CLASS V UNDERGROUND INJECTION WELL INVENTORY AUTHORIZATION FORM, ENHANCED BIOREMEDIATION PILOT STUDY AT SWMU B-3

DEPARTMENT OF THE ARMY ★ UNITED STATES OF AMERICA
1775

Prepared for:

CAMP STANLEY STORAGE ACTIVITY
BOERNE, TEXAS

OCTOBER 2005

Introduction

Camp Stanley Storage Activity (CSSA), located in northern Bexar County near Boerne, Texas, is currently involved in investigating and implementing response actions at solid waste management units (SWMUs) and areas of concern. All work is being undertaken in accordance with regulatory obligations established under the U.S. Environmental Protection Agency's (USEPA) Resource, Conservation, and Recovery Act (RCRA). As part of the RCRA activities, CSSA plans to initiate a Pilot Study to evaluate the effectiveness of enhanced anaerobic degradation to treat volatile organic compounds (VOCs) at the SWMU B-3 site. The pilot study includes injection of organic substrate amendments to change the aquifer geochemistry and increase the naturally occurring biological degradation processes. This Class V Underground Injection Inventory Authorization Form has been prepared per Texas Commission on Environmental Quality (TCEQ) requirements established under 30 Texas Administrative Code (TAC) §331.

The Inventory Authorization Form (TCEQ 10338) and associated information are included in Appendix A of this document. A brief CSSA overview and description of the planned activities are presented in the following sections.

Background

Three VOC source areas have been identified at CSSA (SWMUs B-3 and O-1 and AOC-65). SWMUs B-3 and O-1 are located in the north central portion of CSSA, and AOC-65 is located near the southwestern corner of the facility (Figure F.1 in Attachment F).

SWMU B-3 is a high priority site and the main focus of upcoming investigation and remediation activities. SWMU B-3 is a former trenched landfill area that covers approximately 3 acres which was reportedly used for garbage disposal and trash burning. In 1990, VOCs tetrachloroethene (PCE), trichloroethene (TCE) and *cis*-1,2-dichloroethene (*cis*-DCE) were identified in ground water samples from nearby water wells CS-MW16 LGR and CS-D exceeded groundwater standards. Based on the proximity of SWMU B-3 to the wells, the former landfill became the focus of the VOC plume investigation. Subsequent investigation work confirmed that SWMU B-3 was a VOC source area. A map showing the distribution and concentration of PCE contamination in ground water related to the SWMU B-3 and the other CSSA VOC source areas is provided on Figure F.1.

Geology of the CSSA area consists of Cretaceous age deposits composed predominantly of carbonate sediments overlying Paleozoic age schists of the Quachita structural belt. The Cretaceous system includes shallow marine deposits of the Trinity Group Travis Peak Formation. The Travis Peak Formation attains a maximum thickness of about 940 feet and is divided into five members, in ascending order: Hosston Sand, Sligo Limestone, Hammett Shale, Cow Creek Limestone, and Hensell Sand (and Bexar Shale facies). Overlying the Travis Peak Formation is Glen Rose Limestone, the uppermost member of the Cretaceous-age Trinity Group at the site. The primary units of interest at CSSA are the Glen Rose Limestone, Hensell Sand/Bexar Shale, and the Cow Creek Limestone that form the Middle Trinity Aquifer.

The Cow Creek Limestone is a massive fossiliferous, white to gray, shaley to dolomitic limestone at CSSA that attains a maximum thickness of 90 feet in the area. Above the Cow Creek Limestone lies the Hensell Sand, locally known as the Bexar Shale. This unit averages 60-80 feet, and is composed of silty dolomite, marl, calcareous shale, and shaley limestone which thins by interfingering into the Glen Rose Formation. The Bexar Shale appears to form an aquitard between the Cow Creek Limestone and overlying Glen Rose Formation.

The Glen Rose Limestone, the upper member of the Middle Trinity Aquifer, has been divided into two members, the Upper Glen Rose and the Lower Glen Rose. The Lower Glen Rose consists of a massive fossiliferous limestone, grading upward into thin beds of limestone, marl, and shale. The Lower Glen Rose member is approximately 350 feet thick at CSSA. The Upper Glen Rose overlying the lower member consists of beds of blue shale, limestone, and marly limestone with occasional gypsum beds. Approximately 20 feet of Upper Glen Rose material is present at the SWMU B-3 site.

Groundwater is encountered at CSSA in the Lower Glen Rose limestone. Depth to groundwater at SWMU B-3 fluctuates considerably throughout the year as a result of recharge and the fractured, faulted nature of the material. Historical data from well CS-MW16 indicate that depth to groundwater ranges from a high of 65 feet to a low of 305 feet below ground surface (bgs), but generally does not drop below 210 feet except in rare periods of extreme drought. The Lower Glen Rose and the Cow Creek Limestone units are the primary sources of drinking water in the area.

Based on groundwater level data collected from the Lower Glen Rose monitoring wells, regional groundwater flow in the Lower Glen Rose is to the south, southwest, and southeast. Figure A.2 of Attachment A provides a regional gradient map based on Lower Glen Rose water levels collected in June 2005. Variation in groundwater gradients is related to rainfall recharge and changes in water table levels. Based on plume distribution, it appears that faults and fractures exert some control on flow direction.

Regulatory Authority

Permitting and operation of the planned injection operation at CSSA is subject to the Underground Injection Control regulations of 30 TAC §331. Additional regulations that may apply include those administered by the Edwards Aquifer Authority (EAA) which were established to prevent the degradation of groundwater within the Edwards Formation and associated geologic formations that compose the Edwards Aquifer which is present in several counties in central Texas, including Bexar County. The EAA rules include regulations designed to protect the quantity and quality of groundwater within the aquifer, and include restrictions on the operations of underground injection wells.

The EAA rules were reviewed to determine applicability to the planned activities at the CSSA site. The EAA rules differ depending on proximity of the injection well to the aquifer, with the most restrictive regulations imposed on recharge zones, which are areas directly overlying the aquifer. The Edwards Formation and associated formations composing the Edwards Aquifer are not present at CSSA; therefore, it is not considered to be located within the recharge zone as established by the EAA. The CSSA area is classified as a contributing zone by the EAA as shown on topographic maps for recharge and contributing zones (Camp Bullis and Van Raub quadrangles) available from the EAA (http://www.edwardsaquifer.org). Figure A.3 of Attachment A shows the location of the CSSA site with respect to Edwards Aquifer recharge and contributing zones established by the EAA.

Any well that transects or terminates in the Edwards Aquifer is prohibited under §713.247 of the EAA rules. Since the Edwards Aquifer is not present at CSSA, the planned installation and operation of the injection well is not regulated by EAA rules. Additionally, since the tracer and substrate mixture will not be injected into or through the Edwards Aquifer as prohibited under 30 TAC §331.19(b), requirements of 30 TAC §331.19(a) do not apply. The CSSA area does not meet the definition of "transition zone" as defined in 30 TAC §213.3, and the planned activities do not meet the definition of "regulated activity" as defined in 30 TAC §213.22. Accordingly, regulations pertaining to the Edwards Aquifer established under 30 TAC §213 do not apply. Only the Underground Injection Control regulations of 30 TAC §331 are applicable to the site.

Planned Pilot Study Activities

The objective of the Pilot Study is to evaluate whether enhanced anaerobic biodegradation (EAB) might be a viable remedial option to address the chlorinated aliphatic hydrocarbons (CAH) in groundwater migrating from the SWMU B-3 site. EAB has been shown to be an effective strategy for reducing concentration of chlorinated compounds in groundwater at other sites. If results of the Pilot Study demonstrate that EAB will be effective at reducing contaminant concentrations, CSSA plans to consider full-scale EAB to address the dissolved contaminants migrating from the SWMU B-3 site into the contaminant plume present in the Lower Glen Rose formation. Full scale implementation of EAB might include injections of amendments into the Lower Glen Rose Formation, infiltration from the surface, or a combination of the two delivery methods.

The Pilot Study will be implemented by injecting a mixture of organic substrates and groundwater into the aquifer at the SWMU B-3 site to stimulate *in situ* anaerobic biodegradation of CAHs in groundwater. Injection of the carbon substrate material will stimulate biological activity within the aquifer which will initially utilize available dissolved oxygen causing the aquifer to become anaerobic. Once the oxygen is utilized and anaerobic conditions are established, microbes will begin to utilize alternate electron sources causing the aquifer to become strongly reduced. Biodegradation of CAHs is greatest under strongly reducing anaerobic conditions suitable for a process called reductive dechlorination. Therefore, the purpose of the Pilot Study is to inject sufficient carbon substrate material to create optimal geochemical conditions for anaerobic dechlorination to occur. As the Pilot Study proceeds, CSSA will monitor changes in contaminant concentrations and specific geochemical parameters to assess if natural biological activity can be sufficiently increased to create conditions suitable for degradation of the CAHs.

An organic substrate and a conservative tracer will be injected into the formation through a monitoring well installed within the SWMU B-3 source area. The monitoring well (CS-B3-MW01) was drilled and installed in September 2005 and is screened across a permeable zone within the Lower Glen Rose formation at a depth of 277 to 287 feet bgs. The location and screened interval for well CS-B3-MW01 was determined based on review of site geologic and contaminant distribution information, and from geologic information obtained during drilling for the installation of four multi-port monitoring wells (MPMWs) currently being completed at SWMU B-3. The four MPMW wells (numbered CS-WB05 through 08) will serve as monitoring locations for the source area at SWMU B-3 and future remedial actions at the site, including any full-scale EAB activities that might be implemented. Installation of the four MPMWs is expected to be completed in October 2005.

Well CS-B3-MW01 is located approximately 35 feet southeast of MPMW location CS-WB05 northwest of the SWMU B-3 site (see Figure B.1 in Attachment B). This area was selected for the Pilot Study because groundwater pumping will occur at well CS-MW16-LGR during the study and is expected to influence local groundwater flow directions creating a local gradient toward that well (CS-MW16-LGR). The groundwater gradient created by pumping well CS-MW16-LGR will control the direction and rate of migration of the tracers and substrate injected into the aquifer during the Pilot Study. Pumping at well CS-MW16-LGR will continue during the initial tracer test and substrate injection test without interruption. Groundwater pumped from well CS-MW16-LGR will be treated through an on-post granular activated carbon unit and discharged through Outfall 02 in accordance with CSSA's TPDES permit.

Drilling for the MPMWs and the injection well was performed during August and September 2005. Borehole geophysical and hydraulic data obtained during drilling at MPMW location CS-WB05 were evaluated to select the injection zone for the Pilot Study. Based on evaluation of this data, an injection interval of 277 to 287 feet bgs was selected for the Pilot Study. This zone was selected because it has moderate permeability, is situated sufficiently below the water table so the zone will remain saturated for the duration of the Pilot Study, and because it is situated stratigraphically above the high-permeability zone present at the bottom of the Lower Glen Rose Formation.

Monitoring well CS-B3-MW01 is constructed of 4.0-inch inside diameter well material. It is equipped with a 10-foot section of 0.050-inch slotted stainless steel well screen set between the depths of 277 and 287 feet bgs. The well is extended to land surface with Schedule 40 polyvinyl chloride well material, and is completed above land surface with a protective well cover, concrete well pad, and protective posts. Construction details for well CS-B3-MW01 are included in Figure C.1 of Attachment C. Following completion of the Pilot Study, well CS-B3-MW01 will be used primarily as a monitoring well for SWMU B-3, although CSSA may choose to use this well for substrate injections during future remedial actions as necessary.

Prior to the start of the injection test, baseline groundwater samples will be collected from the injection well CS-B3-MW01, the four MPMW wells in the vicinity of SWMU B-3, and select nearby monitoring wells (CS-MW1-LGR, CS-MW2-LGR, CS-MW3, CS-MW5, CS-MW16-LGR, CS-2, CS-3, CS-4, and CS-D) to determine pre-injection contaminant and geochemical conditions within the aquifer. The initial round of groundwater baseline samples will be analyzed for volatile organic compounds (VOCs), dissolved metals (barium, chromium, copper, nickel, zinc, cadmium, lead, arsenic, and selenium), total organic carbon (TOC), methane, ethene, ethane, sulfate, chloride, sulfate, bromide, biological indicator parameters (volatile fatty acids and phospolipid fatty acids), carbon dioxide, alkalinity, ferrous iron, hydrogen sulfide, manganese, dissolved oxygen, oxidation-reduction potential, pH, temperature, and conductivity. Subsequent baseline sampling will include at a minimum VOCs, TOC, methane, ethene, ethane, carbon dioxide, bromide, dissolved oxygen, oxidation-reduction potential, pH, temperature, and conductivity, and may include other parameters as determined to be appropriate based on initial sampling results. A minimum of two rounds of baseline groundwater samples will be collected prior to injecting the substrate.

