2016	NA	--	NA	--	--
	APPL	SW8260B	12/13/2016	NA	--	NA	0.09F	--	--
	Duplicate	APPL	SW8260B	12/13/2016	NA	--	NA	--	--
CS-12	APPL	SW8260B	3/16/2016	--	--	--	--	--	--
	APPL	SW8260B	6/17/2016	--	--	--	0.35F	--	--
	APPL	SW8260B	7/21/2016	--	--	--	--	--	--
	Duplicate	APPL	SW8260B	7/21/2016	--	--	--	--	--
	APPL	SW8260B	9/27/2016	NA	--	NA	--	--	--
	APPL	SW8260B	12/13/2016	NA	--	NA	0.08F	--	--
CS-13	APPL	SW8260B	3/16/2016	--	--	--	--	--	--
	APPL	SW8260B	6/20/2016	--	--	--	--	--	--
	APPL	SW8260B	10/3/2016	NA	--	NA	--	--	--
CS-D	APPL	SW8260B	9/22/2016	NA	12.71	NA	13.14	18.9	--
CS-MWG-LGR	APPL	SW8260B	2/3/2016	--	--	--	--	--	--
CS-MWH-LGR	APPL	SW8260B	2/3/2016	--	--	--	--	--	--
CS-I	APPL	SW8260B	2/3/2016	--	--	--	--	--	--
CS-MW1-LGR	APPL	SW8260B	9/21/2016	NA	24.14	NA	15.1	24.46	--
CS-MW2-LGR	APPL	SW8260B	9/9/2016	NA	0.49F	NA	--	--	--
CS-MW3-LGR	APPL	SW8260B	9/13/2016	NA	--	NA	--	--	--
CS-MW4-LGR	APPL	SW8260B	9/9/2016	NA	--	NA	--	--	--
CS-MW5-LGR	APPL	SW8260B	2/3/2016	--	16.12	0.43F	7.68	17.93	--
	APPL	SW8260B	3/8/2016	--	16.94	0.44F	6.99	18.68	--
	APPL	SW8260B	6/7/2016	--	10.5	--	4.18	10.96	--
	APPL	SW8260B	9/9/2016	NA	10.89	NA	5.2	12.32	--
	APPL	SW8260B	12/12/2016	NA	12.86	NA	5.26	12.91	--
CS-MW6-LGR	APPL	SW8260B	9/12/2016	NA	--	NA	--	--	--
CS-MW7-LGR	APPL	SW8260B	9/12/2016	NA	--	NA	0.72F	--	--
CS-MW8-LGR	APPL	SW8260B	9/12/2016	NA	--	NA	2.66	--	--
CS-MW9-LGR	APPL	SW8260B	9/13/2016	NA	--	NA	--	--	--
CS-MW10-LGR	APPL	SW8260B	9/12/2016	NA	--	NA	2.02	0.41F	--
CS-MW11A-LGR	APPL	SW8260B	9/12/2016	NA	--	NA	0.56F	--	--
	Duplicate	APPL	SW8260B	9/12/2016	NA	--	0.60F	--	--
CS-MW11B-LGR	APPL	SW8260B	9/13/2016	NA	--	NA	0.90F	--	--
CS-MW12-LGR	APPL	SW8260B	9/8/2016	NA	--	NA	--	--	--
CS-MW17-LGR	APPL	SW8260B	9/21/2016	NA	--	NA	0.74F	--	--
CS-MW18-LGR	APPL	SW8260B	9/9/2016	NA	--	NA	--	--	--
CS-MW19-LGR	APPL	SW8260B	9/8/2016	NA	--	NA	--	--	--
CS-MW20-LGR	APPL	SW8260B	9/13/2016	NA	--	NA	1.47	--	--
CS-MW21-LGR	APPL	SW8260B	9/13/2016	NA	--	NA	--	--	--
CS-MW22-LGR	APPL	SW8260B	9/13/2016	NA	--	NA	--	--	--
CS-MW23-LGR	APPL	SW8260B	9/13/2016	NA	--	NA	--	--	--
CS-MW24-LGR	APPL	SW8260B	9/14/2016	NA	--	NA	--	--	--

