CO_2 SPARGING
PROOF OF CONCEPT TEST REPORT

Revision 1

LCP CHEMICAL SITE, BRUNSWICK, GA

Prepared for Honeywell

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EXECUTIVE SUMMARY

The Proof of Concept test was designed to evaluate the feasibility of CO_2 sparging to remediate a sub-surface caustic brine pool (CBP) formed by historical production of industrial chemicals at the LCP Chemicals Site (Brunswick, GA). The test was conducted in accordance with the "Final Work Plan for CO_2 Sparging Proof of Concept Test, LCP Chemical Site, Brunswick, GA" (Mutch Associates, 2012) dated September 11, 2012, and approved by EPA on September 10, 2012. This CBP has been defined as groundwater with a pH above 10.5. In the area around the Proof of Concept test, the CBP is situated at the 30 to 50 ft interval below land surface (bls) and is underlain by a variably cemented sandstone aquitard.

The specific objectives of the Proof of Concept test as set forth in the EPA-approved work plan included:

- Determine the radius of influence (ROI) of a representative CO_2 sparging well as defined by pH reduction to target levels
- Determine the kinetics of the pH neutralization reaction
- Determine the efficiency of the CO_2 sparging as defined by the amount of pH reduction achieved per mass of CO_2 injected
- Assess whether significant reductions in aquifer hydraulic conductivity occurred within the ROI as a result of the CO_2 sparging
- Assess whether there is significant reduction in the specific capacity of the sparge well, which served as the aquifer testing groundwater extraction well before and after the CO_2 sparging test
- Determine the impact of the CO_2 sparging on the geochemistry of the aquifer within the ROI and in particular on the concentrations of mercury and other metals
- Determine the vertical magnitude, radial extent, rate of propagation, and life-cycle of any groundwater mounding caused by the CO_2 sparging and the extent of groundwater level collapse following cessation of sparging
- Determine practical CO_2 injection rates and ways in which sparging efficiency can be enhanced
- Monitor over time potential rebound in pH, metals, or other geochemical parameters

All of these objectives were met except for completion of the long-term post-sparge rebound monitoring which is scheduled for February and May of 2013. The most important result of this test was that CO_2 sparging was effective in lowering the pH of the CBP at significant distances away from the sparge well. The lower pH results in significantly reduced mobility for the metals, particularly mercury.

Well Network and Test Protocol

Prior to the test, one sparge well (SW-1), and seven new monitoring wells were installed at various radial distances and depths. The screened interval of SW-1 was located at 40 to 45 ft bls. New monitoring wells were installed and screened at three intervals denoted shallow, intermediate, and deep.

A total of 14 monitoring wells were used during the test. These wells were located within 100 ft of the sparge well (Figure 1). To avoid artesian flow from the monitoring wells during sparging, all wells within the monitoring network were fitted with a PVC compression fitting and extended approximately 6

ft with 2 in diameter PVC pipe, such that all wells extended roughly 8-10 ft above ground surface. The wells were also sealed from the atmosphere to prevent CO_2 gas channels from intercepting the well screen and preferentially flowing up through the well. The target flow rate for the test was 20 standard cubic feet per minute (scfm). An upper limit on pressure was set at 25 psig to avoid pneumatic fracturing of the formation.

Pre- and post-sparging aquifer tests were conducted using SW-1 as the pumping well to discern if sparging caused any changes in aquifer properties. Data collection included monitoring of groundwater levels, barometric pressure, the stage of the waterway adjacent to causeway near the junction of Purvis Creek and the Unnamed Ditch, pre-sparge aquifer test pumping, and post-sparge aquifer test pumping.

A round of groundwater samples was taken from the monitoring well network before and after the test. Analysis of pH, specific conductivity (SC), dissolved oxygen (DO), temperature, and oxidation-reduction potential (ORP) was performed in the field as part of normal well purge protocols. In addition, specific gravity was measured using a field hydrometer. Test America (Savannah, GA) was used for analysis of lab pH, dissolved inorganic carbon, alkalinity, total organic carbon, total dissolved solids, dissolved silica, ferrous iron, dissolved sulfide, chloride, mercury, and TAL metals (which includes chromium, arsenic, calcium, magnesium, sodium, etc.). SF_6 in groundwater collected post-sparging was analyzed by CH2M Hill's Applied Sciences Laboratory.

Sparging Activity

Sparging began on Monday October 29, 2012. Flow rates of 20 to 60 scfm were easily achievable at pressures ranging from 22.0 and 25.0 psig. During the first week, sparging into SW-1 took place on five consecutive days for approximately 8.0 hrs/day. The weekend (November 3rd and 4th) was used as a rest period to observe potential pH rebound. In week 2, sparging into SW-1 took place on five consecutive days at approximately 8.7 hrs/day. Sparging occurred at slightly higher flow rates to assess effect on pH reductions in the deep Satilla wells. Once again, the weekend (November 10th and 11th) was used as a rest period to observe potential pH rebound.

Prior to the 11th day of sparging, a decision was made (in consultation with and verbal approval by EPA) to change the sparging point from SW-1 to MW-1C. MW-1C is screened 5 feet deeper than SW-1 and is at the same interval as MW-2C and MW-519B. The reason for this change was to try to lower the pH to between 7 and 8 in the deep Satilla monitoring wells to evaluate the effect of pH and the overall geochemistry of the aquifer. With this change, flow rates of 50 to 60 scfm were achievable at pressures up to 25 psig. Sparging took place on six consecutive days into MW-1C for approximately 9 hrs/day.

Changes in pH

Values from the baseline continuous pH monitoring are shown in profile in Figure 1. Deep Satilla wells had pH values ranging from 11.2 to 11.9. These values are consistent with historical pH values of deep Satilla wells at the site. Shallow and intermediate Satilla well pH values were alkaline (pH > 7), but did not have as high pH as the deep Satilla wells.

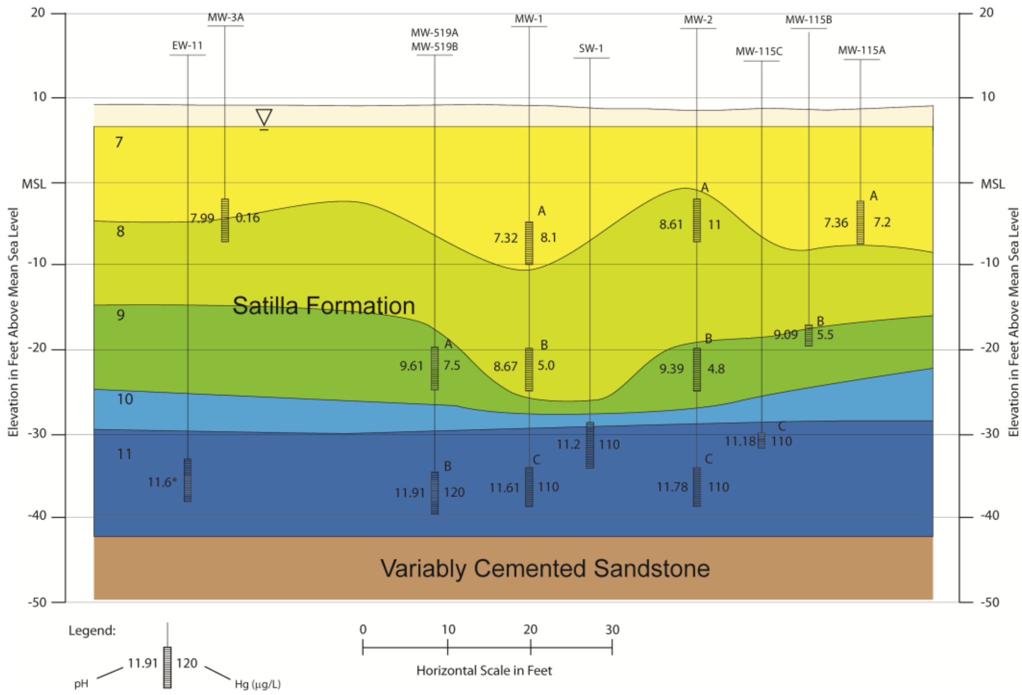

Figure 1: Cross section of pre-sparge pH and mercury concentrations in the area near the Proof of Concept Test. Contours represent pH values. Values shown for pH were recorded in the field, just prior to the start of sparging (October 29, 2012 at 8:45 AM). Mercury values are laboratory measurements from samples collected from October 2 to October 3, 2012.

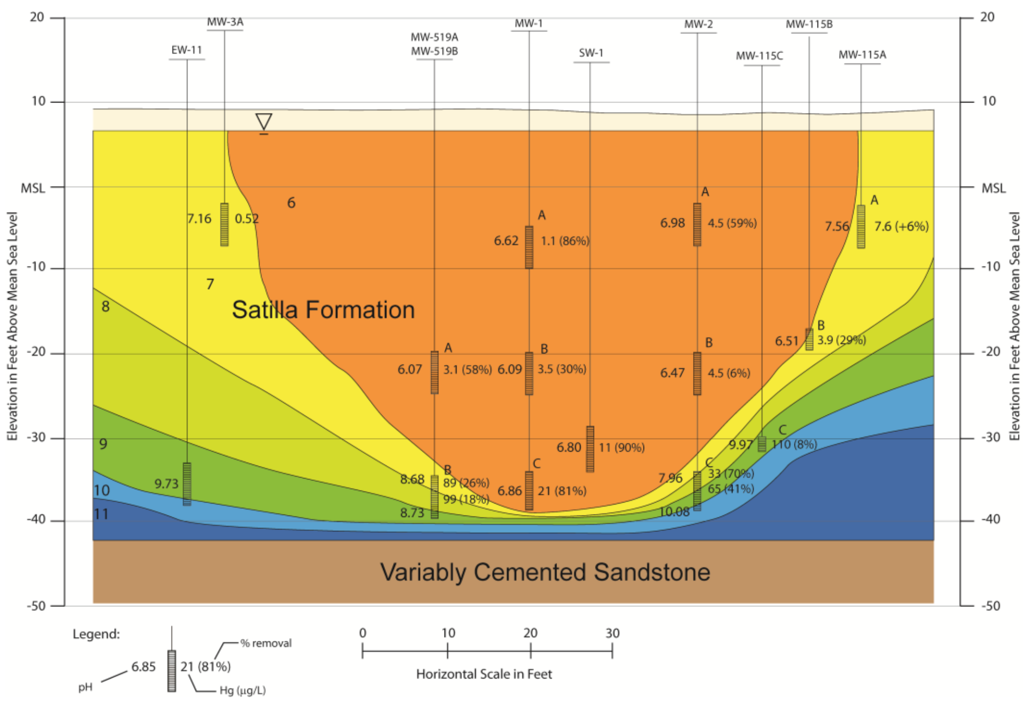

Figure 2: Cross section of post-sparge pH and mercury concentrations in the area near the Proof of Concept Test. Contours represent pH values. Values shown for pH were recorded in the field, one week after the conclusion of sparging (November 28, 2012). Mercury values are laboratory measurements from samples collected from November 27 to November 28, 2012. Note: MW-2C Hg value is the average of field sample and field duplicate.

The day-to-day pH responses of individual wells during the sparging period showed large variations and are discussed in detail in this report. The overall change in pH after 2 weeks of sparging into SW-1 is of note. The lowest pH values recorded were in SW-1 itself (6.60). However, with the exception of SW-1, pH levels in the deep Satilla wells did not decrease to a large extent from pre-sparge levels. The monitoring well that showed the largest decrease in pH after two weeks was MW-2C, which showed a decrease from 11.78 to 9.19 at the top of screen. The pH at the top of the MW-2C well screen was more than 1 pH unit lower than at the bottom of the screen.

The influence on the deep Satilla wells was much more pronounced after sparging was switched from SW-1 to MW-1C (Figure 2). MW-1C, MW-519B and MW-2C all experienced pH decreases of greater than 3 units from pre-sparge levels. MW-519B and MW-2C had post-sparge pH values of 7.96 and 8.68 in water pumped from the top of the well screen. These wells are 15.1 and 19.9 ft from MW-1C, respectively. Decreases in pH in MW-115C and EW-11 were more modest, with post-sparge pH values between 9 and 10. These wells were 24.6 ft and 44.1 ft away from MW-1C. Based upon this information, the effective radius of influence for sparging within the deep Satilla was conservatively estimated at 20 ft.