Also prior to substrate injection, a tracer test will be performed to refine estimates of groundwater velocity and aquifer dispersivity. Iodine, a conservative groundwater tracer, will be used for the initial tracer test. Approximately 3.25 gallons of a potassium iodine and water solution with an iodine concentration of 500 ppm will be added to water within the screened interval of the injection well. Following injection of the tracer, groundwater samples will be collected from the downgradient MPMW intervals and monitoring well CS-MW16-LGR and analyzed in the field for the presence of iodine. Initially, groundwater samples will be collected from the monitoring points every 2 to 3 days beginning the week the tracer is predicted to arrive. Once the iodine slug arrives at the wells, samples will be collected on a daily basis to monitor the passing of the iodine slug. Samples will continue to be collected on a daily basis until the iodine concentration has been reduced to 10 percent of the maximum concentration detected.

Once the initial tracer test is complete and the estimated groundwater velocity has been revised, an organic substrate mixture will be injected into the aquifer. The substrate will consist of a mixture of emulsified vegetable oil, sodium lactate, conservative tracer (potassium), and contaminated groundwater extracted from the formation. The sodium lactate in the mixture is mobile in groundwater and is intended to rapidly distribute through the aquifer to increase the amount of available organic carbon for enhancing the degradation process. The vegetable oil emulsion is relatively immobile in the aquifer and is intended to provide a longer term (1 to 2 years) supply of organic carbon for the biodegradation process. These substrate amendments were selected based on estimated aquifer porosity, groundwater velocity, and estimated carbon loading rates requirements for producing a sufficiently reduced reaction zone within the aquifer.

Preparation of the substrate mixture will utilize a pre-mixed vegetable oil emulsion product consisting of approximately 60 percent soybean oil by weight, 10 percent emulsifiers (*e.g.*, polysorbate, mono- and di-glycerides) by weight, and 4 percent sodium lactate by weight. Approximately 100 gallons of a vegetable oil emulsion mixture will be added to 100 gallons of sodium lactate and water (60% sodium lactate), and approximately 1,800 gallons of groundwater extracted from well CS-B3-MW01. Additionally, approximately 8.4 lbs of sodium bromide will be added to the substrate solution to create an initial sodium bromide concentration of 500 ppm to serve as a conservative tracer during the degradation study. This mixture will be prepared in an above-ground temporary holding tank and pumped into the injection well where it will flow into the aquifer under the influence of gravity. A sample of the injection mixture will be collected as it is added to the injection well and will be analyzed for VOCs, TOC, and bromide. Once the substrate is injected, a second injection consisting of approximately 50 gallons of sodium lactate and water (sodium lactate at 60%) and 900 gallons of contaminated groundwater will be injected into the well to flush any residual substrate mixture from the well and filterpack. A detailed summary of the substrate mixture to be injected is included in Attachment H of the injection inventory authorization form.

During the substrate injection and the following flush with water, contaminated groundwater extracted from well CS-B3-MW01 will be used. The purpose of using contaminated Lower Glen Rose groundwater in the injection process is to create an area within the injection zone that has the same contaminant concentration as the surrounding groundwater but is amended by the addition of the organic substrate. Groundwater sample results are currently not available for this well, and the specific contaminant concentration has not been determined for this location but is expected to be similar to groundwater results from the same depth interval at MPMW location CS-WB05, approximately 35 feet to the northwest. Results of a groundwater sample from the 268-to 288-foot packer interval from well CS-WB05 (Table E.1 in Attachment E) indicate that the concentration of contaminants in the groundwater is below hazardous levels established under 30 TAC §335, Subchapter R. Groundwater from well CS-B3-MW01 will be sampled prior to injection, and if contaminant concentrations are determined to exceed hazardous levels, then either a Class IV injection permit will be submitted or groundwater from nearby monitoring well CS-MW16-LGR will be utilized. Well CS-MW16-LGR is known to contain non-hazardous contaminant levels (Table E.2 in Attachment E).

Following injection, groundwater samples will be collected from the downgradient MPMW well CS-WB05, well CS-B3-MW01, and possibly other nearby wells based on groundwater travel time and distance. The planned sampling interval will be 1, 2, 4, 6, and 9 months following injection of the substrate. At a minimum, groundwater samples will be analyzed for VOCs, TOC, methane, ethene, ethane, carbon dioxide, bromide, dissolved oxygen, oxidation-reduction potential, pH, temperature, and conductivity. Additional analyses that may be performed during performance groundwater monitoring includes dissolved metals (barium, chromium, copper, nickel, zinc, cadmium, lead, arsenic, and selenium), sulfate, chloride, biological indicator parameters (volatile fatty acids and phospolipid fatty acids), alkalinity, ferrous iron, hydrogen sulfide, and manganese.

In addition, CSSA conducts sampling at on and off-post drinking and monitoring wells on a quarterly basis (March, June, September, and December). Wells in this monitoring network are completed in the Lower Glen Rose and Cow Creek units. The nearest downgradient drinking water wells to the SWMU B-3 site range in distance from approximately 4,000 feet to 1 mile. Groundwater samples from those wells will be evaluated for changes in contaminant concentrations and VOC breakdown products during the quarterly monitoring activities. This effort will ensure that any changes in aquifer contaminant composition are recognized and, if needed, appropriate remedial actions taken to protect drinking water supply wells.

Future remedial plans for the SWMU B-3 landfill include removing the remaining contaminated landfill material in the November - December 2005. Once the landfill material has been removed, construction of a bioreactor is planned in former landfill trenches. The bioreactor will be designed to create conditions within the landfill trenches conducive to anaerobic degradation and will also serve as a source for organic material that can leach downward into the groundwater and stimulate anaerobic conditions within the aquifer beneath the landfill. Prior to constructing the bioreactor, an underground injection permit application will be prepared and submitted to the TCEQ for review and approval. Although current plans are for construction of a bioreactor, additional substrate injections may performed at well CS-B3-MW01 as deemed necessary during final remedial actions and would likely utilize the same mixtures and proportions as the initial injection.

APPENDIX A

Class V Underground Injection Well Inventory Authorization Form

Class V Injection Well Inventory/Authorization Form

SUBMIT TO:

TCEQ
Industrial and Hazardous
Waste Permits Section
MC130
PO Box 13087
Austin, Texas 78711-3087
512/239-6075

TEXAS COMMISSION ON ENVIRONMENTAL QUALITY

CLASS V INJECTION WELL
INVENTORY / AUTHORIZATION FORM

For TCEQ Use Only

RegNo. __________

Date Received __________

Date Authorized __________

Reg. No.5X26

Section I General Information

Provide the information in items 1 through 8

1. TCEQ Program Area (PST, VCP, IHW, etc.) Contact Name and Phone Number.

   HW Mr. Sonny Rayos (512) 239-2371

2. Agent/Consultant, Contact Name, Address (Street, City, State, and Zip Code), and Phone Number

   Mr. Gary Cobb Parsons 8000 Centre Park Dr., Suite 200 Austin, TX 78754 (512) 719-6011

3 _____Owner__x___Operator
Owner/Operator, Contact Name, Address (Street, City, State, and Zip Code), and Phone Number

Mr. Jason Shirley, Installation Manager
U.S. Army, Camp Stanley Storage Activity
25800 Ralph Fair Rd.
Boerne, TX 78015-4800 (210) 221-7461

4. Facility Name, Address, (Street, City, County, State, and Zip Code) or location description (if no address is available) and Facility Contact Person and Phone Number.

   Camp Stanley Storage Activity
   25800 Ralph Fair Rd.
   Boerne, TX 78015-4800

5. Latitude and Longitude (degrees-minutes-seconds) and method of determination (GPS, TOPO, etc.). Attach topographic quadrangle map as Attachment A

   From GPS data for SWMU B-3: Latitude = 29 degrees42'34.99"N, Longitude = 98 degrees36'50.61"W.

   A copy of the topographic map for CSSA is included in Attachment A

6. Type of Well Construction (Vertical Injection, Subsurface Fluid Distribution System, Infiltration Gallery, Temporary Injection Points, etc.) and Number of Injection Wells.

   One groundwater monitoring well (CS-B3-MW01) will be utilized as an injection well for the purpose of the proposed pilot test and for subsequent remediation if necessary.

7. Detailed Description regarding purpose of Injection System. Attach a Site Map as Attachment B (Attach the Approved Remediation Plan (if appropriate)).

   A description of the injection system and a site map are included in Attachment B.

8. Water Well Driller/Installer, Address (Street, City, State, and Zip Code), Phone Number, and License Number

   Lee Gebbert
   GeoProjects International, Inc.
   8834 Circle Dr.
   Austin, TX 78736

   (512) 288-3777

   TX License #: 2525PW

Section II Proposed Down Hole Design

Attach a diagram signed and sealed by a licensed engineer as Attachment C

Name of String	Size	Setting Depth	Sacks Cement/Grout – Slurry Volume – Top of Cement	Hole Size	Weight PVC/Steel (lbs/ft)
9. Casing	4" ID	0 – 277'	48 bags of cement w/2.5 bags bentonite yielding 515 gallons of grout. Top of grout is at land surface.	7.875"	Sch 40 PVC
10. Tubing	NA				
11. Screen	4" ID 0.05" slots	277' – 287'	Borehole reamed to 292.5'. Bentonite plug from 292.5' to 287.5'. Pea gravel filter pack from 287.5 to 274'. Screen set at 287' to 277'. Approximately 6' of bentonite seal above filter pack.	7.875"	305 Stainless Steel

Section III Proposed Trench System, Subsurface Fluid Distribution System, or Infiltration Gallery

Attach a diagram signed and sealed by a licensed engineer as Attachment D

12. System(s) Dimension	13. System(s) Construction
A certified diagram of the injection well is included in Attachment C. A map showing the location of the injection well and nearby monitoring points is included in Attachment I. A schematic of the equipment used for the injection is included in Attachment D.	A certified diagram of the injection well is included in Attachment C. A map showing the location of the injection well and nearby monitoring points is included in Attachment I. A schematic of the equipment used for the injection is included in Attachment D.

Section IV Site Hydrogeological and Injection Zone Data

Provide the information in items 14 through 31

14. Name of Contaminated Aquifer

Middle Trinity Aquifer

15. Receiving Formation Name of Injection Zone

Lower Glen Rose Formation

16. Well/Trench Total Depth

287 ft bgs.

17. Surface Elevation

Land surface elevation of the injection well location at SWMU B-3 is approximately 1,239 feet MSL

18. Depth to Ground Water

Highly variable 60-300 feet bgs

19. Injection Zone Depth

277 to 287 ft bgs.

20. Injection Zone vertically isolated geologically? Y/N Impervious Strata between Injection Zone and nearest Underground Source of Drinking Water. No

Name:_ Lower Glen Rose Formation__
Thickness: Approximately 350 ft

The injection will occur at the 277 to 287 foot depth interval of the Lower Glen Rose limestone. The injection location is approximately 4,000 feet from the nearest water supply well, and injection activities are not anticipated to impact local drinking water supplies. The Lower Glen Rose and Cow Creek limestone units are utilized as sources of drinking water in the immediate vicinity of CSSA. The Bexar Shale, a 60 to 80 foot thick sequence of silty dolomite, marl, calcareous shale, and shaley limestone, serves as an aquitard hydraulically separating the Lower Glen Rose and Cow Creek formations.

21. Provide a list of contaminants and the levels (ppm) in contaminated aquifer

Attach as Attachment E

See Tables E.1 and E.2 in Attachment E.

22. Horizontal and Vertical extent of contamination and injection plume

Attach as Attachment F

See Attachment F.

23. Formation (Injection Zone) Water Chemistry (Background levels) TDS, *etc.*

Attach as Attachment G

See Attachment G.

24. Injection Fluid Chemistry in PPM at point of injection

Attach as Attachment H

See Table H.1 in Attachment H.

25. Lowest Known Depth of Ground Water with < 10,000 PPM TDS

The depth to high salinity groundwater containing TDS in excess of 10,000 mg/L has not been identified in the vicinity of the site, however, according to Ground-Water Quality of Texas - An Overview of Natural and Man-Affected Conditions, Texas Water Commission, Report 89-01, March 1989, the Trinity Aquifer in Bexar County does not contain groundwater with TDS concentrations greater than 10,000 mg/L. Therefore, groundwater with TDS below 10,000 mg/L can be expected to extend deeper than the approximately 1000 foot sequence of Cretaceous-age deposits in the area. Groundwater with TDS exceeding 10,000 mg/L is believed to occur in the underlying Paleozoic-age schists where lower groundwater flow velocities and higher water-rock interactions will likely result in highly mineralized groundwater.