Table 6.3 (cont)
2016 On-post Groundwater COCs and Metals Analytical Results

Well ID	Laboratory	Analytical Method	Sample Date	Dichloro-ethene, 1,1 (ug/L)	Dichloro-ethene, <i>cis</i> - 1,2 (ug/L)	Dichloro-ethene, <i>trans</i> - 1,2 (ug/L)	Tetra-chloroethene (ug/L)	Tri-chloroethene (ug/L)	Vinyl chloride (ug/L)
CS-MW25-LGR	APPL	SW8260B	2/3/2016	--	--	--	--	--	--
	APPL	SW8260B	9/13/2016	NA	--	NA	0.07F	--	--
CS-MW35-LGR	APPL	SW8260B	9/12/2016	NA	--	NA	0.96F	--	--
CS-MW36-LGR	APPL	SW8260B	3/8/2016	--	0.28F	--	8.26	7.86	--
	APPL	SW8260B	6/7/2016	--	--	--	4.12	1.53	--
	APPL	SW8260B	9/12/2016	NA	--	NA	5.35	2.35	--
Comparison Criteria									
Maximum Contaminant Level (MCL)				7	70	100	5.0	5.0	2.0
Reporting Limit (RL)				1.2	1.2	0.6	1.4	1.0	1.1
MDL				0.12	0.07	0.08	0.06	0.05	0.08
BOLD	≥ MDL								
BOLD	≥ RL								
BOLD	≥ MCL								

All samples were analyzed by APPL, Inc.

VOC data reported in ug/L & metals data reported in mg/L.

Abbreviations/Notes:

Duplicate Field Duplicate
TCE Trichloroethene
PCE Tetrachloroethene
DCE Dichloroethene

Data Qualifiers

NA = Analyte not analyzed

-- = The analyte was analyzed for, but not detected. The associated numerical value is at or below the MDL.

F = The analyte was positively identified but the associated numerical value is below the RL.

Table 6.3 (cont)
2016 On-post Groundwater COCs and Metals Analytical Results

Well ID	Laboratory	Sample Date	Arsenic (mg/L)	Barium (mg/L)	Cadmium (mg/L)	Chromium (mg/L)	Copper (mg/L)	Lead (mg/L)	Mercury (mg/L)	Zinc (mg/L)
CS-1	APPL	3/16/2016	0.0067F	0.0344	--	--	0.005F	--	--	0.208
	APPL	6/17/2016	0.0078F	0.0395	--	0.0016F	0.014	0.0068F	--	0.284
	APPL	9/27/2016	--	0.0379	--	--	0.008F	--	--	0.392
	APPL	12/13/2016	0.00483F	0.0379	--	--	0.009F	--	--	0.230
CS-10 <i>Duplicate</i> <i>Duplicate</i> <i>Duplicate</i>	APPL	3/16/2016	0.0027F	0.0402	--	--	0.007F	--	0.0002F	0.751
	APPL	3/16/2016	0.0045F	0.0389	--	--	0.006F	--	0.0002F	0.708
	APPL	6/17/2016	0.0060F	0.0403	--	0.0014F	0.005F	0.0050F	--	0.357
	APPL	9/27/2016	--	0.0412	--	0.0013F	0.015	--	--	0.601
	APPL	9/27/2016	0.00024F	0.0429	--	--	0.005F	--	--	0.522
	APPL	12/13/2016	0.00571F	0.0396	--	--	0.005F	--	--	0.374
	APPL	12/13/2016	0.00236F	0.0396	--	--	0.012	--	--	0.413
CS-12	APPL	3/16/2016	0.0048F	0.0308	--	--	0.006F	--	--	0.049F
	APPL	6/17/2016	0.0070F	0.0314	--	0.0016F	0.035	0.0096F	--	0.104
	APPL	9/27/2016	0.00160F	0.031	--	0.0013F	0.006F	--	--	0.047F
	APPL	12/13/2016	0.00682F	0.0318	--	--	0.031	--	--	0.054
CS-13	APPL	3/16/2016	0.0067F	0.0297	--	--	0.005F	--	--	0.247
	APPL	6/20/2016	0.0028F	0.0308	--	0.0017F	--	--	--	0.276
	APPL	10/3/2016	0.00508F	0.0321	--	0.0015F	--	0.0027F	--	0.227
CS-MW5-LGR	APPL	3/8/2016	NA	NA	--	--	NA	--	--	NA
	APPL	6/7/2016	NA	NA	--	--	NA	--	--	NA
CS-MW36-LGR	APPL	3/8/2016	NA	NA	--	0.0131	NA	--	--	NA
	APPL	6/7/2016	NA	NA	--	0.0036F	NA	--	--	NA