The sparging efficiency was calculated by dividing the theoretical CO_2 demand of CBP water by the total amount of CO_2 used for sparging. A numerical titration was performed to calculate the theoretical CO_2 demand of CBP. The efficiency considering the total amount of CO_2 injected into both SW-1 and MW-1C was 4.1%. Since the majority of the demand is present in the deep Satilla, an alternative way of calculating the sparging efficiency is to consider only the amount of CO_2 injected into MW-1C. The sparging efficiency in this case is calculated to be 9.7%. This alternative calculation assumes that the demand of the intermediate and shallow portions of the aquifer would have already been met prior to the 54.5 hr sparging duration into MW-1C. This is a reasonable assumption given the rapid decreases in pH observed in the intermediate and shallow monitoring wells after the start of sparging. Note that the calculated efficiency of 9.7% is very similar to the 10% efficiency assumed as part of the CO_2 demand calculations in the EPA-approved Proof of Concept work plan.

Mercury and other Geochemical Changes

Pre-sparge soluble mercury concentrations in the deep Satilla in the area near SW-1 were consistently between 110 and 120 μg/L (Figure 1). After the three week sparging program, there was a considerable decrease in mercury concentrations in the deep Satilla wells that had post-sparge pH values near 7.0 (Figure 2). For example, SW-1 (11 μg/L) and MW-1C (20 μg/L) showed a reduction of 81% and 90% percent respectively. The next largest reduction among the deep Satilla wells was MW-2C, which showed a 70% reduction in mercury concentrations in water sampled from the top of the well screen. Wells in the intermediate Satilla showed more modest percent reductions.

Changes in TDS, specific gravity, dissolved arsenic (As), chromium (Cr), silicon (Si) and vanadium (V) were quantified by the pre- and post-sparge monitoring data. TDS did not change appreciably from pre- to post-sparging, which is consistent with the expectation for TDS. Dissolved concentrations of As, Cr, Si and V all decreased significantly and to varying extents in deep Satilla wells after sparging.

Aquifer Test Results

The principal objective of the pre-sparging and post-sparging aquifer testing was to determine the extent to which the CO_2 sparging and the associated lowering of pH may have reduced aquifer transmissivity through solids precipitation, particularly precipitation of silica gel. Aquifer testing was used to assess this possible occurrence since aquifer testing measures the transmissivity and hydraulic conductivity of the entire zone of influence of the CO_2 sparging test and, ultimately as the test continues, around the periphery of the test zone. The pre-sparging aquifer testing demonstrated that the basal portion of the aquifer, specifically the lower 20 feet of the aquifer (which roughly corresponds with the high pH, high density CBP waters), had a pre-sparging transmissivity of 1,325 gpd/ft and a mean early-time storativity of 1.4×10^{-3}. After the CO_2 sparging, the transmissivity of the basal portion of the aquifer declined by 66% to 450 gpd/ft. This corresponds to a reduction in hydraulic conductivity from 8.9 ft/day to 2.4 ft/day.

The decline in transmissivity and hydraulic conductivity is believed to be principally the result of residual saturation of CO_2 in aquifer and not the result of silica solid precipitation. The residual saturation was estimated to range from 0.1 to 0.5 (10% to 50% of the pore space). The presence of a substantial residual saturation of CO_2 gas in the aquifer also increased the storativity of the aquifer due to the drawdown-induced expansion of the CO_2 gas.

During sparging, significant mounding of the potentiometric surface was measured, particularly in the deep wells. Less mounding was observed in the intermediate zone and even less in the shallow zone. Nonetheless, during the course of the sparging test, the groundwater table did rise to within a foot of the surface within a 20-foot radius of the sparge wells (SW-1 and MW-1C). Also, the piezometric surface in the deep zone rose as much as 6.5 feet at MW-517B, which is over 100 ft from the sparge well. Mounding and the anticipated superposition of mounding from adjacent sparge wells will be an important factor in design of full-scale implementation. Seasonal or other fluctuations in the level of the groundwater table will also be factors in full-scale implementation.

Conclusions

The results of this test show at the proof of concept level that pH levels can be reduced significantly in the deep Satilla by sparging with CO_2. Furthermore, all of the specific objectives stated in the Proof of Concept test workplan were met, with the exception of long-term, post-sparging rebound monitoring which will occur in February and May of 2013. The following conclusions can be drawn from the test:

1. CO_2 sparging into the Satilla Formation is feasible without the need for fracturing.
2. Significant pH reductions from pH 11-12 in the deep Satilla were achievable in 5 to 7 days sparging at circa 50 scfm.
3. Hg levels in the high pH CBP fully-impacted by the sparging declined from 110-120 μg/L to 11-33 μg/L (70 to 90% reductions)
4. Limited evidence of silica precipitation was observed in wells within the zone of influence of the sparge test.
5. The pH of deep Satilla wells was not lowered to below 6.5 at any point during sparging, which indicates that potential dissolution of the sandstone aquitard is not a risk that would bar use of the CO_2 approach.

6. A radius of influence of at least 20 feet was achieved at the top of the CBP and greater than 60 feet at the water table surface.
7. Some CO_2 gas channels extended out more than 100 feet from the sparge wells.
8. The CO_2 sparging resulted in a significant residual saturation of CO_2 gas in the zone of influence
9. During sparging, significant mounding of the potentiometric surface was measured, particularly in the deep wells.

The Proof of Concept test indicated that CO_2 sparging would be an effective, innovative technology, suitable for full-scale implementation at the site. Observations made during testing further indicate that full-scale implementation of CO_2 sparging be conducted over a multiple-year, sequential effort. The principal drivers for this sequential implementation are:

- Management of groundwater mounding caused by superposition of multiple, closely-spaced sparge wells; and
- Maximization of sparging efficiency to reduce emissions of CO_2.

Groundwater mounding during full scale implementation is particularly critical as mounding during the Proof of Concept test was substantial. The groundwater table rose to within 1 foot of the ground surface during the testing. This mounding will be exacerbated by superposition of mounding from multiple nearby sparging wells and by seasonal rises of the groundwater table. Moreover, in some areas of the CBP, the water table is even closer to the surface than in the test site. Conducting the implementation over multiple years will allow active sparge wells to be further apart, thereby reducing the superposition of groundwater mounding. The optimal time for sparging is when the groundwater table is at its lowest during the drier summer and early fall months.

The Proof of Concept test results suggest that CO_2 sparge efficiency can be enhanced by a sparge regimen that emphasizes short bursts of sparging (anywhere from ½ to 4 hrs.) followed by relatively lengthy rest periods. The rest periods would allow CO_2 gas residual saturation remaining in the formation to both dissolve and diffuse into the surrounding CBP waters. It is proposed that in the first year of sparging, different sparge regimens be tested in an effort to optimize sparge efficiency. In subsequent years, the optimized sparge regimen would be adopted.

Taking these factors into consideration, it is believed that full scale implementation could be accomplished over approximately three years, with four to five months of sparging during the late summer and early fall followed by a seven- to eight-month period of relaxation of sparging. During the relaxation period, data collected from the site would be analyzed using a three-dimensional visualization program. These analyses would permit planning of the next year of the sparge program.

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LIST OF ACRONYMS

Alk	Alkalinity
bls	Below land surface
btoc	Below top of casing
CBP	Caustic brine pool
CO_2	Carbon dioxide
$CO_2(aq)$	Aqueous carbon dioxide
$CO_2(g)$	Gaseous carbon dioxide
CO_3^{2-}	Carbonate ion
DIC	Dissolved inorganic carbon
DO	Dissolved oxygen
DOC	Dissolved organic carbon
DOM	Dissolved organic matter
E_h	Redox potential relative to the Standard Hydrogen Electrode
ESTCP	Environmental Security Technology Certification Program
GEPD	Georgia Environmental Protection Division
$H_2CO_3(aq)$	Carbonic acid
$H_2CO_3^*$	Sum of carbonic acid and aqueous carbon dioxide
HCO_3^-	Bicarbonate ion
H_2SO_4	Sulfuric acid
Hg	Mercury
K	Equilibrium constant
K_h	Hydraulic conductivity
K_{sp}	Solubility product constant
LCP	Linden Chemicals and Plastics
NTU	Nepholometric Turbidity Unit
ORP	Oxidation Reduction Potential
psi	Pounds per square inch
psig	Pounds per square inch – gauge
PVC	Poly vinyl chloride
RAO	Remedial Action Operation
RI	Remedial Investigation
ROI	Radius of influence
scfm	Standard cubic feet per minute
SC	Specific conductivity
SF_6	Sulfur hexafluoride
TDS	Total dissolved solids
TSS	Total suspended solids

1. INTRODUCTION

Mutch Associates, LLC, in collaboration with Parsons Corporation (Parsons), have prepared this report of the CO_2 sparging Proof of Concept test conducted at the LCP Chemical Site in Brunswick, Georgia. The Proof of Concept test was conducted in accordance with the "Final Work Plan for CO_2 Sparging Proof of Concept Test, LCP Chemical Site, Brunswick, GA" (Mutch Associates, 2012) dated September 11, 2012. Formal approval of the workplan was granted in a letter from EPA on September 10, 2012. The Proof of Concept test was designed to evaluate the feasibility of CO_2 sparging to remediate a sub-surface caustic brine pool (CBP) formed by historical production of industrial chemicals on the site.

The CBP is being addressed under an Administrative Settlement Agreement and Order of Consent (AOC) issued by the U.S. Environmental Protection Agency (EPA) Region 4 on April 18, 2007. The remedial action objectives (RAO) were defined in the AOC and included reducing the pH of the CBP to between 10 and 10.5 and reducing the density of the CBP. The Proof of Concept test work plan was also designed to evaluate the ability of CO_2 sparging to reduce trace metals, particularly mercury, within the CBP. It also incorporated pre- and post-sparging aquifer testing to detect any change in aquifer properties due to precipitation of silica or other factors.

This report is organized in the following manner:

- Section 2 - Describes the technical objectives of the Proof of Concept test;
- Section 3 - Describes the specific protocols employed in the proof of concept test ;
- Section 4 - Presents the results of the Proof of Concept test; and,
- Section 5 - Conclusions.

1.1. Site Description

The LCP Chemicals site is located at 4125 Ross Road, in the City of Brunswick, in Glynn County, Georgia. The site is bordered by the Turtle River marshes to the west and south and the urban populations of Brunswick to the north and east. The site encompasses approximately 813 acres, of which 684 acres are tidally influenced salt marsh.

Industrial operations were conducted by multiple parties from 1919 until 1994. The site was originally owned and operated by the Atlantic Refining Company (ARCO) who operated a petroleum refinery from 1919 until 1930 and a petroleum storage facility until approximately 1955. Portions of the site were also owned by Georgia Power Company and the Dixie O'Brien Paint Company. In 1955, the property was purchased by Allied Chemical, Inc. From 1956 to 1979, chlorine, hydrochloric acid, and sodium hydroxide were produced by Allied Chemical by the electrolysis of sodium chloride using mercury cells (the chlor-alkali chemical manufacturing process). In 1979, LCP Chemicals purchased the property and continued to operate the chlor-alkali process.

During chemical production activities at the site, a portion of the shallow aquifer was contaminated by residuals of chlor-alkali-manufacturing operations. A subsurface pool of caustic brine formed, characterized by elevated pH and total dissolved solids and elevated concentrations of dissolved metals. This CBP has been defined as groundwater with a pH above 10.5.

2. TECHNICAL OBJECTIVES

Specific objectives of the Proof of Concept test were listed in the EPA-approved workplan (Mutch Associates, 2012). These objectives included:

- Determine the radius of influence (ROI) of a representative CO_2 sparging well as defined by pH reduction to target levels
- Determine the kinetics of the pH neutralization reaction
- Determine the efficiency of the CO_2 sparging as defined by the amount of pH reduction achieved per mass of CO_2 injected
- Assess whether significant reductions in aquifer hydraulic conductivity occurred within the ROI as a result of the CO_2 sparging
- Assess whether there is significant reduction in the specific capacity of the sparge well, which served as the aquifer testing groundwater extraction well before and after the CO_2 sparging test
- Determine the impact of the CO_2 sparging on the geochemistry of the aquifer within the ROI and in particular on the concentrations of mercury and other metals
- Determine the vertical magnitude, radial extent, rate of propagation, and life-cycle of any groundwater mounding caused by the CO_2 sparging and the extent of groundwater level collapse following cessation of sparging
- Determine practical CO_2 injection rates and ways in which sparging efficiency can be enhanced
- Monitor over time potential rebound in pH, metals, or other geochemical parameters

All of these objectives were met, with the exception of the long-term, post-sparging rebound monitoring which will occur in February and May of 2013. The objectives and the findings from Proof of Concept test will be discussed in more detail in Section 4 of this report.

3. PROOF OF CONCEPT TESTING PROTOCOL

3.1. Sparge and Monitoring Well Network

The sparge and monitoring well network used to implement the Proof of Concept testing consisted of a combination of existing and newly installed wells, as shown on Table 3-1. The location of the sparge and monitoring wells relative to the test area is shown on Figure 3-1. Cross section A-A' of the well network is shown on Figure 3-2.