26. Maximum Injection Rate/Volume/Pressure

For the initial tracer test, 3.5 gallons of potassium iodine tracer solution (water with iodine at 500 ppm) will be injected into the aquifer. For the degradation test an estimated 1800 gallons of injection mixture of emulsified vegetable oil, lactate, and untreated groundwater from CS-B3-MW01 mixed with 8.4 lbs of sodium bromide will be injected into the aquifer. The initial injection will be followed by the injection of approximately 900 gallons of lactate and formation water from CS-B3-MW01 to flush the substrate from the well and filterpack. A summary of the substrate mixture to be injected during the pilot study is included as Table H.1 in Attachment H. Hydrostatic pressure will be utilized to emplace the tracer mixture and the organic substrate into the formation.

27. Water wells within ¼ mile radius (attach map as Attachment I)

No water wells are present within 1/4 mile of the injection well.

See Figure I.1 in Attachment I.

28. Injection wells within ¼ mile radius (attach map as Attachment I)

See Figure I.1 in Attachment I.

29. Monitor wells within ¼ mile radius (attach drillers logs and map as Attachment I)

See Figure I.1 in Attachment I.

30. Sampling frequency

Prior to the substrate injection, a minimum of two rounds of baseline sampling from the injection well and nearby monitoring locations will occur to determine pre-injection water quality. During the initial baseline sampling, groundwater samples will be analyzed for volatile organic compounds (VOCs), dissolved metals (barium, chromium, copper, nickel, zinc, cadmium, lead, arsenic, and selenium), total organic carbon (TOC), methane, ethene, ethane, sulfate, chloride, sulfate, bromide, biological indicator parameters (volatile fatty acids and phospolipid fatty acids), carbon dioxide, alkalinity, ferrous iron, hydrogen sulfide, manganese, dissolved oxygen, oxidation-reduction potential, pH, temperature, and conductivity. Subsequent baseline sampling will include at a minimum VOCs, TOC, methane, ethene, ethane, carbon dioxide, dissolved oxygen, oxidation-reduction potential, pH, temperature, and conductivity, and may include other parameters as determined appropriate based on the initial sampling results.

As part of the initial tracer test, groundwater samples will be collected from the injection well and the downgradient multi-port monitoring well (MPMW) after the injection of the iodine tracer mixture. This will be done to monitor the migration of the tracer through the formation. Groundwater sampling will be collected from the monitoring points every other day beginning 1 week prior to the predicted arrival time. Once the tracer arrives at the MPMW, samples will be collected on a daily basis until the tracer is no longer detected above background concentration or has been reduced to 10% of the maximum concentration detected (90% reduction). Groundwater samples collected for the tracer tests will be analyzed in the field for iodine using field detection equipment.

Following the tracer test, the substrate and second tracer (sodium bromide) will be mixed with formation water from CS-B3-MW01 and injected back into CS-B3-MW01. Samples will be taken of the substrate mixture as it's injected. Analyses will include volatile organic compounds, total organic carbon, and bromide.

Following injection of the substrate, groundwater sampling will occur at intervals of one, two, four, six, and nine months from the time of injection. Groundwater sampling will be from the downgradient MPMW well (CS-WB05) and a select number of monitoring wells hydraulically downgradient of SWMU B-3. At a minimum, the groundwater samples will be analyzed for VOCs, TOC, methane, ethene, ethane, carbon dioxide, bromide, dissolved oxygen, oxidation-reduction potential, pH, temperature, and conductivity. Additionally analyses that may be performed during the performance groundwater monitoring includes dissolved metals (barium, chromium, copper, nickel, zinc, cadmium, lead, arsenic, and selenium), sulfate, chloride, biological indicator parameters (volatile fatty acids and phospolipid fatty acids), alkalinity, ferrous iron, hydrogen sulfide, and manganese.

After the initial pilot study test, additional injections of organic substrate at well CS-B3-MW01 may be performed as part of the remedial actions for groundwater at SWMU B-3. If additional injections are performed, the composition and rate of the substrate mixture are expected to be similar to the above description. Samples of the substrate mixture will be collected during each injection and will be analyzed for include volatile organic compounds, total organic carbon, and bromide. Additionally, groundwater sampling will be performed at downgradient monitoring wells after subsequent injections at sampling frequencies determined appropriate based on results of the pilot study.

31. Known hazardous components in injection fluid

Groundwater sample results from well CS-B30MW01 are currently not available however the results are expected to be similar to groundwater results from MPMW location CS-WB05 approximately 35 feet away. The contaminant concentrations for the injection interval (277-287 ft) from MPMW well CS-WB05 are summarized in the Table E.1 included in Attachment E. Evaluation of CS-WB05 data indicates that these constituents do not exceed hazardous levels as determined by 30 TAC Chapter 335, Subchapter R. Groundwater will be sampled at well CS-B3-MW01 prior to the substrate injection and if contaminant concentrations exceed hazardous levels, groundwater from monitoring well CS-MW16-LGR will be used for the substrate injection. Groundwater sample results for well CS-MW16-LGR are summarized in Table E.2 of Attachment E.

Section V Site History

Provide the information in items 32 through 35

32. Type of facility

CSSA is a U.S. Army facility. SWMU B-3 was reportedly a landfill area thought to have been primarily used for garbage disposal and trash burning.

33. Contamination Dates

The landfill was reportedly last used in 1990-1991, but the first use of SWMU B-3 as a landfill is unknown.

34. Original Contamination (VOCs, TPH, BTEX, *etc.*) and Concentrations

Attach as Attachment J

See Attachment J.

35. Previous Remediation

Attach results of any previous remediation as Attachment K

See Attachment K.

<<**NOTE**>> Authorization Form should be completed in detail and authorization given by TCEQ before construction, operation, and/or conversion can begin. Attach additional pages as necessary.

ATTACHMENT A

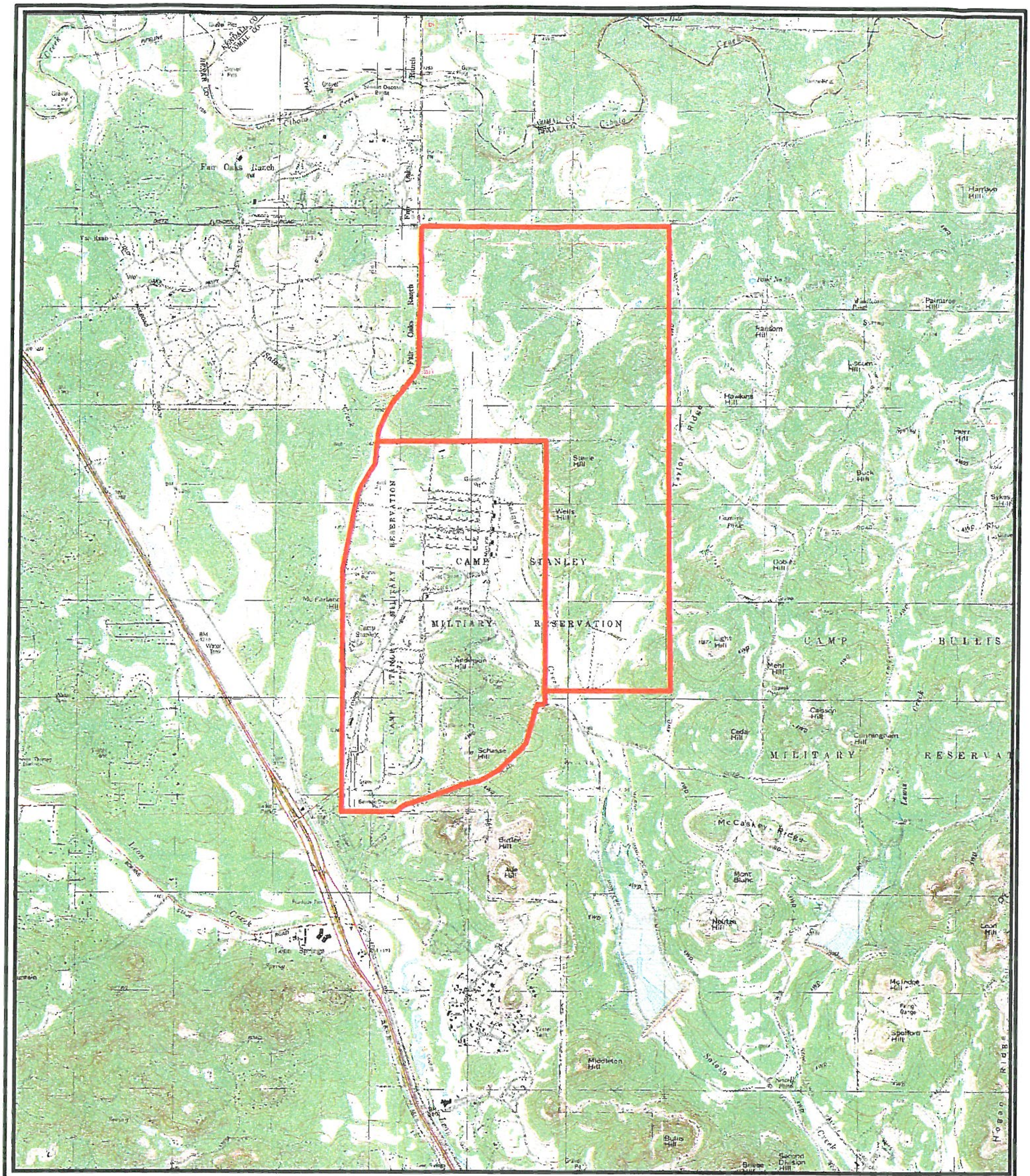

Figure: A.1

USGS Topo Map
Camp Bullis Quadrangle
Camp Stanley Storage Activity

PARSONS

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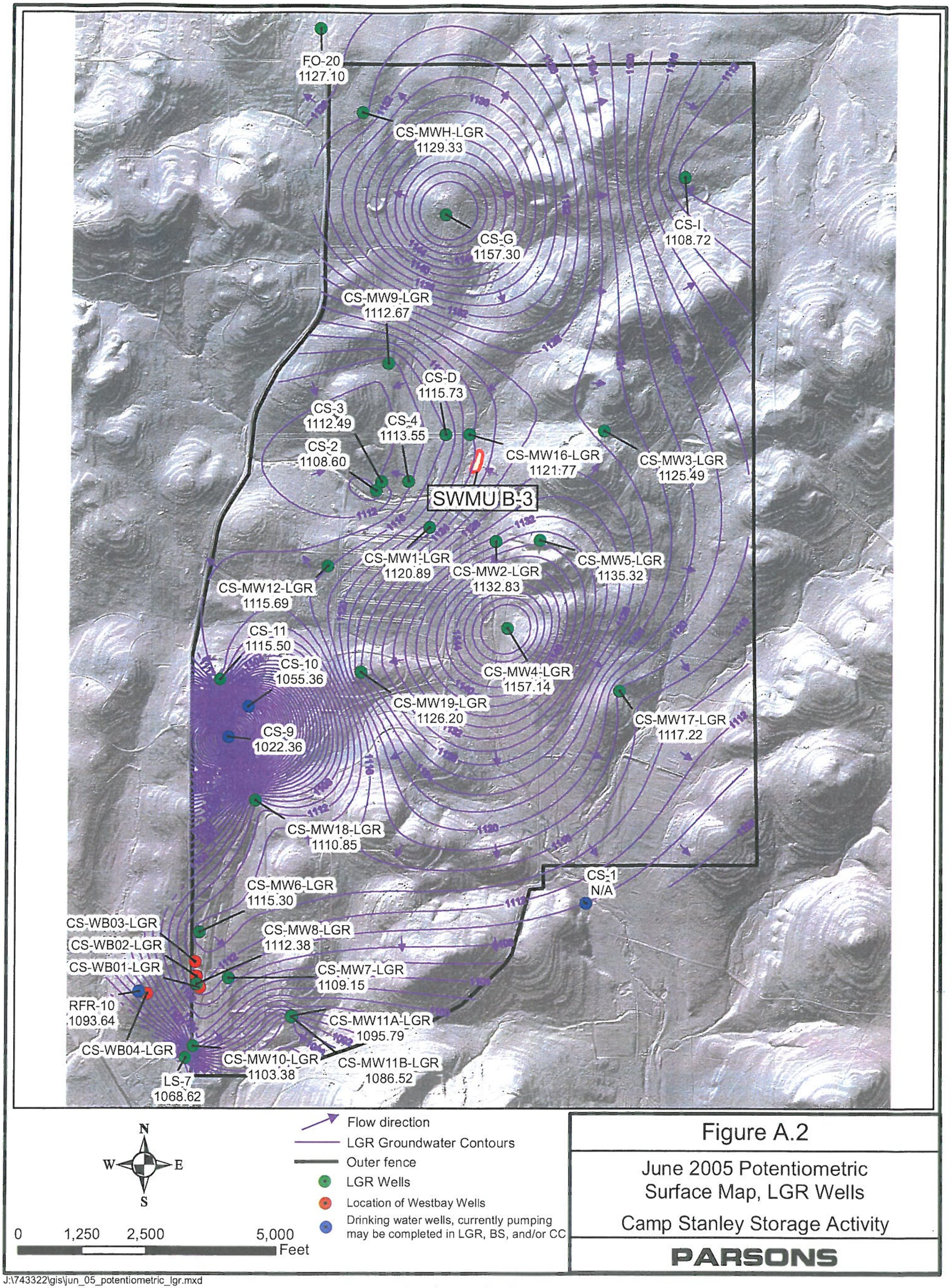