Table 6.3 (cont)
2016 On-post Groundwater COCs and Metals Analytical Results

Well ID	Laboratory	Sample Date	Arsenic (mg/L)	Barium (mg/L)	Cadmium (mg/L)	Chromium (mg/L)	Copper (mg/L)	Lead (mg/L)	Mercury (mg/L)	Zinc (mg/L)
Comparison Criteria										
Maximum Contaminant Level (MCL)			0.01	2.0	0.005	0.1	1.3	0.015 (AL)	0.002	5.0 (SS)
		RL	0.03	0.005	0.007	0.01	0.01	0.025	0.001	0.05
		MDL	0.00022	0.0003	0.0005	0.001	0.003	0.0019	0.0001	0.008
Bold	≥ MCL									
Bold	≥ RL									
Bold	≥ MDL									

All samples were analyzed by APPL, Inc. using laboratory method SW8260B.

VOC data reported in µg/L & metals data reported in mg/L.

Abbreviations/Notes:

µg/L micrograms per liter

mg/L milligrams per liter

Duplicate Field Duplicate

AL Action Level

SS Secondary Standard

Data Qualifiers:

NA = Analyte not analyzed

F = The analyte was positively identified but the associated numerical value is below the RL.

-- =The analyte was analyzed for, but not detected. The associated numerical value is at or below the MDL.

Table 6.4
2016 Westbay® Groundwater COCs and Analytical Results

Well ID	Date	1,1-DCE	cis-1,2-DCE	trans-1,2-DCE	TCE	PCE	Vinyl Chloride
Method Detection Limit	MDL	0.3	0.16	0.19	0.16	0.15	0.23
Current Reporting Limit	RL	1.2	1.2	0.6	1.0	1.4	1.1
Max. Contaminant Level	MCL	7.0	70	100	5.0	5.0	2.0
CS-WB01-UGR-01	8-Jun-16	--	--	--	--	0.99F	--
	14-Sep-16	Dry	Dry	Dry	Dry	Dry	Dry
CS-WB01-LGR-01	8-Jun-16	--	--	--	0.22F	1.36F	--
	14-Sep-16	NA	--	NA	0.53F	0.93F	--
CS-WB01-LGR-02	8-Jun-16	--	--	--	2.05	9.6	--
	14-Sep-16	NA	--	NA	2.46	11.55	--
CS-WB01-LGR-03	8-Jun-16	--	--	--	19.59	7.06	--
	14-Sep-16	NA	--	NA	12.67	4.26	--
CS-WB01-LGR-04	8-Jun-16	--	0.28F	--	--	--	--
	14-Sep-16	NA	0.49F	NA	--	--	--
CS-WB01-LGR-05	8-Jun-16	--	0.41F	--	2.6	--	--
	14-Sep-16	NA	0.60F	NA	1.36	--	--
CS-WB01-LGR-06	8-Jun-16	--	1.58	--	3.03	--	--
	14-Sep-16	NA	2.10	NA	3.11	--	--
CS-WB01-LGR-07	8-Jun-16	--	0.29F	--	13.78	14.3	--
	14-Sep-16	NA	0.23F	NA	13.99	13.07	--
CS-WB01-LGR-08	8-Jun-16	--	18.31	0.76	4.59	0.79F	--
	14-Sep-16	NA	20.78	NA	2.81	--	--
CS-WB01-LGR-09	8-Jun-16	--	0.69F	--	12.56	9.55	--
	14-Sep-16	NA	0.49F	NA	10.89	7.95	--
CS-WB02-UGR-01	14-Jun-16	Dry	Dry	Dry	Dry	Dry	Dry
	15-Sep-16	NA	Dry	NA	Dry	Dry	Dry
CS-WB02-LGR-01	14-Jun-16	--	--	--	--	0.59F	--
	15-Sep-16	NA	Dry	NA	Dry	Dry	Dry
CS-WB02-LGR-02	14-Jun-16	--	--	--	--	0.22F	--
	15-Sep-16	NA	Dry	NA	Dry	Dry	Dry
CS-WB02-LGR-03	14-Jun-16	--	--	--	0.47F	3.28	--
	15-Sep-16	NA	--	NA	--	2.35	--
CS-WB02-LGR-04	14-Jun-16	--	--	--	5.03	2.86	--
	15-Sep-16	NA	--	NA	5.04	2.8	--
CS-WB02-LGR-05	14-Jun-16	--	0.23F	0.25F	1.92	0.66F	--
	15-Sep-16	NA	0.28F	NA	1.79	--	--
CS-WB02-LGR-06	14-Jun-16	--	--	--	2.27	5.38	--
	15-Sep-16	NA	--	NA	1.93	3.81	--
CS-WB02-LGR-07	14-Jun-16	--	0.31F	--	1.57	0.52F	--
	15-Sep-16	NA	0.40F	NA	1.34	0.48F	--
CS-WB02-LGR-08	14-Jun-16	--	3.1	0.36F	0.28F	--	--
	15-Sep-16	NA	4.28	NA	--	--	--
CS-WB02-LGR-09	14-Jun-16	--	--	--	7.42	7.31	--
	15-Sep-16	NA	--	NA	6.81	7.05	--
CS-WB03-UGR-01	16-Jun-16	--	7.94	0.95	73.39	7443.88*	--
	19-Sep-16	NA	16.67	NA	129.76*	9817.43*	--
CS-WB03-LGR-01	16-Jun-16	--	0.89F	--	17.22	314.33*	--
	19-Sep-16	NA	0.71F	NA	15.75	337.86*	--
CS-WB03-LGR-02	16-Jun-16	--	--	--	4.7	146.66*	--
	19-Sep-16	NA	Dry	NA	Dry	Dry	Dry
CS-WB03-LGR-03	16-Jun-16	--	--	--	1.13	3.79	--
	19-Sep-16	NA	--	NA	1.21	4.47	--
CS-WB03-LGR-04	16-Jun-16	--	0.25F	--	6.59	17.97	--
	19-Sep-16	NA	0.30F	NA	5.57	15.06	--