Table 3-1: Monitoring Well Network

	Monitoring Well	Distance from SW-1 (ft)	Distance from MW-1C (ft)	Screened Interval (ft)	Newly Installed (Y/N)
Shallow	MW-1A	7.3	9.8	12 – 17	Y
	MW-2A	13.1	21.3	12 – 17	Y
	MW-3A	42.6	36.2	12 – 17	Y
	MW-115A	30.7	36.6	12 – 17	N
Intermediate	MW-1B	7.9	4.8	30 – 35	Y
	MW-2B	13.5	21.4	30 – 35	Y
	MW-115B	25.7	33.1	27 – 30	N
	MW-519A	20.8	15.4	30 – 35	N
Deep	MW-115C	18.7	24.6	40 – 42	N
	MW-1C	8.4	0.0	45 – 50	Y
	MW-2C	13.1	19.9	45 – 50	Y
	MW-519B	20.6	15.1	42 – 48	N
	MW-517B	104.9	97.2	46 – 51	N
	EW-11	50.6	44.1	43 – 48	N

The new wells were installed during the week of September 17, 2012; boring logs / well construction diagrams are provided in Appendix A. Sonic core samples were collected to depth from wells SW-1, MW-1A, MW-1B, and MW-2C, and from the screened interval for the other wells. Based on the lithology, the total depth of sparge well SW-1 was determined to be 45 ft below land surface (bls), as the zone from 40-45 ft (screened interval) appeared to be more permeable than that from 45-50 ft.

Based on observations made prior to proof of concept testing, the following adaptations were made to the well network with approval from EPA:

- EW-11 was initially proposed in the workplan as a monitoring well, but based on the inability to access the screened interval with a Hach pH electrode, was replaced with MW-517.
- SW-1 was used as the sparge well for the first two weeks of testing. However, as further described in Section 4, and after consultation with EPA on November 12, 2012, MW-1C was used as the sparge well for the last week of testing in order to inject CO_2 lower into the formation.

3.2. Aquifer Testing

Pre- and post-sparging aquifer tests were conducted using SW-1 as the pumping well. This section describes the implementation of those aquifer tests from the initial test pumps through data collection. The data collection included antecedent monitoring of groundwater levels, barometric pressure, the stage of the waterway adjacent to causeway near the junction of Purvis Creek and the Unnamed Ditch, pre-sparge aquifer test pumping, and post-sparge aquifer test pumping.

3.2.1. Antecedent Monitoring of Groundwater Levels, Barometric Pressure and Tidal Efficiency for the Pre-Sparge Test

Prior to the aquifer test, antecedent groundwater level monitoring was conducted throughout the monitoring well network. Solinst Levelloggers were used in conjunction with periodic manual water levels. The level loggers were set to record at a frequency of 15s. Level loggers and manual water levels were deployed in the following wells: 1A, 1B, 1C, 2A, 2B, 2C, 115A, 115B, 115C, 519A, 519B, 3A, 517B, SW-1, Tidal Gage. A Solinst Barologger was set to record barometric pressure at a frequency of 15s and hung outside the well casing of well 1B.

Data collection began on October 3rd, 2012. The test ran October 6th -7th 2012 with a 24 hour recovery period lasting into October 8th 2012. The antecedent data showed negligible tidal and barometric efficiencies as demonstrated in the annotated hydrographs in Appendix B. The hydrographs also show a downward trend in water levels. The aquifer test drawdown data was adjusted to correct for the trend.

3.2.2. Pre-Sparge Pumping of Aquifer Test Well

The sparge well, SW-1, was equipped with a four inch-diameter 0.5HP Grundfos submersible pump. The pump was yield tested and set to a flow rate of 7.72 gallons per minute (gpm) on October 5th 2012. An inline GPI TM050 flow meter was used to dial in and maintain instantaneous flow rate of 7.72 gpm. The 24-hour aquifer test was initiated at 07:45 on October 6th 2012 at a constant in-line flow rate 7.72 gpm. The pump was shut down between 18:35-18:43 to safely refuel the generator powering the pump. The test was completed at 07:50 on October 7th 2012. The discharge water was pumped to a 17,500 gallon discharge tank approximately 400ft away. The discharge tank was cylindrical and had a spyglass to measure water level. The average flow rate for the aquifer test was calculated by tracking the change in water level in discharge tank as a function of time. The average flow for the pre-sparging aquifer test was 7.2 gpm.

3.2.3. Antecedent Monitoring of Groundwater Levels, Barometric Pressure and Tidal Efficiency for the Post-Sparging Test

Prior to the aquifer test, antecedent groundwater level monitoring was conducted throughout the monitoring well network. Solinst Levelloggers were used in conjunction with periodic manual water levels. The level loggers were set to record at a frequency of 15 seconds. Level loggers and manual water levels were deployed in the following wells: 1A, 1B, 1C, 2A, 2B, 2C, 115A, 115B, 115C, 519A, 519B, 3A, 517B. A Solinst Barologger was set to record barometric pressure at a frequency of 15 seconds and hung outside the well casing of MW-1B. There was no tidal gage deployed in the post-sparging test since the pre-sparging test established the absence of tide-induced groundwater level fluctuations.

Data collection began on November 28th, 2012. The test ran November 30th –December 1st, 2012 with a 24 hour recovery period lasting into December 2nd, 2012. The antecedent data showed negligible barometric efficiency as demonstrated in the annotated hydrographs in Appendix B. The hydrographs also show a downward trend in water levels. The aquifer test drawdown data was adjusted to correct for the trend.

3.2.4. Post-Sparging Pumping of Aquifer Test Well

The sparge well, SW-1, was equipped with a four inch-diameter 0.5 HP Grundfos submersible pump. SW-1 was yield tested and the pump set to a flow rate of 7.72 gpm on November 29, 2012. An inline GPI TM050 flow meter was used to dial in and maintain instantaneous flow rate of 7.72gpm. The 24-hour aquifer test was initiated at 07:32 on November 30, 2012 at a constant in-line flow rate 7.72 gpm. The pump was shut down between 18:05-18:11 to safely refuel the generator powering the pump. The test was completed at 07:38 on December 1, 2012. The discharge water was pumped to a 17,500 gallon discharge tank approximately 400 feet away. The discharge tank was cylindrical and had a spyglass to measure water level. The average flow rate for the aquifer test was determined by tracking the change in water level in discharge tank as a function of time. The average flow for the pre-sparging aquifer test was 7.2 gpm.

3.3. Groundwater Monitoring

Prior to the commencement of CO_2 sparging, on October 1, 2 and 3, 2012, twelve monitoring wells and one extraction well (MW-1A, 1B, 1C; MW-2A, 2B, 2C; MW-3A, MW-115A, 115B, 115C; MW-519A, 519B; and EW-11) were sampled to provide a pre-sparge groundwater quality baseline. The wells were purged and sampled using the low flow "Tubing-in-Screened-Interval" method, pursuant to US EPA Region IV Environmental Investigations Standard Operating Procedure (SOP) – October 2011. The guidance document *Groundwater Sampling Guidelines for Superfund and RCRA Project Managers* was also referenced for additional technical support.

Per the method, the tubing intake was lowered to the middle of the screened interval of the well, and a peristaltic pump was used to purge the groundwater at a very low flow rate. Throughout the purge process, depth to water measurements were collected to assess and maintain stable drawdown. A minimum one equipment volume was purged prior to stabilization parameters (pH, specific conductivity, dissolved oxygen, and turbidity) being collected. Although not considered stabilization parameters, temperature and oxidation reduction potential were also recorded. Once the required parameters were stable for three consecutive readings, groundwater samples were collected for laboratory analysis as described in Table 3-2.

The groundwater samples were preserved on ice and submitted to TestAmerica Laboratories in Savannah, GA for analysis. Once the groundwater samples had been collected, approximately 900 mL of groundwater were pumped into a graduated cylinder and the specific gravity was determined using a hydrometer.

Table 3-2: Water Quality Analytes and Associated Laboratory Methods

Analyte	Method	Description
pH	EPA SW-846 9040B	Ion selective electrode
Alkalinity	SM 2320B	Potentiometric titration
Total mercury	EPA SW-846 7470A	Cold-vapor atomic absorption spectrophotometry
Total dissolved solids	SM 2540C	Gravimetric
Chloride and sulfate	EPA SW-846 9056	Ion chromatography
Sulfide	SM 4500 S2 F	Iodometric titration
Total metals & silica[a]	EPA SW-846 6010B	Inductively Coupled Plasma – Atomic Emission Spectroscopy
Dissolved and total organic carbon	SM 5310B	Combustion / Infrared Spectrophotometry
Ferrous iron	SM 3500-Fe-D	Spectrophotometry
[a] Total metals included aluminum, barium, beryllium, calcium, cobalt, chromium, iron, potassium, magnesium, manganese, sodium, nickel, selenium, vanadium, zinc.		

Upon completion of CO_2 sparging, on November 26, 27, and 28, groundwater samples were collected from 12 monitoring wells and the sparge well (MW-1A, 1B, 1C; MW-2A, 2B, 2C; MW-3A, MW-115A, 115B, 115C; MW-519A, 519B; and SW-1) via the same method as the pre- sparge test sampling. SW-1 was sampled in place of EW-11. Additionally, during CO2 sparging, it was observed that pH at the top of the screen was lower than that at the middle of the screen. To assess for pH-related differences in constituent concentrations, once the middle of the screen samples had been collected from MW-2C and MW-519B, the tubing intake was raised to the top of screen, the well was re-stabilized, and another round of samples was collected from the top of the screen from those wells

The post-sparge samples were collected November 26, 27, and 28, 2012 and submitted for the laboratory analyses described in Table 3-2. Post-sparge groundwater samples were also collected for SF_6 analyses. The analyses for SF_6 was performed by the CH2M Hill Applied Sciences Laboratory in Corvallis, OR. Samples were analyzed via gas chromatography with electron capture detection on a Lagus AUTOTRAC analyzer. Assuming no matrix interference, this technique has an approximate detection limit of 0.0002 μg/L.

Purge logs, a summary of stabilization parameters, a summary of collected specific gravity measurements, and analytical data are provided in Appendix C.

3.4. CO_2 Injection and Monitoring

3.4.1. CO_2 Sparge Equipment

A process flow diagram for the CO_2 sparge system is shown on Figure 3-3. The trailer-mounted mobile system consisted of a bulk storage tank with a heated vaporizer and a gas panel to regulate discharge gas flow and pressure. Instrumentation on the gas panel included flow, temperature and pressure monitors. The gas panel also contained flow and pressure regulating valves to optimize flow and pressure during the pilot tests. A separate cylinder with a tracer gas (sodium hexafluoride) was connected to the CO_2 line downstream of the gas panel. The tracer gas line had a dedicated pressure regulator and flow regulating valve to bleed in tracer gas at required rate and pressure. All operation on the sparge system was manual. Pictures of the trailer and control panel are provided as Figure 3-4.

The sparge well (SW-1) was equipped with a well head that included a pressure indicator, flow indicator, pressure regulating valve and a flow regulating valve to optimize pressure and flow at the well head. The well head that was connected to the gas panel using braided steel hose. A picture of the set-up is provided as Figure 3-5.

A diesel generator was used to power the heater vaporizer on the trailer. The generator was operated only during periods of sparge operation.

3.4.2. CO_2 Injection Design Flow Rate and Pressure

The target flow rate for the test was 20 standard cubic feet per minute (scfm) (Mutch Associates, 2012). This flow rate was selected based upon guidance from ESTCP (Leeson et al., 2002), USEPA (2004) and the Army Corps of Engineers Design Manual (2008). The work plan called for (14) 8 hour sparging cycles. This calculation was based on the design flow rate of 20 scfm, an assumed 15 ft radius and 45 ft saturated thickness. The CO_2 demand of CBP water was based upon sulfuric acid titrations of EW-10 water to a pH of 7.5. EW-10 was selected for these calculations because of its similar water quality to EW-11, which is approximately 50 ft from SW-1 (Mutch Associates, 2012).

The flow rate of CO_2 (in ACFM) to the sparge well was read from the rotameter just upstream of the well head (Figure 3-5). This flow rate was converted to SCFM of CO_2 using the following:

$$Q\,(\mathrm{SCFM}) = Q\,(\mathrm{ACFM})\left(\frac{T_{std}}{T_{act}}\right)\left(\frac{P_{act}}{P_{std}}\right)\sqrt{\frac{1}{SG}} \qquad (3\text{-}1)$$

where P_{act} is the actual pressure (in psia), P_{std} is the standard pressure (14.7 psia), T_{act} is the actual temperature (in °R), T_{std} is the standard temperature (520 °R) and SG is the specific gravity of CO_2 gas at 520 °R (1.5189). Throughout this report, CO_2 flow rates are reported in SCFM of CO_2.