Figure A.2

June 2005 Potentiometric Surface Map, LGR Wells

Camp Stanley Storage Activity

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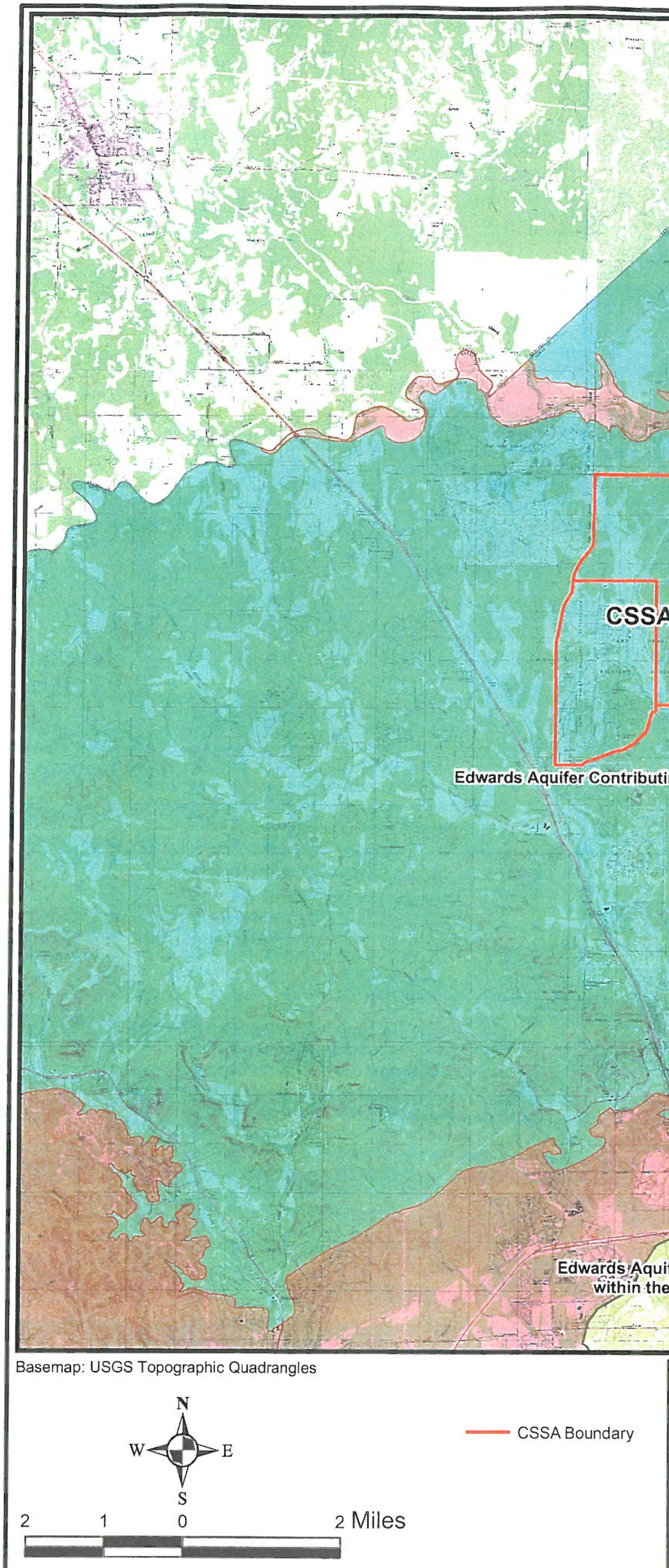

Basemap: USGS Topographic Quadrangles

Figure: A.3

Location of Edwards Aquifer Boundaries

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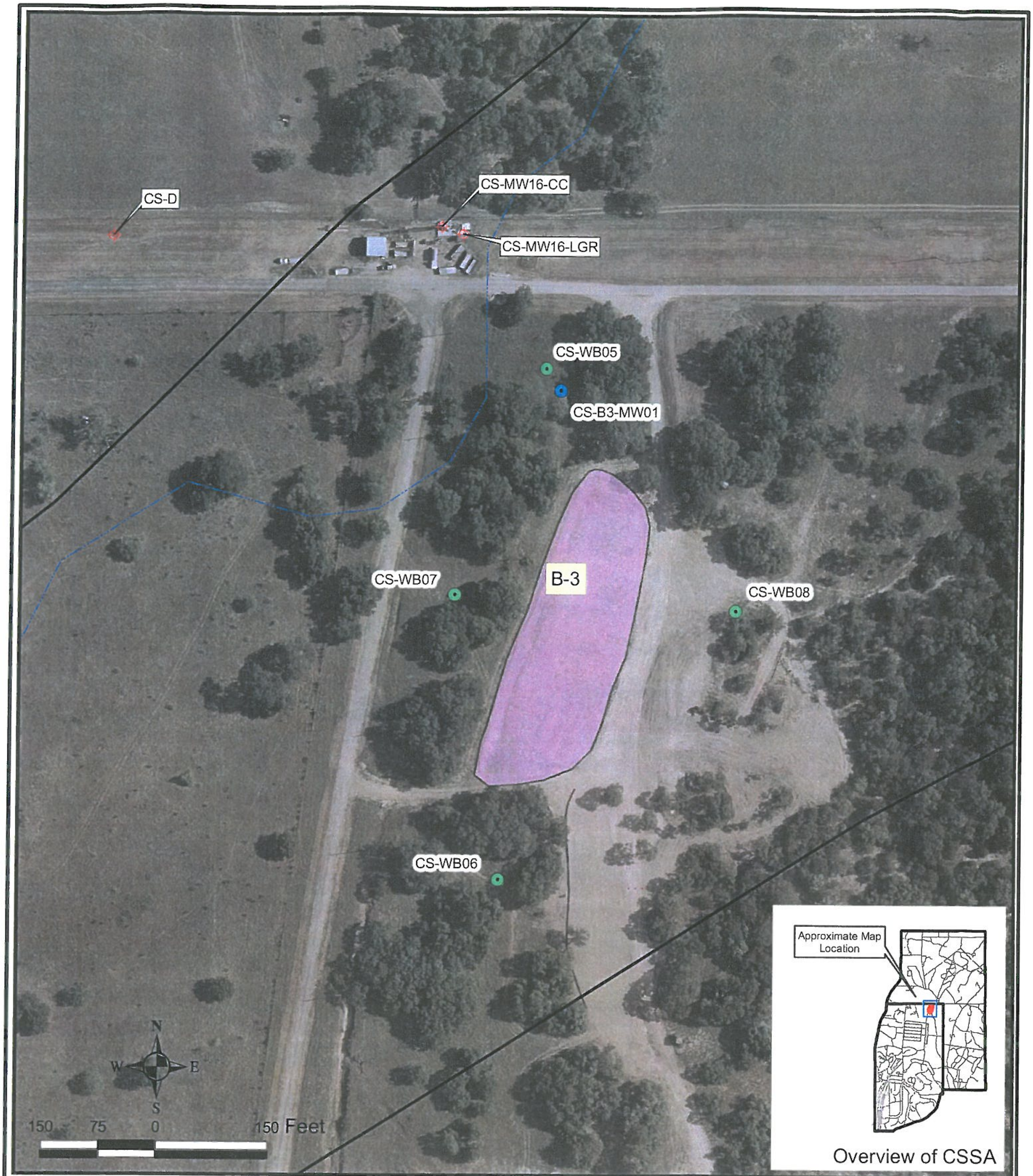
ATTACHMENT B

A pilot study will be performed to assess the effectiveness of enhanced anaerobic biodegradation to treat contaminated groundwater at SWMU B-3. Initially, a conservative tracer (iodine) will be injected into the aquifer to gauge groundwater velocity and evaluate flow paths. After the initial tracer test, contaminated groundwater will be mixed with an organic substrate (vegetable oil emulsion) and a sodium bromide tracer and injected into the aquifer. Groundwater samples will be collected to monitor the progress of the degradation processes. The test is expected to take up to 12 months to provide sufficient data to analyze the effectiveness of enhanced bioremediation at the site. The vegetable oil mixture can be expected to degraded in approximately 2 years under normal circumstances.



Aerial Photo Date: 2003

● Proposed WestbayÆ Well Location

● Proposed Injection Well Location

↖ Approximate Groundwater Flow Direction, Sept. 2004

Faults (USGS)

Creeks (Dashed where intermittent)

○ Water Well Locations

▨ SWMU Boundary

Figure: B.1

Pilot Study Well Location Map

Camp Stanley Storage Activity

PARSONS

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ATTACHMENT C

Monitoring well CS-B3-MW01, which will be utilized as the injection well for the Pilot Study, was completed in September 2005. Borehole geophysical testing and discrete interval packer testing from nearby MPMW well location CS-WB05 were utilized to determine completion depth and desired screen length for well CS-B3-MW01. Therefore, coring was not performed on the planned injection well and a drillers log was not generated. Certified well construction details for well CS-B3-MW01 is included as Figure C.1. Geologic log for nearby monitoring wells CS-MW16-LGR and CS-MW16-CC are also included.

Monitoring Well CS-B3-MW01 Certification

This is to certify that installation of the following facility component has been completed and that construction of said component has been performed in accordance with the information provided herein.

Between September 13 and 27, 2005 monitoring well CS-B3-MW01 was installed at the Solid Waste Management Unit (SWMU) B-3 at Camp Stanley Storage Activity (CSSA), Boerne, Texas. This well was installed to serve as a groundwater monitoring well for SWMU B-3 and may be utilized in remedial efforts for the unit as appropriate. Construction and installation of this well was completed in accordance with the specification included in CSSA's approved Field Sampling Plan dated February 1996 and associated addenda. A well construction diagram for this well is attached. Completion specifications for this well was based on drilling observations from an adjacent monitoring well and sampling was not performed during drilling for well CS-B3-MW01. Therefore, a drillers log for this well will not be completed. Additionally, the location and elevation of this newly installed well will be surveyed by a licensed professional surveyor: however, this survey has not been completed and the survey information is not included as part of this certification

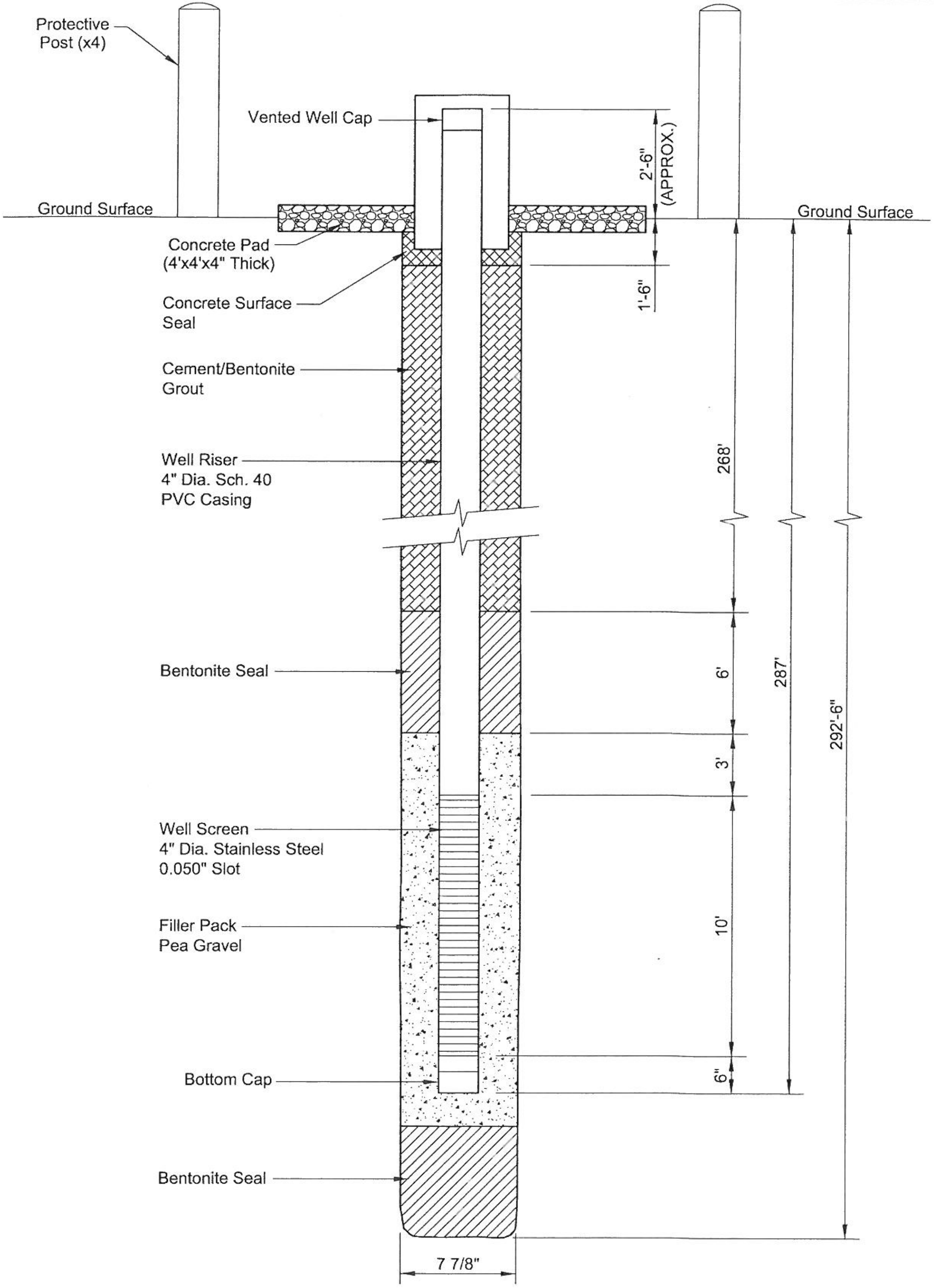
I, Gary Cobb, P.G., hereby certify that the geoscientific products presented in this well certification accurately reflects the construction of well CS-B3-MW01 at the subject site. This certification is limited to only the geoscientific products contained in this certification and is made on the basis of written and verbal information provided by the Parsons Field Geologist and the operator of the facility, and is true to the best of my knowledge and belief.