Table 6.4 (cont)
2016 Westbay® Groundwater COCs and Analytical Results

Well ID	Date	1,1-DCE	cis-1,2-DCE	trans-1,2-DCE	TCE	PCE	Vinyl Chloride
Method Detection Limit	MDL	0.3	0.16	0.19	0.16	0.15	0.23
Current Reporting Limit	RL	1.2	1.2	0.6	1.0	1.4	1.1
Max. Contaminant Level	MCL	7.0	70	100	5.0	5.0	2.0
CS-WB03-LGR-05	15-Jun-16	--	--	--	2.48	14.1	--
	19-Sep-16	NA	--	NA	2.67	15.71	--
CS-WB03-LGR-06	15-Jun-16	--	6.83	--	0.13F	--	--
	19-Sep-16	NA	8.87	NA	--	--	--
CS-WB03-LGR-07	15-Jun-16	--	3.09	--	21.75	6.22	--
	19-Sep-16	NA	3.47	NA	10.62	2.82	--
CS-WB03-LGR-08	15-Jun-16	--	2.73	--	0.27F	--	0.81F
	19-Sep-16	NA	3.14	NA	0.41F	--	1.14
CS-WB03-LGR-09	15-Jun-16	--	--	--	2.69	1.94	--
	19-Sep-16	NA	--	NA	2.87	2.64	--
CS-WB04-UGR-01	9-Jun-16	Dry	Dry	Dry	Dry	Dry	Dry
	20-Sep-16	NA	Dry	NA	Dry	Dry	Dry
CS-WB04-LGR-01	20-Sep-16	NA	--	NA	--	1.11F	--
CS-WB04-LGR-06	9-Jun-16	--	3.83	0.24F	13.37	13.96	--
	20-Sep-16	NA	5.53	NA	18.38	12.8	--
CS-WB04-LGR-07	9-Jun-16	--	37.11	0.23F	1.15	--	--
	20-Sep-16	NA	40.9	NA	2.15	0.40F	--
CS-WB04-LGR-08	9-Jun-16	--	--	--	0.86F	0.51F	--
	20-Sep-16	NA	0.42F	NA	1.29	1.41	--
CS-WB04-LGR-09	9-Jun-16	--	--	--	6.02	7.6	--
	20-Sep-16	NA	--	NA	7.84	14.72	--
CS-WB04-LGR10	9-Jun-16	--	--	--	0.73F	1.71	--
	20-Sep-16	NA	--	NA	0.57F	4.34	--
CS-WB04-LGR-11	9-Jun-16	--	--	--	--	--	--
	20-Sep-16	NA	--	NA	--	1.41F	--
BOLD	≥ MDL						
BOLD	≥ RL						
BOLD	≥ MCL						

Data Qualifiers

F = The analyte was positively identified but the associated numerical value is below the RL

* = dilution was performed for this sample.