Fractures can be generated in geologic formations if air or any other gas is injected at a pressure that exceeds the sum of the natural strength of the formation and the in-situ stresses present (Suthersan, 1997). The pressure required to fracture a consolidated geologic formation is a function of the cohesive or tensile strength of the formation and the pressure exerted by the weight of soil and water. Ignoring the cohesion of the soil, and considering only the weight of the water and soil, the minimum pneumatic fracture initiation pressure, P_i is:

$$P_i > d_w(\gamma_w \eta + \gamma_{soil}(1-\eta)) + (d_{tot} - d_w)\gamma_{soil}(1-\eta) \qquad (3\text{-}2)$$

where d_w is the depth of water (saturated thickness), d_{tot} is the total depth of soil, η is the soil porosity, γ_w is the specific weight of water (62.4 lb/ft^3) and γ_{soil} is the specific weight of soil. The minimum pneumatic fracture initiation pressure for SW-1 was calculated to be 30 psig assuming a saturated thickness of 35 ft, 40 ft of soil, porosity of 0.30, and a specific gravity of soil equal to 2.65. As such, the upper limit of injection pressures was set as 25 psig so that fracturing of the Satilla would not occur.

3.4.3. Well Preparation

Prior to CO_2 injection, an air sparge test was performed to assess the capacity of sparge well SW-1 to accept gas. The test was performed using an air compressor with the discharge connected to the well head. Pressure and flow of air was regulated using the flow control valve and pressure regulator on the well head. The test was performed by gradually increasing flow and pressure of the air being injected into the well. The air sparge test confirmed the capacity of the sparge well to accept flow at 20 scfm at a pressure below 25 psi.

Water levels were monitored during the air sparge test and a rise in the water elevation was observed within approximately 10 minutes from the start of the air sparge test. Subsequently, 5-foot extensions were installed on all the monitoring wells to contain the rise of water. Fittings and ports were provided at the top of the extensions to allow for instrumentation cables (i.e., for pH probes) and so that manual pressure measurements could be obtained. The well extensions and fittings were sealed to prevent CO_2 gas from preferentially flowing up though the wells. A picture of the extensions and fittings is provided as Figure 3-6; a picture of the well set-up as a whole (for MW-519A and MW-519B) is provided as Figure 3-7.

3.4.4. System Start-up and Operation

Prior to beginning of CO_2 injection, the system was started-up and tuned to obtain the required carbon dioxide flow and pressure. Based on observations made during start-up, a daily start-up method was developed wherein the injection system was initially set to a low pressure and flow which was slowly increased to desired flow and pressure. This method was employed to mitigate groundwater elevation rises and immediate development of gas channels.

The system was operated for 16 days during the period October 29 through November 17, 2012. System operation data, including injection pressure, flow, and temperature, is provided in Appendix D.

3.4.5. Groundwater pH Monitoring

Groundwater pH was continuously monitored during the Proof of Concept test in each of the 13 monitoring wells using field pH electrodes (Hach model PHC101 Rugged) with varying cable lengths (10, 15 and 30 m). The electrodes were connected to portable field pH meters (Hach Model HQ40d and HQ11d) (Figure 3-7). The meters were strapped to the well casing. The electrodes were lowered to a depth of 1 foot below the top of screen in each well. These meters were pre-programmed to collect data at 15 minute intervals. The data was recorded and stored within the internal memory of the meters and downloaded daily.

All pH electrodes were calibrated prior to first use. Calibration of pH electrodes involved immersing the electrode in a fresh pH standard and storing the resulting mV reading in the internal memory of the pH meter. This process continued until all standards were read. Typically, a three or four point standard curve was employed using pH 4.01, 7.00, 10.01 and 12.45 standards. Once all of the standards were entered, a valid pH calibration curve was obtained only when the slope was within 5% of the theoretical value of −59 mV/pH.

A calibration check was performed for pH electrodes in deep zone wells MW-1C, MW-2C, MW-115C, and MW-519B on a daily basis. MW-517B was calibrated on a weekly basis because it was outside the expected radius of influence. A calibration check was performed for all other monitoring wells on a weekly basis. A calibration check consisted of uncapping the well, retrieving the electrode, and bringing it to the surface. The electrode was rinsed using deionized water and blotted with a lint-free laboratory wipe. Then, the electrode was submersed in a pH 7.00 standard and the pH was measured. If the pH was outside of the range 6.85 < pH < 7.15, the electrode was recalibrated. Upon re-calibration, if the electrode failed the slope and intercept calibration criteria, it was taken out of service for reconditioning or replacement.

All pH electrodes were reconditioned once per week. The electrode was rinsed with deionized water and blotted dry with a lint-free cloth. The glass bulb of the electrode was soaked for 12 to 16 hours in an electrode cleaning solution (Hach Product #2965249). The electrode was then soaked for 1 minute in deionized water.

Continuous pH monitoring occurred on site for the duration of the sparging Proof of Concept test, October 29 – November 17, 2012, and for 7 days following the sparging test, November 17 - 21 and November 25 – 28. November 22 – 24 were not monitored due to the Thanksgiving holiday.

Groundwater pH was periodically measured in EW-11 by low flow sampling. In addition, wells MW-1C, MW-2C, MW-115C, MW-517A, MW-517B, MW-519B and SW-1 were periodically measured for pH by low flow sampling. A Global Water pump was used to low flow sample the wells. The wells were pumped for approximately 2.5 gallons of CBP water then a sample was taken and pH was measured by a Hach PHC101 electrode. The data from these sampling events were also stored on a Hach field pH meter and downloaded daily. The collected pH data is presented and discussed in Section 4.

3.4.6. Air Monitoring

Ambient air monitoring during the sparge test included continuous direct monitoring of oxygen, carbon dioxide, and hydrogen sulfide using a MultiRae continuous monitoring device. Grab sample monitoring for mercury in the breathing zone was also conducted. The concentrations of constituents monitored generally remained steady and near normal ambient concentrations during the period of the testing. The MultiRae meter occasionally displayed a high ambient oxygen concentration, which was considered to be a fault alarm. Most ambient air within the work zone had CO_2 readings between 410 and 490 ppmv. No exceedances in the ambient carbon dioxide, hydrogen sulfide, and mercury concentration were observed as shown in Table 3-3.

Table 3-3: Ambient Air Monitoring Measurements

Air Constituent	Units	Action Level	Minimum Observed Level	Maximum Observed Level
CO_2	ppmv	2500	320	920 (at rear of trailer)
O_2 (%)	% by volume	< 19.5% and > 22.0%	20.0	30.0[a]
Hg	mg/m^3	0.05	0.000	0.000
H_2S	ppmv	10	0	1

(a) This reading was probably the result of a sensor error. Oxygen levels returned to ambient conditions upon resetting the meter.

4. PROOF OF CONCEPT RESULTS

4.1. Overview of Test Results

Section 4 describes the results from the various elements of the Proof of Concept Test. The Proof of Concept workplan called for 14 days of sparging into SW-1 at 8 hrs/day. Weekends were reserved for an extended rest period to observe rebound potential. After sparging into SW-1 for 10 days, the pH of the deep Satilla monitoring wells were not appreciably changed. Prior to the 11th day of sparging, a decision was made to change from SW-1 to MW-1C. MW-1C is screened 5 feet deeper than SW-1 and is at the same interval as MW-2C and MW-519B. The basis for this change was the importance of lowering the pH to between 7 and 8 in the deep Satilla to evaluate the effect of pH on mercury concentrations and the overall geochemistry of the aquifer. This decision was made in consultation with Honeywell. Verbal approval was granted by EPA on the morning of November 12, 2012.

4.2. Sparge Well Flow Rates

Sparging began on Monday October 29h, 2012. In the first week, sparging into SW-1 took place on five consecutive days for approximately 8.0 hrs/day (Figure 4-1). The weekend (November 3rd and 4th) was used as a rest period to observe potential pH rebound. In week 2, sparging into SW-1 took place on five consecutive days at approximately 8.7 hrs/day. Sparging occurred at slightly higher flow rates to assess effect on pH reductions in the deep Satilla wells. Once again, the weekend (November 10th and 11th) was used as a rest period to observe potential pH rebound. On November 12th, the sparge well was switched from SW-1 to MW-1C. Sparging took place on six consecutive days into MW-1C for approximately 9.1 hrs/day. A summary of all sparging activities is provided in Table 4-1. The record of sparging flow rates is included in Appendix D.

Table 4-1: Summary of Proof of Concept Sparging Activity

	SW-1 (Week 1 & 2)	MW-1C (Week 3)	Total
Days of Sparging:	10	6	16
Duration of Sparging, t_{sparge}:	83.3 hr (8.3 hr/d)	54.5 hr (9.1 hr/d)	137.8 hr (8.6 hr/d)
$\bar{Q}$, Time-weighted average Flow Rate[1]:	50.5 SCFM	57.6 SCFM	53.3 SCFM
Total Mass of CO_2 injected[2]:	13,290 kg (29,300 lb /14.7 tons)	9,900 kg (21,800 lb / 10.9 tons)	23,190 kg (51,100 lb /25.6 tons)

A typical CO_2 sparging daily program is shown in Figure 4-2 for SW-1 on November 2, 2012. Set-up occurred each morning at approximately 7:30 am. Sparging typically began between 8:30 and 11:00 am. Start-up involved slowly increasing the pressure at the injection well over a 15 to 30 minute period. It was observed that after the static well head and capillary pressures are exceeded, the flow rate increases dramatically with small increases in pressure. This threshold pressure was approximately 22 psig. On most

[1] Time-weighted average flow rate was calculated by numerically integrating the instantaneous flow rate as a function of time and dividing by the sparging duration.
[2] Mass of CO_2 injected was calculated according to: $\bar{Q}\rho_{gas}t_{sparge}$ where ρ_{gas} is the density of CO_2 at 14.7 psia and 520 °R (1.857 g/L or 0.1157 lb/ft^3)

days, the pressure was increased and maintained between 24 and 25 psig. These pressures were shown to be capable of sustaining sparging flow rates between 30 and 75 scfm of CO_2 in both SW-1 and MW-1C.

4.3. Changes in pH

The pH of the treatment area was measured as part of the baseline pre-sparge well sampling and as part of continuous pH monitoring. Values from the baseline continuous pH monitoring are shown in profile in Figure 4-3. These values were recorded a few hours prior to the start of sparging (November 29, 2012 at 8:45 AM). The deep Satilla wells had pH values ranging from 11.18 to 11.91. These values are consistent with historical pH values of the deep Satilla wells. The shallow and intermediate Satilla well pH values were alkaline (pH > 7), but did not have as high pH as the deep Satilla wells.

The pH response of each of the monitoring wells is shown in Figures 4-4 through 4-10. The deep Satilla wells are shown in Figures 4-4, 4-5, and 4-6. The intermediate Satilla wells are shown in Figures 4-7 and 4-8. The shallow Satilla wells are shown in Figures 4-9 and 4-10. Each data point (black circles) represents a pH value recorded at a 15 minute interval. Note that for the deep Satilla wells, additional pH data was recorded by pumping the wells with a peristaltic pump. These data points are either yellow or blue depending upon whether water was collected at the top or bottom of the well screen.

The day-to-day pH responses of individual wells showed large variations and it is not practical to describe the various daily changes in pH of the entire monitoring well network. However, the following observations are of note:

- In general, all wells with the exception of MW-115A (30.7 feet away from SW-1), and MW-517B (over 100 ft away SW-1) showed a decrease in pH.
- Some wells showed a significant pH decrease only after multiple days of sparging. Examples of this include MW-1C (Figure 4-4), MW-2A (Figure 4-8) and MW-115B (Figure 4-7).
- Responses in monitoring wells after sparging were fairly rapid. Once sparging started, monitoring wells started showing a change in pH after approximately 1 hour.
- Significant pH rebound during the early phases of CO_2 injection typically occurred within an hour of stopping the flow of CO_2 gas to the sparge well. This can be seen very clearly for MW-2C (Figure 4-4) on Day 1 (October 29th). The pH started at 11.5, dropped to 6.8 during sparging and then increased to 10.5 before the beginning of the next day of sparging.
- Not all monitoring wells showed the same responses each day. For example, MW-1C (Figure 4-4) showed virtually no change in pH after the first day of sparging. However, on Day 2 (October 30th), the pH dropped from 11.7 to 10.3 and then rebounded significantly back to 11.3. This indicates that CO_2 channels are not in the same physical location each day, and that adequate coverage around the sparge well can only be achieved by sparging on multiple days.
- Many shallow wells, for example MW-1A and MW-3A, showed modest increases in pH during sparging for the first few days. This is probably the result of a modest movement of lower Satilla water upward into the well screen as pore spaces fill with CO_2. This was followed by a sudden, dramatic decrease to pH 6 or 7 during sparging without significant

subsequent rebound. This is an indication that CO_2 channels have come into close contact with water in the area near these monitoring wells.