Gary Cobb
Geology
2514

Gary Cobb

Gary Cobb, P.G.
State of Texas
Licensed Professional Geoscientist No. 2514

Date: 5 October 2005



744223 CSSA-IWELL.DWG

Note:
Well materials include flash-threaded joints. Drawing not to scale.

Figure C.1

Well CS-B3-MW01
Construction Details

Camp Stanley Storage Activity, Texas

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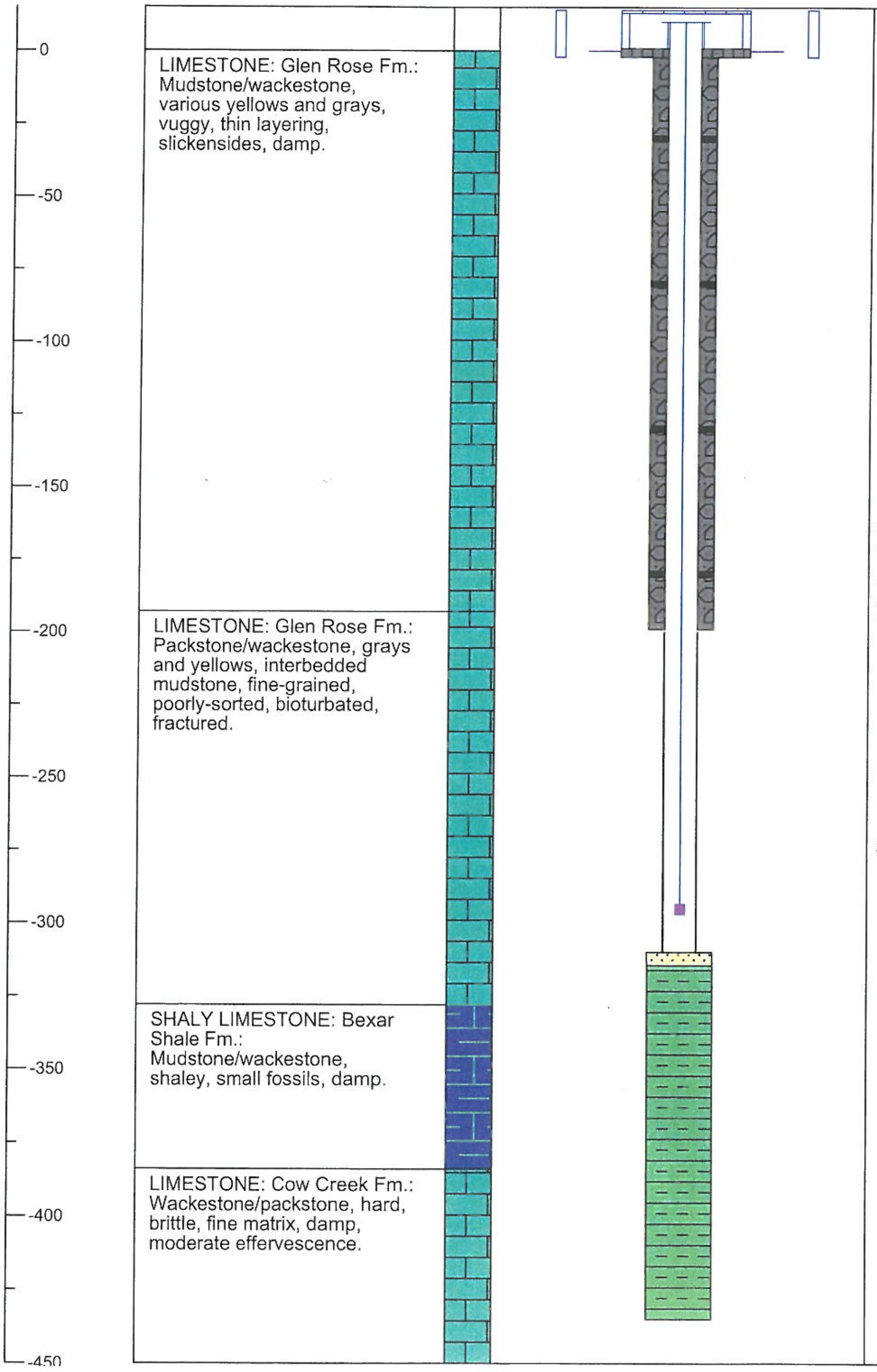
Monitor Well Completion Log
CS-MW16-LGR

Project:	740911.04000	**Installation:**	Camp Stanley Storage Activity
Geologist:	E. Tennyson	**Size and Type of Bit:**	4.25" Continuous Air-Core
Drilling Agency:	Geoprojects International	**Make and Model of Rig:**	Gardner-Denver 1500

Well ID	Interval	Northing (m)	Easting (m)	Ground Level (ft MSL)	TOC (ft MSL)	Start	Stop
CS-MW16-LGR	0-314.5'	3286841.19	537285.90	1241.59	1244.60	06/25/02	07/09/02

Depth (feet bgs)	Classification of Materials	Lithology	Well Construction	Construction Material



Classification of Materials

LIMESTONE: Glen Rose Fm.: Mudstone/wackestone, various yellows and grays, vuggy, thin layering, slickensides, damp.

LIMESTONE: Glen Rose Fm.: Packstone/wackestone, grays and yellows, interbedded mudstone, fine-grained, poorly-sorted, bioturbated, fractured.

SHALY LIMESTONE: Bexar Shale Fm.: Mudstone/wackestone, shaley, small fossils, damp.

LIMESTONE: Cow Creek Fm.: Wackestone/packstone, hard, brittle, fine matrix, damp, moderate effervescence.

Construction Material

Locking well protector, 4 steel guard posts (3' tall).

0'-435': Borehole (7-7/8").

0'-199': Portland grout (14.3 lb/gal).

+3'-199': Schedule 80 PVC casing (3.83" ID/4.5" OD).

SS304 Centralizers every 50'.

379'-407.7': 1,400 lbs. sand pack (8/16 mesh).

374'-379': 200 lbs. medium bentonite chips.

199'-310': Open borehole from previous installation (4").

Submersible Pump Depth: 293.5'.

Attachment C - 4

PARSONS

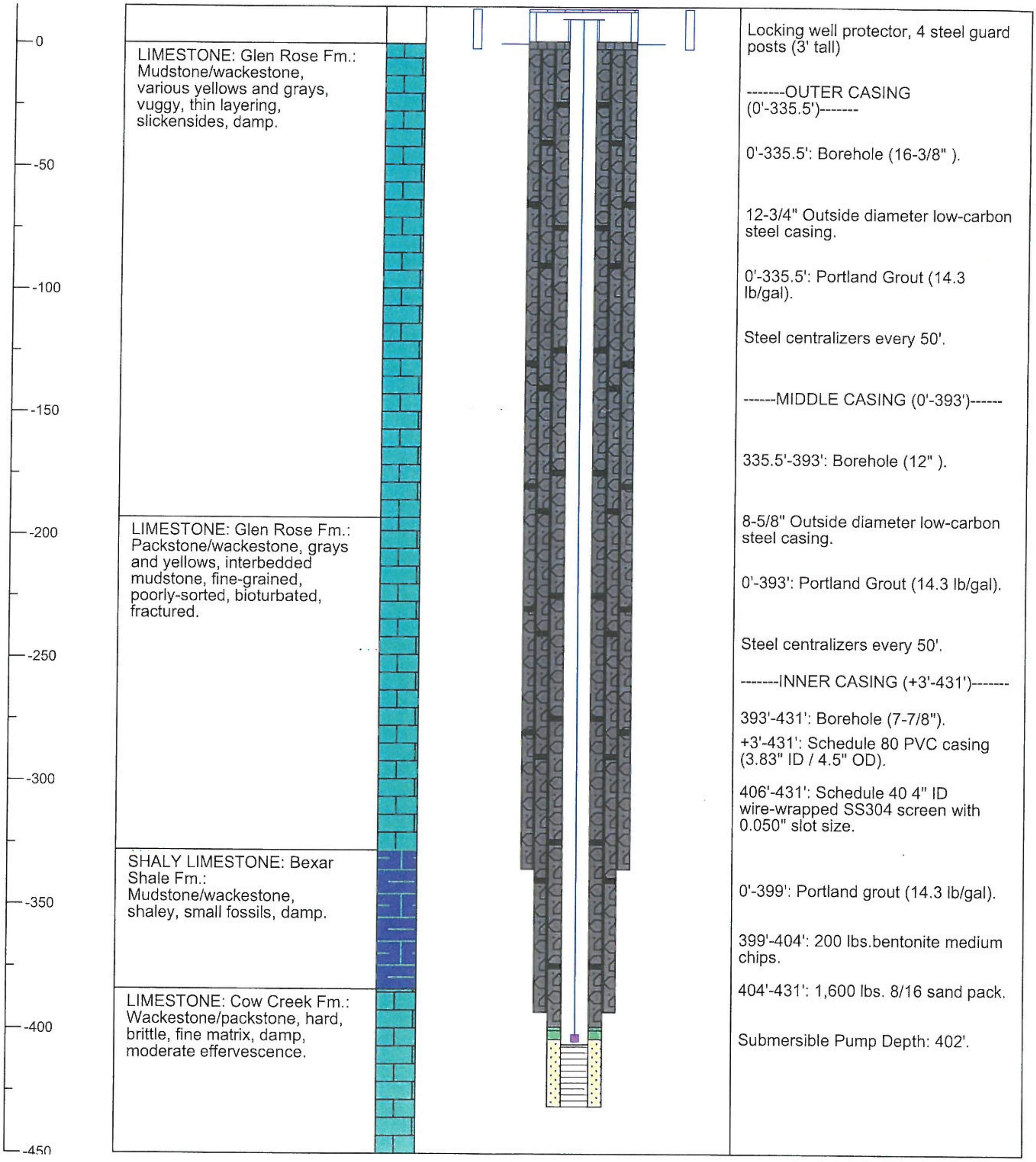
Monitor Well Completion Log

CS-MW16-CC

Project:	740911.04000	**Installation:**	Camp Stanley Storage Activity
Geologist:	E. Tennyson	**Size and Type of Bit:**	4.25" Continuous Air-Core
Drilling Agency:	Geoprojects International	**Make and Model of Rig:**	Gardner-Denver 1500

Well ID	Interval	Northing (m)	Easting (m)	Ground Level (ft MSL)	TOC (ft MSL)	Start	Stop
CS-MW16-CC	384-459'	3286844.09	537277.45	1241.97	1244.51	04/10/03	06/16/03

Depth (feet bgs)	Classification of Materials	Lithology	Well Construction	Construction Material



LIMESTONE: Glen Rose Fm.: Mudstone/wackestone, various yellows and grays, vuggy, thin layering, slickensides, damp.

LIMESTONE: Glen Rose Fm.: Packstone/wackestone, grays and yellows, interbedded mudstone, fine-grained, poorly-sorted, bioturbated, fractured.

SHALY LIMESTONE: Bexar Shale Fm.: Mudstone/wackestone, shaley, small fossils, damp.

LIMESTONE: Cow Creek Fm.: Wackestone/packstone, hard, brittle, fine matrix, damp, moderate effervescence.