-- = The analyte was analyzed for, but not detected. The associated numerical value is at or below the MDL.

NA = not analyzed

All values are reported in µg/L.

Table 6.5
2016 Off-Post Groundwater COCs and Analytical Results

Well ID	Laboratory	Analytical Method	Sample Date	1,1-Dichloro-ethene (ug/L)	cis -1,2-Dichloro-ethene (ug/L)	trans -1,2-Dichloro-ethene (ug/L)	Tetra-chloroethene (ug/L)	Trichloro-ethene (ug/L)	Vinyl chloride (ug/L)
Laboratory Detection Limits & Maximum Contaminant Level									
Method Detection Limit (MDL)				0.12	0.07	0.08	0.06	0.05	0.08
Reporting Limit (RL)				1.2	1.2	0.6	1.4	1	1.1
Max. Contaminant Level (MCL)				7	70	100	5	5	2
BSR-04	APPL	SW8260B	9/14/2016	NA	--	NA	--	--	--
HS-1	APPL	SW8260B	9/7/2016	NA	--	NA	--	--	--
I10-8	APPL	SW8260B	9/14/2016	NA	--	NA	--	--	--
Duplicate	APPL	SW8260B	9/14/2016	NA	--	NA	--	--	--
I10-10	APPL	SW8260B	9/7/2016	NA	--	NA	--	--	--
JW-5	APPL	SW8260B	9/12/2016	NA	--	NA	--	--	--
JW-7	APPL	SW8260B	9/8/2016	NA	--	NA	--	--	--
JW-8	APPL	SW8260B	9/8/2016	NA	--	NA	--	--	--
JW-20	APPL	SW8260B	9/8/2016	NA	--	NA	--	--	--
LS-1	APPL	SW8260B	9/7/2016	NA	--	NA	0.25F	--	--
LS-4	APPL	SW8260B	9/7/2016	NA	--	NA	0.16F	--	--
LS-5	APPL	SW8260B	3/7/2016	--	--	--	1.12F	2.5	--
	APPL	SW8260B	6/6/2016	--	--	--	0.88F	1.79	--
	APPL	SW8260B	9/6/2016	NA	--	NA	0.75F	1.85	--
	APPL	SW8260B	12/5/2016	NA	--	NA	1.06F	2.16	--
LS-5-A2	APPL	SW8260B	3/7/2016	--	--	--	--	--	--
	APPL	SW8260B	9/6/2016	NA	--	NA	--	--	--
LS-6	APPL	SW8260B	3/7/2016	--	--	--	0.76F	1.47	--
	APPL	SW8260B	6/6/2016	--	--	--	0.72F	0.89F	--
	APPL	SW8260B	9/6/2016	NA	--	NA	0.88F	--	--
	APPL	SW8260B	12/5/2016	NA	--	NA	--	--	--
LS-6-A2	APPL	SW8260B	3/7/2016	--	--	--	--	--	--
	APPL	SW8260B	9/6/2016	NA	--	NA	--	--	--
LS-7	APPL	SW8260B	3/7/2016	--	--	--	1.63	0.28F	--
	APPL	SW8260B	6/6/2016	--	--	--	0.62F	--	--
	APPL	SW8260B	9/6/2016	NA	--	NA	0.57F	--	--
	APPL	SW8260B	12/5/2016	NA	--	NA	--	--	--
LS-7-A2	APPL	SW8260B	3/7/2016	--	--	--	--	--	--
	APPL	SW8260B	9/6/2016	NA	--	NA	--	--	--
OFR-3	APPL	SW8260B	3/7/2016	--	--	--	2.86	2.38	--
	APPL	SW8260B	6/6/2016	--	--	--	3.16	3.02	--
	APPL	SW8260B	6/6/2016	--	--	--	3.34	3.03	--
	APPL	SW8260B	9/6/2016	NA	--	NA	3.14	2.02	--
	APPL	SW8260B	12/5/2016	NA	--	NA	6.59	3.02	--
OFR-3-A2	APPL	SW8260B	3/7/2016	--	--	--	--	--	--
	APPL	SW8260B	9/6/2016	NA	--	NA	--	--	--
OW-BARNOWL	APPL	SW8260B	9/8/2016	NA	--	NA	--	--	--
OW-HH2	APPL	SW8260B	9/8/2016	NA	--	NA	--	--	--
RFR-10	APPL	SW8260B	3/7/2016	--	0.18F	--	13.85	7.4	--
	APPL	SW8260B	3/7/2016	--	--	--	13.33	6.76	--
	APPL	SW8260B	4/4/2016	--	0.17F	--	11.89	6.73	--
	APPL	SW8260B	5/3/2016	--	--	--	6.53	4.48	--
	APPL	SW8260B	6/6/2016	--	--	--	7.70	4.90	--
	APPL	SW8260B	9/6/2016	NA	0.18F	NA	6.95	4.27	--
	APPL	SW8260B	12/5/2016	NA	--	NA	7.99	3.62	--
RFR-10-HKT	APPL	SW8260B	4/1/2016	--	--	--	--	--	--
RFR-10-TKT	APPL	SW8260B	4/1/2016	--	--	--	--	--	--
RFR-10-TANK	APPL	SW8260B	4/4/2016	--	--	--	--	--	--
RFR-10-A1	APPL	SW8260B	4/4/2016	--	--	--	--	--	--
RFR-10-A2	APPL	SW8260B	3/7/2016	--	0.17F	--	10.38	6.41	--
	APPL	SW8260B	4/4/2016	--	--	--	--	--	--
	APPL	SW8260B	5/3/2016	--	--	--	--	--	--
	APPL	SW8260B	9/6/2016	NA	--	NA	--	--	--
	APPL	SW8260B	9/6/2016	NA	--	NA	--	--	--
RFR-10-B1	APPL	SW8260B	4/4/2016	--	--	--	--	--	--
RFR-10-B2	APPL	SW8260B	3/7/2016	--	--	--	--	--	--
	APPL	SW8260B	4/4/2016	--	--	--	--	--	--
	APPL	SW8260B	5/3/2016	--	--	--	--	--	--
	APPL	SW8260B	9/6/2016	NA	--	NA	--	--	--
RFR-11	APPL	SW8260B	3/7/2016	--	--	--	0.96F	1.62	--
	APPL	SW8260B	6/6/2016	--	--	--	0.94F	0.30F	--
	APPL	SW8260B	9/6/2016	NA	--	NA	1.49	0.47F	--
	APPL	SW8260B	12/5/2016	NA	--	NA	0.91F	1.28	--