Values of pH after 2 weeks of sparging into SW-1 (November 11, 2012) are shown in profile on Figure 4-11. SW-1 had the lowest pH (6.60) of all the deep Satilla wells. However, other than SW-1, pH levels in the deep Satilla wells did not decrease to a large extent from pre-sparge levels. In the deep Satilla monitoring wells, the pH at the bottom of screen was consistently higher than that at the top of the screen indicating a large change in water quality across a relatively small (5 ft) vertical distance. The most notable difference in pH across the well screen was at MW-2C with a difference of greater than 1 pH unit. The well which showed the largest pH decrease was MW-2C which showed a decrease from 11.78 to 9.19 at the top of screen. The intermediate Satilla wells located laterally within 20 feet of SW-1 showed large decreases in pH. Specifically, wells MW-1B, MW-519A, and MW-2B had post-sparge pH values of 5.97, 5.86 and 6.23 respectively. These wells had pH values of approximately 9.0 pre-sparge (Figure 4-3), and therefore this represents a decrease in pH of approximately 3 units.

As described earlier, the sparge well was switched from SW-1 to MW-1C. MW-1C was sparged for 6 continuous days. At the conclusion of the week sparging program, there was a 1 week of pH rebound continuous monitoring. Values of pH at the end of this monitoring period (November 28, 2012) are shown in profile in Figure 4-12 and summarized in Table 4-2. The following discussion of the results of sparging on pH levels is broken up into three sections according to the screened interval of the various monitoring wells in the Satilla (i.e. deep, intermediate and shallow).

Table 4-2: Changes in pH at Conclusion of Proof of Concept Test[3]

	Monitoring Well	Pre-sparge pH	Post-sparge pH	ΔpH
Shallow	MW-1A	7.32	6.62	-0.70
	MW-2A	8.61	6.98	-1.63
	MW-3A	7.99	7.16	-0.83
	MW-115A	7.36	7.56	+0.20
Intermediate	MW-1B	8.67	6.09	-2.58
	MW-2B	9.39	6.47	-2.92
	MW-115B	9.09	6.51	-2.58
	MW-519A	9.61	6.07	-3.54
Deep	MW-115C	11.18	9.97	-1.21
	MW-1C	11.61	6.86	-4.75
	MW-2C	11.78	7.96 / 10.08	-3.82 / -1.70
	MW-519B	11.91	8.68 / 8.73	-3.23 / -3.18
	EW-11	11.60	9.73	-1.87
	MW-517B	11.42	10.95	-0.47
Note: When two values are listed, first entry is value at top of screen, second entry is at mid screen				

[3]Pre-sparge values recorded in the field prior to the start of sampling using continuous pH monitoring (October 29, 2012 at 8:45 AM) with the exception of EW-11 which was sampled shortly after the start of sparging on October 31, 2012. Post-sparge pH values recorded in field using low-flow sampling at end of post-sparge monitoring period on November 28, 2012. Measurement of pH was also performed in the field during the pre and post-sparge sampling events. The final pH values for the deep Satilla wells were: MW-115C (10.4); MW-1C (6.74); MW-2C (6.88 / 7.74); MW-519B (8.80 / 9.22). The values are similar to those listed in Table 4-2 except for MW-2C which are somewhat lower in pH.

The influence on the deep Satilla wells was much more pronounced after sparging was switched from SW-1 to MW-1C. MW-1C, MW-519B and MW-2C all experienced pH decreases of greater than 3 units. MW-519B and MW-2C are 15.1 and 19.9 ft from MW-1C, respectively. Decreases in pH in MW-115C and EW-11 were more modest, with post-sparge pH values between 9 and 10. These wells are 24.6 ft and 44.1 ft away from MW-1C. Based upon this information, the effective radius of influence of sparging within the deep Satilla was at least 20 ft. Essentially all wells at the intermediate depth were lowered to pH values between 6 and 7. Most notable was MW-115B which dropped to pH 6.51 after the switch from SW-1 to MW-1C. MW-115C is 33.1 ft from MW-1C. Also notable, was the visible bubbling and low pH (6.43) of MW-517A observed while sparging into, MW-1C. MW-517A is screened at the intermediate depth and is 97.2 ft from MW-1C. Based upon this information, the effective radius of influence within the intermediate Satilla is at least 33 ft and could extend as far as 100 ft in some areas.

The shallow Satilla initial pH values were only slightly alkaline, with values ranging from 7.32 to 8.61. All of the shallow wells were directly influenced by sparging into SW-1 and MW-1C with the exception of MW-115A. MW-115A is in the shallow Satilla and is 30.7 and 36.6 ft away from SW-1 and MW-1C, respectively.

4.3.1. Efficiency of CO_2 Sparging

One of the objectives of the Proof of Concept test was to assess the efficiency of CO_2 sparging. Since CO_2 is a weak acid, the amount of CO_2 required to reach a specific pH is dependent upon the initial pH, the final pH, and the alkalinity of the water. A numerical titration was performed to calculate the CO_2 demand of CBP water. The first step in this titration was determination of the total carbonate, C_T of representative water from the deep, intermediate and shallow Satilla. To start, all of the alkalinity (Alk) of the water was assumed to be present as carbonates, silicates and hydroxide ion:

$$\text{Alk} = [\text{HCO}_3^-] + 2[\text{CO}_3^{2-}] + [\text{Si(OH)}_3^-] + 2[\text{Si(OH)}_2^{2-}] + [\text{OH}^-] - [\text{H}^+] \tag{4-1}$$

The concentrations of all 6 components of Equation (4-1) are a function of pH, and are related by laws of mass action:

$$\text{H}_2\text{CO}_3^* \rightleftharpoons \text{HCO}_3^- + \text{H}^+ \qquad {}^c K_{a1} = \frac{[\text{HCO}_3^-][\text{H}^+]}{[\text{H}_2\text{CO}_3^*]} \tag{4-2}$$

$$\text{HCO}_3^- \rightleftharpoons \text{CO}_3^{2-} + \text{H}^+ \qquad {}^c K_{a2} = \frac{[\text{CO}_3^{2-}][\text{H}^+]}{[\text{HCO}_3^-]} \tag{4-3}$$

$$\text{Si(OH)}_4(\text{aq}) \rightleftharpoons \text{Si(OH)}_3^- + \text{H}^+ \qquad {}^c K_{a1,Si} = \frac{[\text{Si(OH)}_3^-][\text{H}^+]}{[\text{Si(OH)}_4(\text{aq})]} \tag{4-4}$$

$$\text{Si(OH)}_3^- \rightleftharpoons \text{Si(OH)}_2^{2-} + \text{H}^+ \qquad {}^c K_{a2,Si} = \frac{[\text{Si(OH)}_2^{2-}][\text{H}^+]}{[\text{Si(OH)}_3^-]} \tag{4-5}$$

where ${}^{c}K_{a1}$, ${}^{c}K_{a2}$, ${}^{c}K_{a1,Si}$ and ${}^{c}K_{a2,Si}$ are concentration-based acidity constants[4]. The concentrations of the species in Equation (4-1) were calculated by combining the appropriate mole balance equations with the mass action laws shown above. For the carbonate system:

$$C_T = [H_2CO_3^*] + [HCO_3^-] + [CO_3^{2-}] \tag{4-6}$$

$$[HCO_3^-] = C_T \frac{{}^{c}K_{a1}[H^+]}{[H^+]^2 + {}^{c}K_{a1}[H^+] + {}^{c}K_{a1}\,{}^{c}K_{a2}} \tag{4-7}$$

$$[CO_3^{2-}] = C_T \frac{{}^{c}K_{a1}\,{}^{c}K_{a2}}{[H^+]^2 + {}^{c}K_{a1}[H^+] + {}^{c}K_{a1}\,{}^{c}K_{a2}} \tag{4-8}$$

For the silica system:

$$Si_T = [Si(OH)_4(aq)] + [Si(OH)_3^-] + [Si(OH)_2^{2-}] \tag{4-9}$$

$$[Si(OH)_3^-] = Si_T \frac{{}^{c}K_{a1,Si}[H^+]}{[H^+]^2 + {}^{c}K_{a1,Si}[H^+] + {}^{c}K_{a1,Si}\,{}^{c}K_{a2,Si}} \tag{4-10}$$

$$[Si(OH)_2^{2-}] = C_T \frac{{}^{c}K_{a1,Si}\,{}^{c}K_{a2,Si}}{[H^+]^2 + {}^{c}K_{a1,Si}[H^+] + {}^{c}K_{a1,Si}\,{}^{c}K_{a2,Si}} \tag{4-11}$$

For hydroxide ion:

$$[OH^-] = \frac{{}^{c}K_w}{[H^+]} \tag{4-12}$$

Equations (4-7), (4-8), (4-10), and (4-11) were combined with (4-1) to obtain an equation which relates the alkalinity, total carbonate, total silica and $[H^+]$:

$$Alk = C_T\left(\frac{{}^{c}K_{a1}[H^+] + 2\,{}^{c}K_{a1}\,{}^{c}K_{a2}}{[H^+]^2 + {}^{c}K_{a1}[H^+] + {}^{c}K_{a1}\,{}^{c}K_{a2}}\right) + Si_T\left(\frac{{}^{c}K_{a1,Si}[H^+] + 2\,{}^{c}K_{a1,Si}\,{}^{c}K_{a2,Si}}{[H^+]^2 + {}^{c}K_{a1,Si}[H^+] + {}^{c}K_{a1,Si}\,{}^{c}K_{a2,Si}}\right) + \frac{{}^{c}K_w}{[H^+]} - [H^+] \tag{4-13}$$

Water quality data was available for deep, intermediate and shallow Satilla wells for Alk, Si_T and pH. From these values, Equation (4-13) was used to calculate C_T from Alk, Si_T and pH.

The numerical titration was performed by incrementally increasing the C_T of the system until the target pH was achieved (pH 7.5). This process assumes Alk and Si_T are constant. The difference in C_T from the start of the titration to the end represents the total amount of CO_2 that is needed to satisfy the demand. The results of the numerical titrations for a selection of shallow, intermediate and deep Satilla wells are shown in Figure 4-13. The results for all the wells are tabulated in Table 4-3. MW-3A had

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[4] In low TDS (low ionic strength) water, concentration-based equilibrium constants are often assumed to be equal to equal to the true activity-based (thermodynamic constants). Since the Satilla has high TDS, ionic strength corrections were performed. The ionic strength was estimated using the Langelier (1936) relationship $I = TDS(2.65\times10^{-5})$, where I is the ionic strength (in mol/L) and TDS is the total dissolved solids in mg/L. The Davies equation (1962) was then used to calculate activity coefficients, which were then applied to the activity-based constants to calculate the concentration based constants. The values of the activity-based constants used for the calculation were: $K_{a1} = 10^{-6.532}$, $K_{a2} = 10^{-10.329}$, $K_{a1,Si} = 10^{-9.84}$, $K_{a2,Si} = 10^{-13.2}$, $K_w = 10^{-13.997}$.

alkalinity and TDS values that were approximately 5-times larger than nearby shallow Satilla wells, but had a similar pH. The cause of this variability across the shallow Satilla monitoring wells is not known.

Table 4-3: Theoretical CO_2 Demand for Shallow, Intermediate and Deep Satilla Wells

		Pre-sparge Water Quality				
	Well	Alkalinity (mg/L as $CaCO_3$)	pH (lab)	Silica (mg/L as SiO_2)	TDS (mg/L)	CO_2 Demand (mol/L)
Shallow	MW-1A	810	8.42	44	5,000	0.0011
	MW-2A	920	8.68	80	5,200	0.0018
	MW-3A	4,900	8.14	13	30,000	0.0045
	MW-115A	600	7.66	19	3,700	0.00018
					Average:	0.0019
Intermediate	MW-1B	800	8.93	57	8,500	0.0024
	MW-2B	770	9.16	30	4,300	0.0028
	MW-115B	640	9.11	18	3,400	0.0021
	MW-519A	920	9.71	30	5,800	0.0064
					Average:	0.0034
Deep	MW-115C	5,800	11.77	2,870	33,000	0.068
	MW-1C	5,700	11.20	2,000	48,000	0.078
	MW-2C	5,300	11.30	1,900	38,000	0.074
	MW-519B	7,410	11.76	3,200	44,000	0.11
	EW-11[a]	5,000	11.71	2,270	26,600	0.077
					Average:	0.081

[a] Data from May 2010

The total CO_2 demand for the Proof of Concept Test was estimated by considering the Satilla to consist of three discrete layers, each with a constant CO_2 demand. The layering used for the calculation was consistent with the shallow/intermediate/deep designation shown in Table 3-1 and used throughout the report. The calculation is shown schematically in Figure 4-14. The volume of the deep Satilla layer was calculated assuming a 20 ft radius of influence, and a 15 ft thickness. Assumptions related to ROI and thickness within the intermediate and deep Satilla layers are shown in Table 4-4. Note that this CO_2 demand is a conservative estimate because there was evidence of pH reductions (i.e. consumption of CO_2 demand) at radial distances larger than 20 ft in the deep Satilla.