Locking well protector, 4 steel guard posts (3' tall)

-------OUTER CASING (0'-335.5')-------

0'-335.5': Borehole (16-3/8").

12-3/4" Outside diameter low-carbon steel casing.

0'-335.5': Portland Grout (14.3 lb/gal).

Steel centralizers every 50'.

------MIDDLE CASING (0'-393')------

335.5'-393': Borehole (12").

8-5/8" Outside diameter low-carbon steel casing.

0'-393': Portland Grout (14.3 lb/gal).

Steel centralizers every 50'.

-------INNER CASING (+3'-431')-------

393'-431': Borehole (7-7/8").

+3'-431': Schedule 80 PVC casing (3.83" ID / 4.5" OD).

406'-431': Schedule 40 4" ID wire-wrapped SS304 screen with 0.050" slot size.

0'-399': Portland grout (14.3 lb/gal).

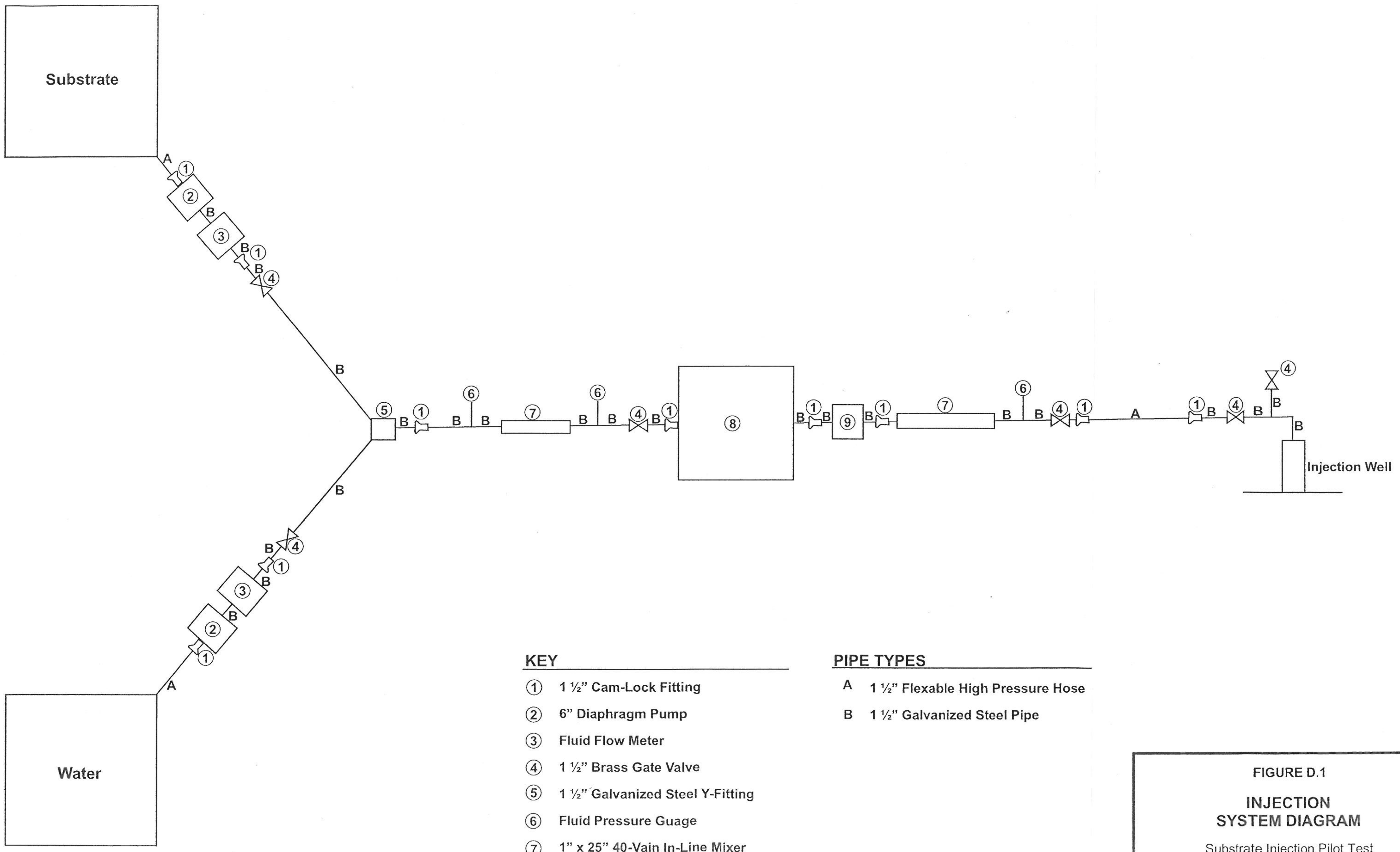
399'-404': 200 lbs.bentonite medium chips.

404'-431': 1,600 lbs. 8/16 sand pack.

Submersible Pump Depth: 402'.

Attachment C - 5

ATTACHMENT D



KEY

①	1 ½" Cam-Lock Fitting
②	6" Diaphragm Pump
③	Fluid Flow Meter
④	1 ½" Brass Gate Valve
⑤	1 ½" Galvanized Steel Y-Fitting
⑥	Fluid Pressure Guage
⑦	1" x 25" 40-Vain In-Line Mixer
⑧	100 gallon Sealed Poly Tank
⑨	8" Diaphragm Pump

PIPE TYPES

A	1 ½" Flexable High Pressure Hose
B	1 ½" Galvanized Steel Pipe

FIGURE D.1

INJECTION
SYSTEM DIAGRAM

Substrate Injection Pilot Test
SWMU B-3
Camp Stanley Storage Activity, Texas

PARSONS

Denver, Colorado

Note: This drawing is not to scale

draw\738863 Injection System Diagram .cdr ma 04/07/03

ATTACHMENT E

Groundwater from the planned injection well CS-B3-MW01 has not been sampled and contaminant concentrations from this location are currently not available. However, concentrations from the injection well are expected to be similar to results from a groundwater sample collected during packer testing of the 268 to 288-foot depth interval at MPMW location CS-WB05, located 35 feet northwest of the injection well (Table E.1). Groundwater samples will be collected from well CS-B3-MW01 prior to the substrate injection and if contaminant concentrations are determined to exceed hazardous levels established under 30 TAC §335, Subchapter R, then either a Class IV UIC Permit Application will be submitted or groundwater from nearby monitoring well CS0MW16-LGR will be utilized. The June 2005 groundwater results for monitoring well CS0MW16-LGR are summarized in Table E.2.

Table E.1
Groundwater Sample Results Well CS-WB05 (268 - 288 Foot Interval)
Spetember 2005

Compound	Results (mg/L)		Class I Maximum Leachable Concentration (mg/L) *
1,1-Dichloroethene	0.000458	U	0.6
Bromodichloromethane	0.000438	U	0.3
Bromoform	0.000432	U	70
Chloroform	0.000388	U	6.0
Dibromochloromethane	0.000162	U	*NE*
Dichlorofluoromethane	0.000312	U	*NE*
Methylene Chloride	0.000890	U	50
Naphthalene	0.000608	U	*NE*
Tetrachloroethene	0.0313		0.7
Toluene	0.00418		1000
Trichloroethene	0.152		0.5
Vinyl Chloride	0.000178	U	0.2
cis-1,2-Dichloroethene	0.286		*NE*
trans-1,2-Dichloroethene	0.000278	U	*NE*

U = The analyte was analyzed for but not detected. The associated numerical value is at or below the method detection limit.

NE - Class I Maximum Leachable Concentration not established

* Class 1 Toxic Constituents' Maximum Leachable Concentrations, 30 TAC §335.521 Table 1

Table E.2
Groundwater Results for Monitoring Well CS-MW16-LGR
June 2005

Compound	Results (mg/L)		Class I Maximum Leachable Concentration (mg/L) *
Volatiles			
1,1-Dichloroethene	0.00017	U	0.6
Bromodichloromethane	0.00019	U	0.3
Bromoform	0.0002	U	70
Chloroform	0.00015	U	6.0
Dibromochloromethane	0.00019	U	ne
Dichlorofluoromethane	0.00019	U	ne
Methylene Chloride	0.00017	U	50
Naphthalene	0.00023	U	ne
Tetrachloroethene	0.018		0.7
Toluene	0.00017	U	1000
Trichloroethene	0.019		0.5
Vinyl Chloride	0.00021	U	0.2
cis-1,2-Dichloroethene	0.017	U	ne
trans-1,2-Dichloroethene	0.00016	U	ne
Metals			
Arsenic	0.00042	F	1.8
Barium	0.037		100
Cadmium	0.000093	F	0.5
Chromium	0.00082	U	5.0
Copper	0.0045	U	1.0**
Lead	0.00056	F	1.5
Mercury	0.000044	U	0.2
Nickel	0.0012	U	70
Zinc	0.32		5.0**

F =The analyte was positively identified, but the associated numerical value is below the reporting limit.

U =The analyte was analyzed for but not detected. The associated numerical value is at or below the method detection limit.

ne - Class I Maximum Leachable Concentration not established

* Class 1 Toxic Constituents' Maximum Leachable Concentrations, 30 TAC §335.521 Table 1

** Secondary drinking water standards

ATTACHMENT F

Water level and analytical data collected as part of the CSSA Groundwater Monitoring Program indicate that the horizontal and vertical extent of groundwater contamination in and around CSSA varies over time. It is likely these fluctuations are in response to variations in groundwater gradients resulting from the rise and fall of groundwater levels due to seasonal changes in rainfall and recharge rates. For the most part, VOC contamination appears to be confined to the Lower Glen Rose unit of the Middle Trinity Aquifer (Figure F.1). Lesser amounts of VOCs have been identified in the Upper Glen Rose, Bexar Shale, and Cow Creek units.

The injection of the lactate and vegetable oil into the aquifer will not result in significant migration of these fluids because the lactate will be quickly degraded and the vegetable oil emulsion will have limited mobility in the aquifer. Based on experience, the lactate can be expected to completely degrade by normal biological activity within 1 month of injection. The vegetable oil will be introduced into the aquifer as an emulsion which will be injected outward from the injection well to an estimated radius of 15 feet. Since the oil is present as an emulsion it will adhere to the inter-granular surfaces within the formation and is not expected to migrate significantly. Degradation byproducts (such as Cl- and Fe2+) will likely be mobilized in the aquifer due to anaerobic conditions occurring within the reaction zone established within the formation. Degradation products mobilized in the reduced reaction zone will undergo chemical alterations (oxidation, mineralization, *etc.*) once they migrate outside the reaction zone at which time their mobility will be reduced. More conservative degradation products (Cl-) and the conservative tracers used during the Pilot Study will have the highest mobility in the aquifer but will undergo significant dilution over time. Additionally, with the exception of organic compounds created during the degradation process, the inorganic degradation products are generally not produced at concentrations that could result in health concerns.

The biggest issue with the enhanced biodegradation process is incomplete degradation resulting in the generation of toxic intermediate breakdown products such as vinyl chloride (VC). If not degraded anaerobically, these toxic degradation products are often degraded under aerobic (oxidizing) conditions present outside the reaction zones. If these toxic breakdown products are produced, a potential VC plume would be created and expand until the rate of generation equals the rate of attenuation, at which time the plume would be considered stabilized. Since the vegetable oil substrate is expected to be consumed by biological processes within approximately 2 years, generation of byproducts would cease at that time and any associated byproduct plumes would cease to grow and eventually attenuate through dilution, adsorption, and degradation. Therefore, it is estimated that byproducts generated during the degradation process would not migrate to a public water supply at concentrations above drinking water standards.

Accurate predictions of byproduct concentration over distance and time that also account for the effects of attenuation (dilution, absorption, degradation), generally require complex numerical modeling. However, the migration rate of degradation byproducts (and also the conservative tracers) can be approximated using analytical solutions to groundwater flow and transport processes. Using a maximum hydraulic conductivity for the injection zone of 15.8 feet per day (ft/day) (5.6 x 10-3 cm/sec) as determined during previous CSSA investigations, an assumed hydraulic gradient of 0.01 ft/ft and an effective porosity of 5 percent, the maximum estimated groundwater velocity in the area would be 1.3 ft/day (475 ft/yr). Applying this estimated groundwater velocity and assuming no retardation or attenuation, it would take approximately 8.5 years for these constituents to migrate from the injection location to the nearest water supply well, approximately 4,000 feet away. Since this approximation does not include the effects of attenuation, it represents a conservative estimate and the actual migration rates can be expected to be much longer.

As an added precaution, CSSA will continually pump nearby downgradient well CS-MW16-LGR during the Pilot Study which will induce flow of the tracer, substrate, and degradation byproducts toward the well where it can be captured, treated, and discharged at TPDES Outfall 002. In addition, CSSA has set up an effective monitoring network to track any degradation byproduct plume development/migration. If any drinking water wells are threatened, CSSA will respond with appropriate well-head protection in accordance with the CSSA Off-Post Monitoring and Response Plan.