Table 6.5 (cont)
2016 Off-Post Groundwater COCs and Analytical Results

Well ID	Laboratory	Analytical Method	Sample Date	1,1-Dichloroethene (ug/L)	cis -1,2-Dichloroethene (ug/L)	trans -1,2-Dichloroethene (ug/L)	Tetra-chloroethene (ug/L)	Trichloroethene (ug/L)	Vinyl chloride (ug/L)
Laboratory Detection Limits & Maximum Contaminant Level									
Method Detection Limit (MDL)				0.12	0.07	0.08	0.06	0.05	0.08
Reporting Limit (RL)				1.2	1.2	0.6	1.4	1	1.1
Max. Contaminant Level (MCL)				7	70	100	5	5	2
RFR-11-A2	APPL	SW8260B	3/7/2016	--	--	--	--	--	--
	APPL	SW8260B	9/6/2016	NA	--	NA	--	--	--
RFR-12	APPL	SW8260B	9/7/2016	NA	--	NA	--	0.49F	--
RFR-14	APPL	SW8260B	9/8/2016	NA	--	NA	--	--	--
<i>Duplicate</i>	APPL	SW8260B	9/8/2016	NA	--	NA	--	--	--

BOLD	≥ MDL
BOLD	≥ RL
BOLD	≥ MCL

All samples were analyzed by APPL, Inc.

VOC data reported in ug/L.

Abbreviations/Notes:

Duplicate Field Duplicate
TCE Trichloroethene
PCE Tetrachloroethene
DCE Dichloroethene
-- non detect

Data Qualifiers

U-The analyte was analyzed for, but not detected. The associated numerical value is at or below the MDL.

F-The analyte was positively identified but the associated numerical value is below the RL.