Table 4-4: CO_2 Demand Estimate

	ROI	Sat. Thickness	Volume of water[a]		CO_2 Demand		
Layer:	(ft)	(ft)	(ft^3)	(gal)	(mol/L)	(kg)	(lb)
Shallow	60	19	75,210	562,606	0.0019	178	391
Intermediate	40	15	26,389	197,406	0.0034	112	246
Deep	20	15	6,597	49,351	0.0814	668	1,470
					TOTALS:	958	2,107

[a] Calculation assumes porosity of 0.35

Based on the mass of CO_2 injected (Table 4-1) and the estimate of CO_2 demand (Table 4-4), the sparging efficiency, η, can be calculated from the following:

$$\eta = \frac{CO_2 \text{ demand (kg)}}{\text{mass of } CO_2 \text{ injected (kg)}} \times 100\% \quad (4\text{-}14)$$

The sparging efficiency considering the total amount of CO_2 injected into both SW-1 and MW-1C is 4.1%. Since the majority of the demand is present in the deep Satilla, an alternative way of calculating the sparging efficiency is to consider only the amount of CO_2 injected into MW-1C. The sparging efficiency in this case is 9.7%. This alternative calculation assumes that the demand of the intermediate and shallow portions of the aquifer would have already been met prior to the 54.5 hr sparging duration into MW-1C. This is a reasonable assumption given the rapid decreases in pH observed in the intermediate and shallow monitoring wells after the start of sparging (see Figures 4-4 through 4-10). Note that this is not far off from the 10% efficiency assumed as part of the CO_2 demand calculations in Proof of Concept work plan. However, it is important to note that the Proof of Concept test was not designed to optimize CO_2 efficiency. As discussed in Section 2, this test was intended to show at the proof of concept level that pH levels could be reduced in the deep Satilla by sparging with CO_2.

The efficiency calculated above describes the amount of CO_2 required to meet the CO_2 demand within a prescribed treatment ROI. The efficiency calculation does not represent a mass balance on CO_2 or the amount of CO_2 lost to the atmosphere. This is because the demand estimate is based upon the assumption that no demand was met outside of the ROI used in the calculation. In reality, pH monitoring data indicate that some CO_2 demand was consumed outside of the 20 ft ROI used to compute the demand in the deep Satilla. For example, the pH of EW-11 was reduced by almost 2 full pH units. In addition, the post-sparge aquifer test results (described in section 4.6.6) indicate that a large amount of residual saturation of CO_2 remained in the aquifer after the test was complete.

The CO_2 sparging efficiency is dependent upon many factors including the CO_2 flow rate, extent of radial travel of CO_2 gas channels, time for gas channels to reach the surface, and rate of mass transfer of CO_2 from the gas phase to the water. Increasing the flow rate of CO_2 pushes gas channels out further (increases the treatment ROI), but also leads to less efficient use of CO_2 once channels reach the surface. Increasing the sparging efficiency may be possible by sparging for shorter periods of time, thereby limiting the amount of CO_2 escape to the atmosphere. Furthermore, a longer rest period in-between sparging event may allow the trapped CO_2 gas to dissolve into the water before the start of the next sparging event.

4.4. Changes in Aquifer Geochemistry

4.4.1. Pre and Post Differences Observed During Field Sampling

The majority of the monitoring wells sampled over the two events displayed very similar characteristics in regards to water table drawdown, percent dissolved oxygen content, and specific conductivity as the majority of the readings were within the same order of magnitude (Appendix C). The A wells, which are screened approximately 15-20 feet bls, exhibited the least variation in the water quality characteristics. The pH of the groundwater decreased for all of the wells sampled. Turbidity decreased significantly in many of the monitoring wells to levels so low that the field instrument was unable to measure it. During the pre-test sampling event, it was noted that the majority of the generated purge water had a strong indistinguishable odor, while the post-test purge water did not smell as strongly.

Specific gravity increased slightly from pre- to post- sparging in many of the deep Satilla wells. During the post-sparge specific gravity measurements, there was noticeable gas evolution from wells screened in the deep interval. This likely increased the buoyancy of the field hydrometer resulting in biased specific gravity readings. Note that a similar increase was not observed in TDS (Section 4.4.3). This is further evidence for positive bias in the post-sparge readings since specific gravity and TDS are linearly related.

Two monitoring wells (MW-2C and MW-115B) displayed very notable differences between the pre- and post- sparge testing. During the first event, MW-2C had slight drawdown, but the water table stabilized quickly; while drawdown was quite significant during the post-test sampling. The MW-2C purge process commenced on November 26, 2012, at a very low flow rate, and the water level dropped from 8.91 feet below top of casing (btoc) to 14.5 feet btoc, at which time the purge was stopped. MW-2C was purged and sampled on the following day, and the water table had not recovered completely as it was recorded to be 9.22 feet btoc at the beginning of the purge. The water level had dropped to 13.06 feet by the end of the purge.

During the pre-test groundwater sampling, MW-115B had a recorded pH of 9.49 SU, which was stable throughout the purge. However, the post-test pH for MW-115B did not stabilize as it fluctuated from 6.40 to 11.43 SU. The pH started off low and gradually decreased and then began to increase to subsequently decrease and increase again. It is theorized that the pH fluctuation was due in part to the well's upgradient location, and to the well location on the perimeter of radius of the CO_2 sparge influence.

4.4.2. Mercury

Pre-sparge mercury dissolved phase concentrations are shown in cross section on Figure 4-15. Mercury concentrations in the deep Satilla in the area near SW-1 were consistently between 110 and 120 μg/L. Concentrations in the intermediate and shallow Satilla were considerably lower with concentrations ranging from 0.16 to 11 μg/L. Note that pH values are also shown on Figure 4-15 for reference. Wells with elevated Hg levels (Table 4-5) were always accompanied by pH values greater than 11.0. The intermediate Satilla wells also had a narrow range in mercury concentrations and were approximately 20-times less than the deep Satilla, with an average concentration of 5.8 μg/L. The shallow Satilla wells were of comparable magnitude to the intermediate Satilla wells but had a larger range. A complete summary of the laboratory analytical data is provided in Appendix E.

Figure 4-16 shows a cross section of post-sparge mercury and pH concentrations. The contours shown on this figure are for pH. Among the deep Satilla wells, the two wells that exhibited the largest decreases in Hg concentrations were the two sparge wells: SW-1 and MW-1C. Both SW-1 and MW-1C had post-sparge pH values near 7.0. The next largest reduction (in terms of ΔHg) was MW-2C which showed a change of −77 μg/L (70% reduction) in water sampled from the top of the well screen. This water had a pH of 7.96.

The relationship between pH and mercury concentrations was examined further by plotting pre- and post-sparge Hg versus pH for the deep Satilla wells (Figure 4-17a). Data points represent water samples taken during the pre- and post-sparging sampling events. As discussed earlier, the pre-sparge deep Satilla wells possessed a consistent dissolved mercury concentration (orange circles). The post-sparge deep Satilla wells show a clear trend of decreasing Hg concentrations with decreasing pH. Once the pH drops below 8.5, mercury concentrations begin to decrease dramatically.

Table 4-5: Percent Reduction of Dissolved Phase Mercury at Conclusion of Proof of Concept Test

		Pre-Sparge	Post-Sparge		
	Well	Hg (µg/L)	Hg (µg/L)	ΔHg (µg/L)	% Reduction
Shallow	MW-1A	8.1	1.1	−7.0	86%
	MW-2A	11	4.5	−6.5	59%
	MW-3A	0.16 J	0.52	0.36	---
	MW-115A	7.2	7.6	0.4	−6%
Intermediate	MW-1B	5.0	3.5	−1.5	30%
	MW-2B	4.8	4.5	−0.3	6%
	MW-115B	5.5	3.9	−1.6	29%
	MW-519A	7.9	3.1	−4.8	61%
Deep	MW-115C	120	110	−10	8%
	MW-1C	110	21	−89	81%
	MW-2C	110	64.5 / 33	−45.5 / −77	41% / 70%
	MW-519B	120	99 / 89	−21 / −31	18% / 26%
	SW-1	110	11	−99	90%
Note: When two values are listed, first entry is value at top of screen, second entry is at mid screen					

There is also a relationship between pH and Hg in the intermediate Satilla; it is different, however, than the deep Satilla (Figure 4-17b). Pre-sparge concentrations of the intermediate Satilla wells fall below the curve shown earlier for the deep Satilla (Figure 4-17a). All of the intermediate Satilla wells experienced a significant change in pH with final post-sparge values all showing little variability between 6.0 and 6.5 (Table 4-2). This resulted in very constant post-sparge Hg values in the intermediate Satilla of approximately 3.8 µg/L.

The relationships between Hg and pH (Figure 4-17) indicate that local Hg concentrations behave predictably as a function of pH over the portion of the site used for the Proof of Concept test. As one might expect, this relationship is specific to the geochemical conditions of the aquifer. Since the geochemical conditions of the CBP are vertically stratified, the attenuation of dissolved Hg as a function of pH is different for the three intervals employed in the Proof of Concept test.

The CBP is a sulfide-rich, reducing environment. In sulfide-rich environments, mercury speciation is known to be dominated by (Skyllberg, 2008):

- Hg(II) complexes with sulfide such as $HgHS^-$, HgS_2^{2-}
- Hg(II) complexes with polysulfides such as $Hg(S_x)_2^{2-}$, HgS_xOH^-,
- Hg(II) complexes with thiol groups present on dissolved organic matter (DOM)
- HgS(s) precipitated as metacinnabar or cinnabar

Speciation models have been developed by many investigators for Hg complexes with reduced sulfur. In general, these models show that dissolved mercury concentrations decrease with decreasing pH in systems containing sulfides and polysulfides. For example, Jay et al. (2000) used a speciation model to describe total dissolved mercury concentrations as a function of pH in systems containing synthetic cinnabar and dissolved sulfide. The extent of the decrease in mercury concentrations with pH was dependent upon the total dissolved sulfide in the system and whether or not zero valent sulfur is present.

The geochemical conceptual model for mercury within the CBP is discussed in the RI (GeoSyntec, 1997). E_h-pH diagrams were prepared for a representative "background water" and CBP water. The E_h-pH diagrams indicate that there is a transition from soluble mercury sulfide complexes to insoluble HgS(s) that occurs under moderately reducing conditions between pH 8.5 and 10.5. The data collected as part of the Proof of Concept test is consistent with this conceptual model. All of the deep Satilla wells contain significant dissolved sulfide concentrations that are well in excess of the dissolved mercury concentrations (Appendix E). The decrease in dissolved Hg concentrations as the pH decreased is most likely due to a shift in equilibrium toward mercury sulfide (HgS(s)) precipitation.

4.4.3. Additional Geochemical Changes

Changes in TDS, As, Cr, Si and V are shown in Table 4-6. TDS did not change appreciably from pre- to post-sparging. Dissolved concentrations of arsenic, chromium, silicon and vanadium all decreased significantly in deep Satilla wells after sparging (Table 4-6).

The decrease in dissolved silica concentrations in the deep Satilla wells is due to precipitation of silica solids. Laboratory testing of CBP water with similar characteristics to the water near EW-11 showed precipitation of small to moderate amounts of silica solids gel upon sparging of CBP with carbon dioxide to pH 6.5 (Mutch Associates, 2012). Silica is known to be less soluble at lower pH and so some precipitation is to be expected. There was also visual evidence of some solids precipitation covering pH electrodes in the deep and intermediate Satilla wells a few days after sparging.