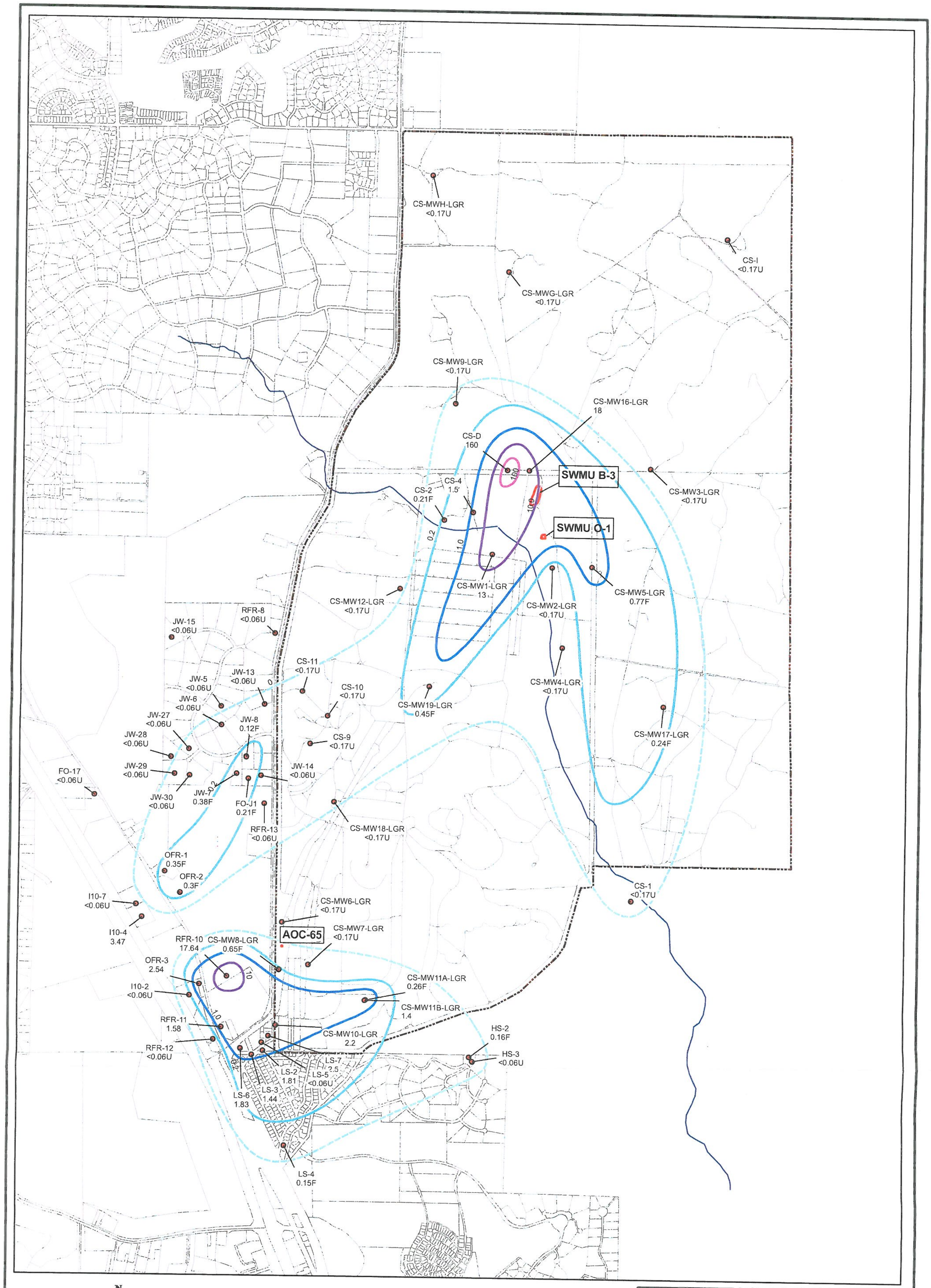


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Figure F.1

PCE Concentrations for LGR Wells, June 2005

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ATTACHMENT G

Results of geochemical analyses for the Lower Glen Rose Formation are summarized in Table G.1.

Table G.1
Results of Natural Attenuation Study - On-Post Monitoring Wells
Field Analysis
Camp Stanley Storage Activity

SampleID	CS-16	CS-D	CS-9	CS-10	CS-11	CS-1	CS-MW1-LGR	CS-MW2-LGR	CS-2	CS-MW8-LGR	CS-MW5-LGR	CS-MW4-LGR	CS-MW3_LGR
Sample Date	09/09/02	09/09/02	09/10/02	09/10/02	09/10/02	09/10/02	09/10/02	09/10/02	09/10/02	09/10/02	09/11/02	09/11/02	9/11/2002
ParamID													
Hach Testing (mg/L)													
Alkalinity	230	250	236	258	244	228	258	262	242	300	244	280	158
Carbon Dioxide	60	45	55	45	65	65	45	35	60	56	65	55	45
Ferrous Iron	0	0	0	0	0.29	0.02	0.08	0.08	0.04	0	0.02	0.05	0
Hydrogen Sulfide	0	0	0	0	0	0	0	0	0	0	0	0	0
Manganese	0.2	0.2	0	0	0	0	0	0.5	0.1	0	0	0.1	0
Nitrate	3.2	3.9	2.5	2.2	0.6	2	1.9	1.3	1.9	10.4	2.8	1.7	2.1
Nitrite	0	0.001	0.001	0	0	0.001	0.002	0.002	0.002	0.018	0	0	0.006
Sulfate	24.37	18.89	28.19	28.91	43.39	38.94	23.44	40.7	48.35	3.59	20.75	36.25	24.57
Direct Readings													
pH	6.81	7.01	7.46	7.62	7.13	7.47	6.39	6.94	6.02	5.43	6.38	6.57	5.86
Conductivity*													
Redox Potential	188	207.8	-26.4	3.4	33.6	35	377.4	352.3	369.4	418.2	262.3	333.7	436.9
Dissolved Oxygen	3.44	1.41	3.65	3.35	2.52	3.35	5.24	0.16	2.51	0.44	0.47	0.11	0.95
Temperature	21.94	22.23	22.54	22.89	22.12	22.97	23.09	22.44	22.51	23.11	23.09	22.9	23.56
DH (nM)													
Dissolved Hydrogen	59	1.8	1.8	2.7	1.4	2.1	1.3	1.9	1.7	2.4	0.14	2	2.3
M2720C (ug/L)													
Methane	0.22 F	0.25 F	0.23 F	0.3 F	6.3	1	0.23 F	9.2	0.32 F	0.28 F			
Ethane	0 U	0 U	0 U	0 U	0 U	0 U	0 U	0 U	0 U	0 U	0 U	0 U	0 U
Ethene	0 U	0 U	0 U	0 U	0 U	0 U	0 U	0 U	0 U	0.25 F	0 U	0.36 F	0 U
SW9056 (mg/L)													
Chloride	12	11	17	13	17	12	9	9.7	26	11			
Method SW9060													
DOC	5.4	4.7	3.8	3.6	3.9	1.5	2.1	2.5	3	1.5	1.6	4.5	2.1

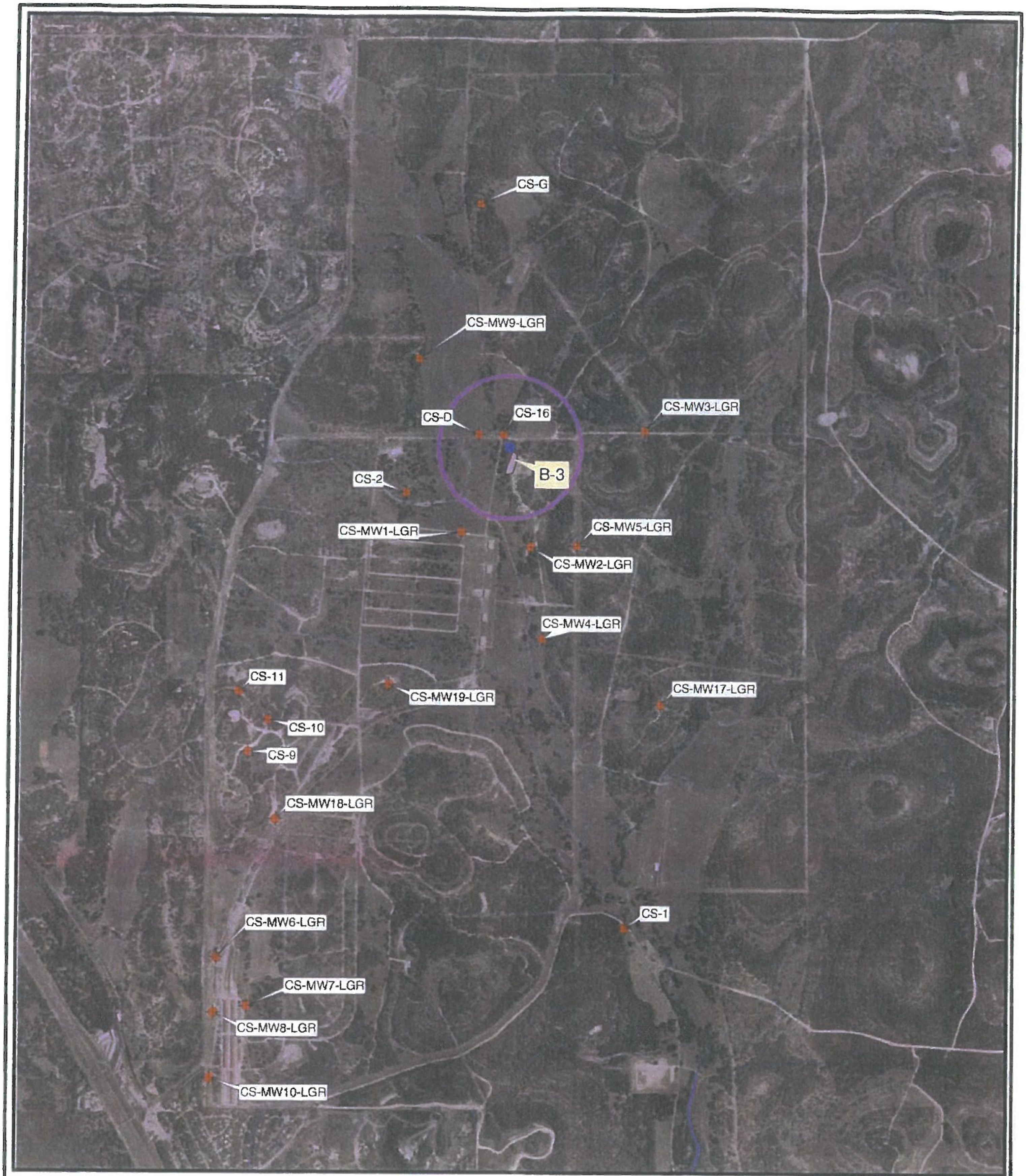

Figure: G.1

On-Post Monitoring Well Locations
Used in Natural Attenuation Study
Camp Stanley Storage Activity

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ATTACHMENT H

The composition of the injection mixture is summarized in Table H.1. For the tracer test, 3.5 gallons of a potassium iodine mixture with an iodine concentration of 500 ppm will be injected into the aquifer. For the degradation test an estimated 1,800 gallons of injection mixture will be injected and will then be followed by injection of approximately 900 gallons of formation water from the injection interval. A detailed summary of the substrate mixture to be injected during the Pilot Study is included as Table H.1.

TABLE H.1
SUBSTRATE MIXTURE SPECIFICATIONS
AREA B-3 ENHANCED MNA TREATABILITY STUDY
CAMP STANLEY, TEXAS

Injection Point		Emulsion Injection Mixture							Post-Emulsion Push			Total Volume					
			Soybean Oil Component		WillClear				WillClear								
Well ID	Injection Interval (feet)	Product Volume (gallons)	(gallons)	(pounds)	Volume (gallons)	Lactic Acid (pounds)	Makeup Water (gallons)	Sodium Bromide (pounds)	Volume (gallons	Lactic Acid (pounds)	Makeup Water (gallons)	Substrate (pounds)	Water/ Substrate (gallons)	Injection Interval (feet)	Estimated Effective Porosity (percent)	Radius of Influence (feet)	Injection Time at 5 gpm (hours)
CS-B3-MW01	277-287	100	100	462	100	531	1800	8.3	50	266	900	1,259	1,158	10	5%	9.9	3.9

SUBSTRATE CONCENTRATIONS

Final Percent Substrate by Weight: 16.6%
Final Percent Water by Weight: 83.4%
Final Lactic Acid Concentration: 82.6 grams/liter
Final Oil Concentration: 47.9 grams/liter
Percent Oil by Volume in Emulsion: 92.3%
Final Residual Percent Oil by Volume: 8.6%

NOTES: Sodium Lactate Product

1. Assumes WillClear sodium lactate product is 60 percent sodium lactate by weight.
2. Molecular weight of sodium lactate (CH_3-CHOH-COONa) = 112.06.
3. Molecular weight of lactic Acid ($C_6H_6O_3$) = 90.08 .
4. Specific gravity of WillClear Product = 1.323 @ 20 degrees Celsius.
5. Weight of WillClear Product = 11.0 pounds per gallon.
6. Pounds per gallon of lactic acid in product = 1.323 x 8.33 lb/gal H_2O x 0.60 x (90.08/112.06) = 5.31 lb/gal.