Table 6.5 (cont)
2016 Off-Post Groundwater COCs and Analytical Results

	Sample ID:		LS-7	LS-7-A2	LS-7-SHOWER TAP
	Sample Date:		12/30/2016	12/30/2016	12/30/2016
Analyte	MDL	RL	Results	Results	Results
1,1,1,2-TETRACHLOROETHANE	0.09	0.5	--	--	--
1,1,1-TCA	0.03	0.8	--	--	--
1,1,2,2-TETRACHLOROETHANE	0.07	0.4	--	--	--
1,1,2-TCA	0.06	1.0	--	--	--
1,1-DCA	0.07	0.4	--	--	--
1,1-DCE	0.12	1.2	--	--	--
1,1-DICHLOROPROPENE	0.10	1.0	--	--	--
1,2,3-TRICHLOROBENZENE	0.24	0.3	--	--	--
1,2,3-TRICHLOROPROPANE	0.17	3.2	--	--	--
1,2,4-TRICHLOROBENZENE	0.16	0.4	--	--	--
1,2,4-TRIMETHYLBENZENE	0.04	1.3	--	--	--
1,2-DCA	0.05	0.6	--	--	--
1,2-DCB	0.02	0.3	--	--	--
1,2-DIBROMO-3-CHLOROPROPANE	0.76	2.6	--	--	--
1,2-DICHLOROPROPANE	0.06	0.4	--	--	--
1,2-EDB	0.06	0.6	--	--	--
1,3,5-TRIMETHYLBENZENE	0.04	0.5	--	--	--
1,3-DCB	0.03	1.2	--	--	--
1,3-DICHLOROPROPANE	0.05	0.4	--	--	--
1,4-DCB	0.07	0.3	--	--	--
1-CHLOROHEXANE	0.04	0.5	--	--	--
2,2-DICHLOROPROPANE	0.10	3.5	--	--	--
2-CHLOROTOLUENE	0.04	0.4	--	--	--
4-CHLOROTOLUENE	0.04	0.6	--	--	--
BENZENE	0.07	0.4	--	--	--
BROMOBENZENE	0.06	0.3	--	--	--
BROMOCHLOROMETHANE	0.11	0.4	--	--	--
BROMODICHLOROMETHANE	0.06	0.8	--	--	--
BROMOFORM	0.13	1.2	--	--	--
BROMOMETHANE	0.08	1.1	--	--	--
CARBON TETRACHLORIDE	0.06	2.1	--	--	--
CHLOROBENZENE	0.04	0.4	--	--	--
CHLOROETHANE	0.07	1.0	--	--	--
CHLOROFORM	0.06	0.3	--	--	--
CHLOROMETHANE	0.16	1.3	--	--	--
CIS-1,2-DCE	0.07	1.2	--	--	--
CIS-1,3-DICHLOROPROPENE	0.03	1.0	--	--	--
DIBROMOCHLOROMETHANE	0.06	0.5	--	--	--
DIBROMOMETHANE	0.06	2.4	--	--	--
DICHLORODIFLUOROMETHANE	0.11	1.0	--	--	--
ETHYLBENZENE	0.05	0.6	--	--	--
HEXACHLOROBUTADIENE	0.17	1.1	--	--	--
ISOPROPYLBENZENE	0.04	0.5	--	--	--
M&P-XYLENE	0.07	0.5	--	--	--
METHYLENE CHLORIDE	0.35	1.0	--	--	--
N-BUTYLBENZENE	0.17	1.1	--	--	--
N-PROPYLBENZENE	0.03	0.4	--	--	--
NAPHTHALENE	0.07	0.4	--	--	--
O-XYLENE	0.06	1.1	--	--	--
P-ISOPROPYLTOLUENE	0.05	1.2	--	--	--
SEC-BUTYLBENZENE	0.05	1.3	--	--	--
STYRENE	0.08	0.4	--	--	--
TCE	0.05	1.0	0.24F	--	--
TERT-BUTYLBENZENE	0.04	1.4	--	--	--
TETRACHLOROETHENE	0.06	1.4	0.97F	--	--
TOLUENE	0.06	1.1	--	--	--
TRANS-1,2-DCE	0.08	0.6	--	--	--
TRANS-1,3-DICHLOROPROPENE	0.04	1.0	--	--	--
TRICHLOROFLUOROMETHANE	0.07	0.8	--	--	--
VINYL CHLORIDE	0.08	1.1	--	--	--

BOLD	≥ MDL
BOLD	≥ RL
BOLD	≥ MCL

Table 6.5 (cont)
2016 Off-Post Groundwater COCs and Analytical Results

All samples were analyzed by APPL, Inc.

VOC data reported in ug/L.

Abbreviations/Notes:

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PCE Tetrachloroethene

DCE Dichloroethene

-- non detect

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SECTION 7

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