One concern over CO_2 sparging into the Satilla was the potential dissolution of the variably cemented sandstone. The CO_2 Work Plan (Mutch Associates, 2012) discusses various kinetic and thermodynamic calculations which suggested that conditions which promote dolomite dissolution would not be present as a result of sparging. Specifically, laboratory sparging results showed that pH < 6.5 would not be attained in the deep Satilla where CBP water is in contact with the variably cemented sandstone. This result was confirmed in the Proof of Concept test, as the pH of deep Satilla wells was not lowered to below 6.5 during sparging. Values of pH as low as 5.9 were obtained temporarily, but this was in the intermediate Satilla wells which are not in contact with the variably cemented sandstone.

Table 4-6: Changes in TDS, As, Cr, Si and V in Deep Satilla Wells[5]

	TDS				Silicon			
Well	Pre (mg/L)	Post (mg/L)	ΔTDS (mg/L)	% Change	Pre (mg/L)	Post (mg/L)	ΔSi (mg/L)	% Change
MW-115C	33000	34000	1000	3.0%	2000	470	-1530	-76.5%
MW-1C	48000	48000	0	0.0%	2000	86	-1914	-95.7%
MW-2C (mid)	38000	35000	-3000	-7.9%	1900	180	-1720	-90.5%
MW-2C (top)	-	32000	-	-	-	110	-	-
MW-519B (mid)	43000	46000	3000	7.0%	2000	210	-1790	-89.5%
MW-519B (top)	-	45000	-	-	-	180	-	-
			Avg:	0.5%			Avg:	-88%
	Arsenic				Chromium			
Well	Pre (mg/L)	Post (mg/L)	ΔAs (mg/L)	% Change	Pre (mg/L)	Post (mg/L)	ΔCr (mg/L)	% Change
MW-115C	280	98	-182	-65%	340	340	0	0%
MW-1C	320	120	-200	-63%	500	320	-180	-36%
MW-2C (mid)	260	44	-216	-83%	370	320	-50	-14%
MW-2C (top)	-	26	-	-	-	300	-	-
MW-519B (mid)	390	170	-220	-56%	610	380	-230	-38%
MW-519B (top)	-	130	-	-	-	390	-	-
			Avg:	-67%			Avg:	-22%
	Vanadium							
Well	Pre (mg/L)	Post (mg/L)	ΔV (mg/L)	% Change				
MW-115C	1500	1400	-100	-6.7%				
MW-1C	2200	370	-1830	-83.2%				
MW-2C (mid)	1700	760	-940	-55.3%				
MW-2C (top)		620	-	-				
MW-519B (mid)	2300	1100	-1200	-52.2%				
MW-519B (top)		1100	-	-				
			Avg:	-49%				

[5] Pre-sparge water samples were collected only from mid-screen of monitoring wells. Top-of-screen water samples were collected post-sparge because of the significant pH gradient observed across the well screen while sparging and during the post-sparge monitoring period of the Proof of Concept test

4.5. SF_6 Tracer Distribution

As described earlier, SF_6 was added to the CO_2 gas throughout most of the duration of the Proof of Concept test. Concentrations of dissolved SF_6 (in µg/L) are listed Table 4-7. SF_6 concentrations were detected in all wells. In addition, two sets of "direct sparge" samples were prepared by bubbling the CO_2/SF_6 mixture into VOA vials. These samples had 44.1 and 39.8 µg/L of SF_6 respectively.

Table 4-7: SF_6 Tracer Concentrations at Conclusion of Test

	Well	SF_6 (µg/L)	Maximum Pressure During Sparging into SW-1 (psi)	Maximum Pressure During Sparging into MW-1C (psi)
Shallow	MW-1A	8.8	9	8
	MW-2A	26.2	2	-
	MW-3A	3.8	8	6
	MW-115A	0.49	-	-
Intermediate	MW-1B	0.62	16	16
	MW-2B	104	16	-
	MW-115B	12.7	-	-
	MW-519A	0.70	16	16
Deep	MW-115C	61.6	-	-
	MW-1C	10.0	-	N/A
	MW-2C	104	-	-
	MW-519B	133	-	-
	MW-517B	3.4	-	-
	SW-1	0.77	N/A	N/A[6]

The purpose of adding SF_6 throughout the test was to determine where the injected gas travelled throughout the test. SF_6 is commonly used as a tracer for sparging studies because it does not occur naturally and background concentrations are extremely low. For example surface waters in equilibrium with current atmospheric SF_6 levels (6.9 pptv) have approximately 0.24 ng/L of dissolved SF_6. Also SF_6 can be detected at extremely low concentrations in water and is not biodegradable, so it acts as a conservative tracer to show where the injected gas was delivered.

The concentrations of SF_6 present in a monitoring water during sparging are a function of the CO_2/SF_6 ratio in the gas mixture, the effectiveness of mass transfer to the water as gas channels travel thorough the aquifer, and additional advective or dispersive mass transfer through groundwater that does

[6] Prior to sparging into MW-1C, SW-1 was converted to a monitoring well by installing a well extension as described in Section 3.3.2. However, the well casing became unsealed during installation. As a result there was visible gas escaping from the well pack once sparging started. A packer was placed inside the well to prevent CO_2 gas from escaping. This prevented a measurement of pressure in the well during sparging into MW-1C.

not directly contact gas channels. Slight changes in the CO_2/SF_6 ratio can result in uneven delivery of SF_6 to the aquifer. As such, it is best to interpret SF_6 tracer concentrations based on whether they have the same order of magnitude. The direct sparge of the CO_2/SF_6 gas yielded concentrations of approximately 40 μg/L. Thus, concentrations greater than 4 μg/L are a good indication that the injected gas has either directly travelled through the area, or close enough such that advective and dispersive transport would impart very high concentrations of SF_6.

Within the deep Satilla, all wells with the exception of SW-1 and MW-517B showed concentrations greater than 4 μg/L. This indicates that the injected gas reached all of the deep Satilla monitoring wells that are within 35 ft of the two sparge wells. Even MW-115C, which only saw a slight lowering of pH at the end of the test, showed high SF_6 concentrations. This indicates that the injected gas (CO_2 and SF_6) was in fact reaching MW-115C. However, the mass flow of CO_2 to this area was not sufficient to satisfy the acid demand.

Water from MW-517B contained 3.4 μg/L of SF_6 and is approximately 100 ft away from SW-1 and MW-1C. Recall that MW-517A directly intercepted CO_2 gas channels during sparging into MW-1C. MW-517A is in the same location as MW-517B, but is screened approximately 15 ft higher. There was no evidence (pressure buildup or rapid pH decreased) that MW-517B directly intercepted gas channels during sparging. The appearance of SF_6 at MW-517B is likely the result of advective or diffusive transport of aqueous SF_6 from nearby areas that were in direct contact with the injected gas.

It is surprising that the sparge well, SW-1, had lower concentrations of SF_6 than the other deep Satilla wells. Also, many intermediate and shallow wells which showed large pH decreases had lower than expected SF_6 concentrations. For example, MW-1B showed a large decrease in pH from 8.67 to 6.09 after sparging. This indicates that this well was clearly influenced by the CO_2 sparging program. Large SF_6 concentrations would be expected in this well, but the concentration was only 0.62 μg/L.

There appears to be a relationship between the occurrences of pressure in monitoring wells and lower than expected SF_6 concentrations. Table 4-7 shows pressure measurements that were recorded during sparging. Wells such as SW-1 and MW-1B were pressurized throughout the entire Proof of Concept test. Escape of SF_6 via off-gassing or volatilization prior to sample collection may have caused some loss of SF_6.

4.6. Pre- and Post-Sparging Aquifer Test Results

The principal objective of the pre-sparging and post-sparging aquifer testing was to determine the extent to which the CO_2 sparging and the associated lowering of pH may have reduced aquifer transmissivity through solids precipitation, particularly precipitation of silica gel. Aquifer testing was considered the best way to assess this possible occurrence since aquifer testing measures the transmissivity and hydraulic conductivity of the entire zone of influence of the CO_2 sparging test and, ultimately as the test continues, around the periphery of the test zone. In contrast, slug testing of individual wells only measures the hydraulic conductivity in the immediate vicinity of the well screens.

4.6.1. Technical Approach to Aquifer Test Analysis

The following observations related to the hydrogeology of the site and the aquifer test serve as an important context for the technical approach to the aquifer test analyses described subsequently:

1. The Satilla formation in this area consists of fine- to medium-grained sand. The aquifer generally grades downward toward coarser-grained and more permeable deposits at its base, except for a discontinuous layer of clay and interbedded sand and clay that lies at the base of the formation.
2. The aquifer is underlain by the variably cemented sandstone, which in conjunction with the discontinuous clay, acts as a low permeability aquitard, defining the base of the aquifer.
3. The aquifer behaves as an unconfined aquifer. As is typically the case in unconfined aquifers, the aquifer test exhibits three phases—an early-time phase when the basal portion of the aquifer behaves much like a confined or semi-confined aquifer with rapid drawdown and low storativity, a second phase dominated by delayed gravity drainage from the upper portion of the aquifer during which further drawdown diminishes or ceases altogether, and then a third phase when drawdown begins anew as the aquifer begins to dewater. The first two phases are well-represented in this test, while the third phase is just beginning at the conclusion of the test.

The Satilla formation is both unconfined and the extraction well, SW-1, is partially-penetrating; that is, it penetrates only the basal portion of the saturated thickness of the aquifer. This dictates that care must be taken in selection of wells for aquifer test analysis and in the methodology used to analyze the data from those wells. First, observation wells must be selected that are in the specific stratigraphic interval being pumped by the extraction well. Wells overlying or underlying the pumped stratigraphic interval will exhibit less drawdown and when subject to conventional aquifer test methodologies, such as the Theis (1935) or Neuman (1972) methods, will yield unreliable results. Neuman, who developed a complete analytical solution for unconfined aquifers (1972), recommends that if the primary objective of the aquifer test of an unconfined aquifer is determination of the transmissivity of the pumped interval of the aquifer (as is the case here), three things should be done:

1. Drawdown should be measured in wells sufficiently close to the extraction well such that significant drawdown is observed before the onset of delayed gravity drainage,
2. Only early-time data, before significant delayed gravity drainage begins, should be analyzed, and
3. This early-time data should be analyzed by means of the Theis Method or the straight line Cooper-Jacob Method.

Therefore, we have selected four wells that are in the principal stratigraphic zone being pumped, are sufficiently close to the extraction well, and exhibit significant drawdown before the onset of delayed gravity drainage. These wells include MW-2C, MW-115C, MW-519B, and MW-517B.

The presence of a residual saturation of CO_2 gas in the aquifer following the CO_2 sparging complicates analysis of the post-sparging aquifer test. The CO_2 residual saturation has the effect of lowering the aquifer transmissivity and raising the aquifer storativity. This complication is addressed by a comparative analysis of calculated transmissivity using the DeGlee distance-drawdown method (DeGlee, 1930; DeGlee, 1951) using drawdown data from the conclusion of the aquifer test when the impacts of storativity are reduced. It is also addressed by deriving a new storativity term that incorporates the effects of CO_2 gas expansion on aquifer storativity. This allows us to "fit" calculated drawdown values to the observed data using the transmissivity value calculated by the DeGlee method and to calculate CO_2 residual saturations.

4.6.2. Aquifer Test Interpretation

In this section of the report, we describe the interpretation of the aquifer test data. This interpretation includes calculation of any barometric or tidal efficiencies of observation wells and calculation of pre-aquifer test water level trends. These calculated parameters were then used to adjust the observed aquifer test drawdown data, as necessary, to account for tidal fluctuations and variations in barometric pressure during the aquifer test or for any pre-aquifer test trends in water levels.

4.6.3. Pre-Processing of Aquifer Test Data

Hydrographs for all of the observation wells are found in Appendix C. These hydrographs show the water level in each observation well during the antecedent, aquifer test, and recovery periods. The hydrographs are annotated to show the start of the yield test, the start and conclusion of the aquifer test pumping period, and the temporary pump shut down for refueling of the generator. The graphs also show a calculation of the generally downward trend in aquifer water levels occurring between the start of the aquifer test and the conclusion of the recovery period. This trend was used to correct drawdown values to what they would have been had there been no trend in aquifer water levels during the test. Barometric pressure was virtually constant during the aquifer test and, therefore, no corrections to drawdown values were necessary to compensate for barometric pressure changes. The wells did not exhibit significant tidal-induced water level fluctuations, so no adjustments to the data were necessary to account for tidal fluctuations in Purvis Creek or the Turtle River.

4.6.4. Pre-Sparging Aquifer Test Analysis

Four wells were initially selected for early-time, Cooper-Jacob analysis. These wells were MW-2C, MW-115B, MW-519B, and MW-517B. These four wells are all in the stratigraphic interval being pumped by SW-1 and are at sufficiently close distances to SW-1 to minimize the effects of delayed gravity drainage on the early-time data. The results of the early-time Cooper-Jacob analyses are presented in Table 4-8. The Cooper-Jacob straight-line fits and calculations are illustrated in Figures 4-18 through 4-21. The transmissivity calculated from these four observation wells varied from 1,200 to 1,900 gallons per day per foot (gpd/ft). As shown in Table 4-8, the mean value of transmissivity calculated from the four Cooper-Jacob analyses of early-time data is 1,325 gpd/ft (177 ft^2/day). The mean storativity is 1.4×10^{-3}.