NOTES: Vegetable Oil Emulsion Product

1. Assumes emulsion product is 100 percent soybean oil by weight.
2. Soybean oil is 7.8 pounds per gallon.

NOTES: Conservative Tracer (Bromide)

1. Assume sodium bromide will be used to produce soluble bromide for conservative tracer.
2. Desired bromide concentration in substrate mixture is 500 mg/L.

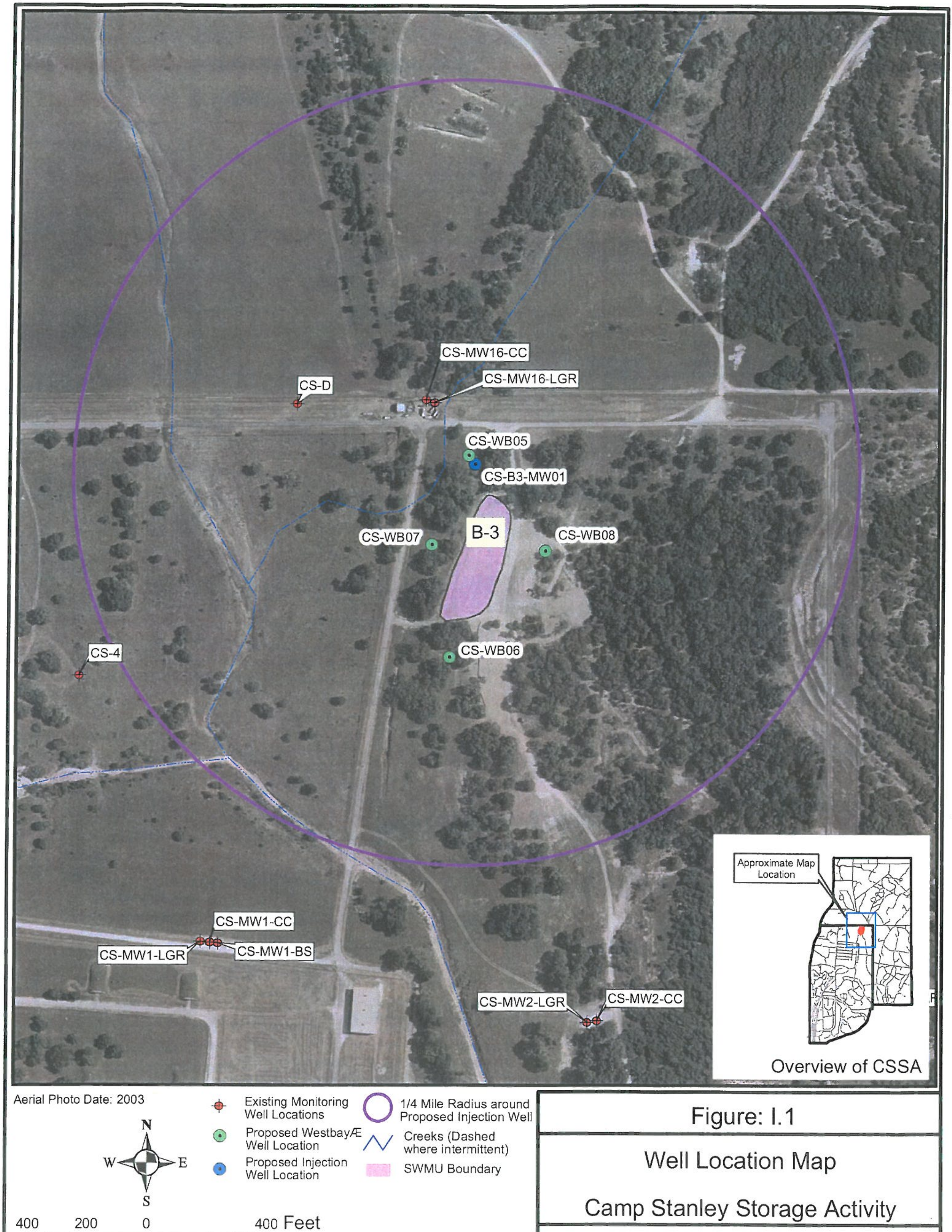
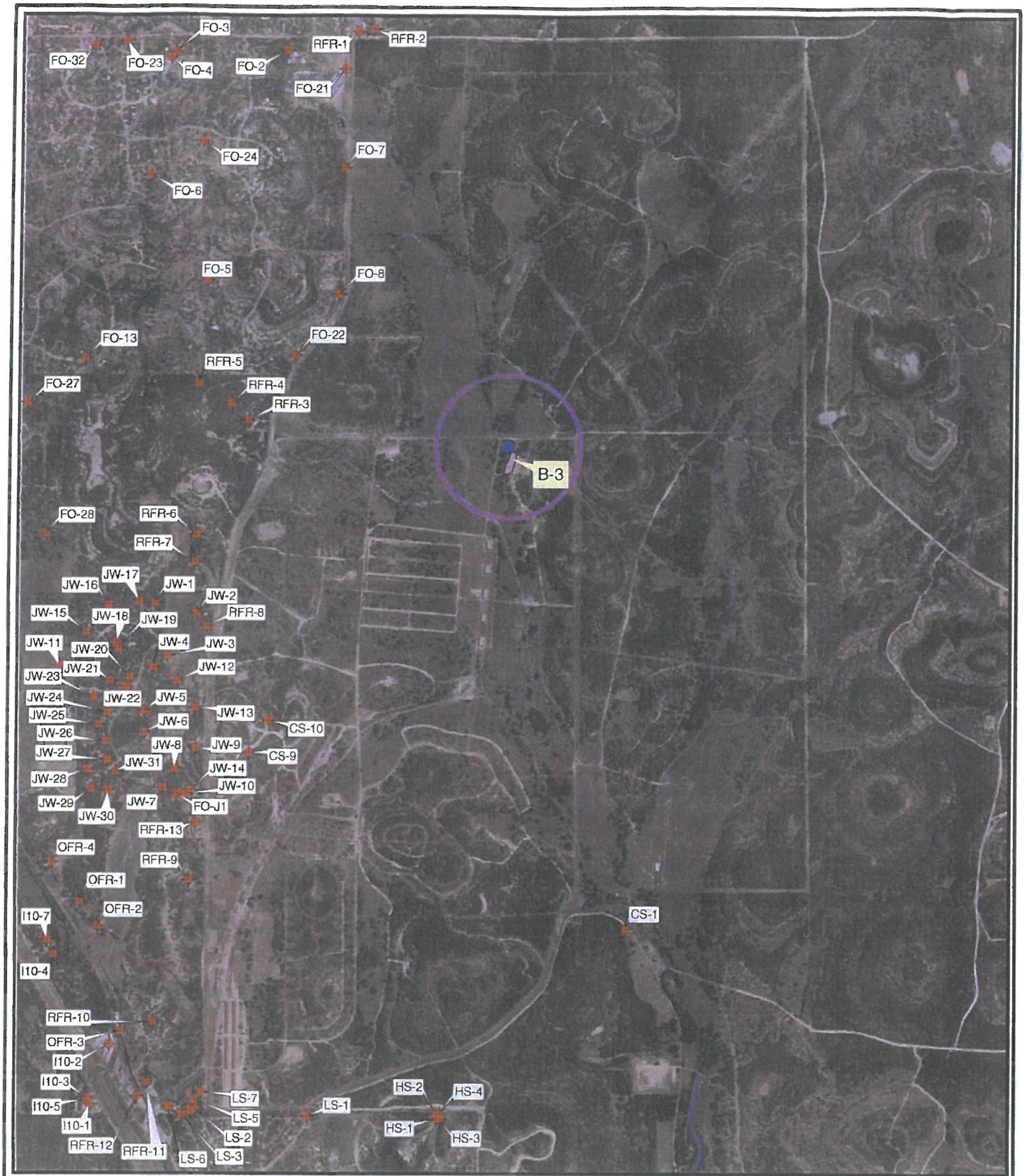


Figure: I.1

Well Location Map

Camp Stanley Storage Activity

PARSONS



Aerial Photo Date: 2003

N
W E
S

2,000 1,000 0 2,000 Feet

✦ Existing Water Supply Well Locations

○ 1/4 Mile Radius around Proposed Injection Well

Creeks (Dashed where intermittent)

▨ SWMU Boundary

Figure: I.2

Water Supply Well Location Map

Camp Stanley Storage Activity

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ATTACHMENT J

In 1991, volatile organic compounds (chlorinated hydrocarbons) were detected in groundwater from well CS-MW16 approximately 500 feet north-northwest of SWMU B-3. The concentrations were above drinking water standards and prompted several investigations aimed at identifying possible source areas that could be contributing to the contamination. Various investigations, including geophysical surveying, surface and subsurface soil sampling, and soil gas sampling, indicated that tetrachloroethene (PCE) and trichloroethene (TCE) were present at SWMU B-3. The presence of these chlorinated hydrocarbons implicated SWMU B-3 as a likely source area for the contamination detected in well CS-MW16-LGR. The original contamination concentrations in the landfill at SWMU B-3 are unknown; however, the concentrations detected at the nearby monitoring well CS-MW16-LGR are presented in Table E.2 of Attachment E.

ATTACHMENT K

There have been no remediation efforts within the saturated zone at the site. A soil vapor extraction (SVE) system was installed at SWMU B-3 in 1996 as a pilot study to evaluate the effective of SVE at the site. The SVE system remained in operation as an interim remedial action for the site until 2002 when the SVE system was removed during limited removal actions performed at the site. A new two-well SVE system was installed in 2003, and CSSA plans to expand that SVE system to address volatile organic contaminants in the bedrock material underlying the landfill. CSSA plans to conduct additional removal actions at SWMU B-3 during December 2005 to remove the remaining contaminated landfill material.

Table G.1 (continued)
Results of Natural Attenuation Study - On-Post Monitoring Wells
Field Analysis
Camp Stanley Storage Activity

SampleID	CS-G	CS-MW9-LGR	CS-MW6-LGR	CS-MW19-LGR	CS-MW17-LGR	CS-MW18-LGR	CS-MW7-LGR	CS-MW10-LGR	Min	Max
Sample Date	9/11/2002	9/11/2002	9/11/2002	9/12/2002	9/12/2002	9/12/2002	9/13/2002	9/13/2002		
ParamID										
Hach Testing (mg/L)										
Alkalinity	180	262	226	256	274	254	250	282	158	300
Carbon Dioxide	50	45	50	35	60	55	65	85	35	85
Ferrous Iron	0	0	0	0	0.02	0	0.01	0	0	0.29
Hydrogen Sulfide	0	0	0	0	0	0	0	0	0	0
Manganese	0	0	0	0.1	0	0.3	0	0.2	0	0.5
Nitrate	3	2.5	2.2	4.4	4.3	0.14	8.8	0	0	10.4
Nitrite	0.004	0.002	0.001	0.004	0.003	0.002	0	0.002	0	0.018
Sulfate	15.37	17.96	21.58	10.62	20.75	43.8	1.84	17.96	1.84	48.35
Direct Readings										
pH	6.09	4.2	7.38	7.3	7.03	7.63	8	7.9	4.2	8
Conductivity*			571	617	618	564	624	688	564	688
Redox Potential	404	535.6	12	93.9	40.1	32.5	-108.6	-59.5	-108.6	535.6
Dissolved Oxygen	3.83	2.2	1.12	7.36	4.57	1.74	0.32	1.96	0.11	7.36
Temperature	22.27	23.11	22.79	22.11	22.29	22.54	21.4	22.22	21.4	23.56
DH (nM)										
Dissolved Hydrogen	4.1	2.7	2.4	0.8	1.4	2	3	2.5	0.14	59
M2720C (ug/L)										
Methane	0.21 F		2.1	0.34 F	0.32 F	0.34 F		0.26 F	0.21 F	9.2
Ethane	0 U	0 U	0 U	0 U	0 U	0 U	0 U	0 U	0	0
Ethene	0 U	0 U	0 U	0 U	0 U	0 U	0 U	0 U	0	0.36 F
SW9056 (mg/L)										
Chloride	13		12	14	15	11		9.2	9	26
Method SW9060										
DOC	2.1	3.7	5	6.2	6.2	5.9	5.5	6.2	1.5	6.2