Table 4-8: Summary of Time Drawdown Aquifer Test Analyses

Well	Transmissivity (gpd/ft)	Storativity (dimensionless)
MW-2C	1,150	2.8×10^{-3}
MW-115C	1,150	1.6×10^{-3}
MW-519B	1,150	9.6×10^{-4}
MW-517B	1,825	1.9×10^{-4}
Mean	1,325 gpd/ft	1.4×10^{-3}

In calculating the unit properties of the aquifer; that is, the hydraulic conductivity and the specific storage, it is important to understand the vertical thickness of the hydrostratigraphic zone being pumped. In this case, because the vertical thickness of the principal stratigraphic zone expands during the course of the aquifer test, it is important to understand the thickness of the hydrostratigraphic zone during the early-time interval (i.e. the first 10 minutes or so) that has been analyzed by the Cooper-Jacob Method. Figure 4-22 shows a generally ENW to ESE cross section through the test zone showing drawdown contours after ten minutes of pumping. It can be seen that after 10 minutes of pumping, the principal hydrostratigraphic zone being influenced is approximately 20 feet in thickness. Therefore, for the purposes of calculating hydraulic conductivity and specific storage, an early-time, 20-foot vertical thickness of the aquifer is employed. Using this early-time vertical thickness, the mean hydraulic conductivity derived from the early-time, Cooper-Jacob analysis is 66 gpd/ft^2 (8.9 feet per day). Dividing the mean storativity of 1.4×10^{-3} by this same early-time vertical thickness of 20 feet yields a specific storage of 7.0×10^{-5} ft^{-1}. This value of specific storage is consistent with values commonly found in medium dense sands (Batu, 1998).

4.6.5. Post-Sparging Aquifer Test Analysis

The most striking observation made relative to the post-sparging aquifer test data is the markedly smaller amounts of drawdown observed in the CO_2 sparging test zone after 10 minutes of pumping as compared to the pre-sparging test. Even though the two tests were run at the same pumping rate, after 10 minutes of pumping, there is very nearly 1/10th as much drawdown in the post-sparging test as there was in the earlier, pre-sparging aquifer test. This observation is illustrated in Figure 4-23, which shows contours of drawdown at 10 minutes for both the pre-sparging aquifer test (in red) and the post-sparging aquifer test (in blue). Where at the same time in the pre-sparging test there was nearly 2.0 feet of drawdown, there is now 0.2 feet. Where there was 1.0 feet of drawdown, there is now approximately 0.1 feet. This can only be attributable to a large *increase* in the storativity of the aquifer in this region of the aquifer. The cause of this is the residual saturation of CO_2 within the proof of concept test zone of influence. The disparity between pre- and post-sparging drawdown diminishes, but is never completely eliminated over the course of the 24-hour aquifer test. Figures 4-24 and 4-25 depict pre- and post-sparging contours of drawdown at times of 100 and 1000 minutes, respectively. As the post-sparging aquifer test approaches steady-state conditions, storativity becomes less of a dominant factor and the tests come into closer alignment with each other.

CO_2 gas within the aquifer test cone of influence increases the aquifer's storativity because it expands in response to declines in hydraulic head (i.e. drawdown) produced by the aquifer test. As it expands, it increases its partial saturation of the pore spaces at the expense of water. It does so because CO_2, being a gas, expands far more in response to changes in pressure than water, which is very nearly incompressible. The result is an increase in the percent saturation of CO_2 gas and a release of water from storage in the aquifer.

The CO_2 gas also *decreases* the transmissivity of the aquifer as the gas occupies pore spaces that would otherwise be occupied by groundwater and be available for groundwater flow. Moreover, capillary behavior dictates that the non-wetting fluid, in this case, CO_2, will tend to preferentially migrate through and occupy as a residual saturation the larger pore spaces within the porous media. Those are the same pore spaces that groundwater can more easily flow through. Consequently, reductions in transmissivity resulting from increasing saturation of a non-wetting fluid are not proportional to the decrease in fractional water saturation. A typical relative permeability graph for two immiscible fluids in a porous medium is illustrated in Figure 4-26.

The top and bottom axes of the graph are saturation of the non-wetting fluid (S_{nw}) and saturation of the wetting fluid (S_w), respectively. The left axis is relative permeability (k_r) of either the wetting fluid (water) marked (k_{rw}) or the non-wetting fluid (in this case, CO_2 gas) marked (k_{rnw}). The figure has been further annotated in red to illustrate that at a water saturation (S_w) of 0.75 (a 25% reduction in water saturation), the permeability of the formation for water flow has been disproportionately reduced by more than 50%. This is typical and reflects the fact that saturation of non-wetting fluids (like CO_2 in a groundwater system) tends to begin in and expand outward from the larger-diameter, more permeable, pore spaces. As the CO_2 gas dissolves into the groundwater over time, the residual saturation of CO_2 will decline to zero and those vacated pore spaces will be re-occupied by groundwater.

The CO_2 gas-related increase in storativity makes interpretation by time-drawdown techniques, like the early-time, Cooper-Jacob analysis of the pre-sparging aquifer test difficult for the following reasons:

1. The amount of gas expansion is not linearly related to the amount of drawdown, but is a function of both the total hydraulic head, including barometric pressure, and the drawdown in hydraulic head.
2. The gas is not omnipresent or uniformly distributed in the aquifer, consequently the storativity associated with gas expansion is not a uniform property of the aquifer.

The non-linearity of the CO_2-induced storativity makes direct curve fitting to the early-time drawdown of the post-sparging aquifer test inappropriate. Fitting a straight line to any of the semi-logarithmic plots of early-time drawdown, as was done without issue in the pre-sparging test, produces a calculated transmissivity *greater* than in the pre-sparge aquifer test—a result that is clearly in error. Recognizing this problem, a distance-drawdown technique is used to estimate the post-sparging decline in transmissivity.

In a confined aquifer, distance-drawdown analyses can be performed using the distance-drawdown, Cooper-Jacob methodology (Cooper and Jacob, 1946). In this methodology, drawdown is plotted on a semi-logarithmic graph, with drawdown on the Cartesian scale and distance from the pumping well plotted on a logarithmic scale. Plotted in this manner, drawdown data (except for early-time data) generally plot as a straight line and transmissivity can be calculated based upon the slope of that line. However, in an unconfined aquifer, such as this one, steady-state (or near steady-state) drawdowns similarly plotted semi-logarithmically, do not form a straight line. Instead, drawdown in the outlying portions of the cone of influence is reduced due to delayed gravity drainage from the upper portion of the aquifer.

DeGlee developed a distance-drawdown methodology for analyzing drawdowns in semi-confined aquifers (DeGlee, 1930; DeGlee, 1951; Anonymous, 1964). The methodology involves a log-log plotting of drawdown and associated distances from the pumping well and matching those drawdowns to a type curve (referred to herein as the DeGlee type curve). This methodology can be used to obtain an approximate transmissivity of an unconfined aquifer during delayed gravity drainage since delayed gravity drainage is similar to the leakage through an overlying aquitard. A DeGlee Method analysis of the drawdowns at the conclusion of the pre- and post-sparging aquifer test is presented as Figure 4-27. Only wells MW-2C, MW-115C. and MW-519B are used in this analysis as only these wells pass the DeGlee method criterion that "u" be less than 0.01. In Figure 4-27, each data point is annotated to indicate the particular observation well represented by that data point. As can be seen in Figure 4-27, the slope of the post-sparging data points is considerably steeper than the pre-sparging data points indicating that the transmissivity is lower in the post-sparging test. The DeGlee method, although an approximate method under these circumstances, yields a pre-sparge transmissivity of 1,800 gpd/ft, which comports fairly well with the mean transmissivity of 1,325 gpd/ft calculated from the time-drawdown, Cooper-Jacob method.

In contrast to the pre-sparging data, the DeGlee method analysis of the post-sparging aquifer test data yields a transmissivity of 450 gpd/ft. This indicates that the aquifer transmissivity has been reduced by about 66%. It is believed that this diminution of transmissivity is principally the result of CO_2 residual saturation in the aquifer. As was discussed earlier in this report, the amount of silica in the groundwater is not believed to be sufficient to cause much clogging of the aquifer. Also, the degree of residual saturation of CO_2 gas in the proof of concept test zone of influence is quite substantial and could easily account for the measured decline in transmissivity. We'll look at this more closely in the following section.

4.6.6. Estimating the Residual Saturation of CO_2 in the Sparge Test Zone of influence

As described above, the presence of a residual saturation of CO_2 gas in the Satilla formation increases the overall storativity of the aquifer. The impact of the gas-related storativity is particularly evident in the early-time drawdown in the unconfined aquifer before actual pore space dewatering (i.e. specific yield) begins to occur later in the aquifer test. This is because during early-time behavior, storativity is normally limited to the effects of aquifer compression and water expansion, both of which are small in magnitude compared to specific yield. However, with a partial gas saturation in the formation, a third storativity term comes into play—gas expansion. As drawdown begins in the aquifer from the aquifer test pumping, pressure heads are accordingly reduced. This reduction in pressure head produces a concomitant reduction in gas pressure. This reduction in gas pressure, in turn, causes the gas to expand, releasing water from storage in the aquifer. In other words, as the gas expands, it increases its degree of saturation of the pore spaces and correspondingly reduces the degree of water saturation. Let's look at this phenomenon more quantitatively.

The Ideal Gas Law (Mortimer, 1967) states the following:

$$PV = nRT \tag{4-15}$$

Where:
P = pressure
V = volume
n = number of moles of gas
R = constant
T = temperature

Solving for the volume, V, we see that if all other terms remain equal, the volume of gas is inversely proportional to the pressure.

$$V = \frac{nRT}{P} \tag{4-16}$$

Consider for example, the post-sparging aquifer test that produced after 10 minutes of pumping approximately 0.2 feet of drawdown in the area within about 20 feet of the sparge well as shown in Figure 4-23. A 0.2 feet drop in total head (pressure head and atmospheric pressure) from a starting total head of 78 feet represents a 0.26 % drop in pressure (0.2/78 = 0.0026 = 0.26%). This would produce a corresponding expansion in the gas of 0.26% if we assume the gas temperature remains constant. If we assume for the moment that all the water released from storage during the first 10 minutes of the post-sparge aquifer test came from this one mechanism of gas expansion (we will see later that this is a reasonable assumption), then it is possible to estimate how much gas is present in that area within 20 feet laterally of the sparge well.

The amount of water pumped (and thereby removed from storage) during the first ten minutes of the post-sparge aquifer test was 72 gallons (7.2 gpm times 10 minutes) or 9.63 cubic feet. The area of aquifer affected during the first 10 minutes of the test was an approximate cylinder of radius, 20 feet, and a height of 20 feet (See Figure 4-23). The volume of affected aquifer can simply be calculated using the equation of a cylinder:

$$V_{aq} = \pi r^2 d \qquad (4\text{-}17)$$

Where: V_{aq} = Volume of aquifer
r = radius of cylinder
d = height of cylinder

The volume of affected aquifer is calculated to be:

$$V_{aq} = \pi(20\ \text{ft})^2(20\ \text{ft}) = 25{,}132\ \text{ft}^3 \qquad (4\text{-}18)$$

The volume of groundwater within that region can be calculated by multiplying the total volume of the aquifer by the approximate porosity of 0.35:

$$V_{gw} = 25{,}132\ \text{ft}^3(0.35) = 8{,}796\ \text{ft}^3 \qquad (4\text{-}19)$$

If we assume that all of the water released from storage in the aquifer came from gas expansion, then gas expansion would equal the amount of water pumped from the aquifer during the first 10 minutes of the test or 72 gallons (9.63 cubic feet). The initial volume of gas in the affected area can then be calculated by dividing the volume of gas expansion by the fractional expansion as follows:

$$\text{Initial Volume of gas} = \frac{\text{Expansion Volume}}{\text{Fractional Expansion}} = \frac{9.63\ \text{feet}^3}{0.0026} = 3{,}700\ \text{ft}^3 \qquad (4\text{-}20)$$

Comparing the calculated initial volume of gas to the total volume of all pore spaces in the affected region, we can calculate that the residual saturation of CO_2 gas in the affected region is approximately 0.42 (3,700 ft^3 of gas/8,796 ft^3 of total pore spaces). This value comports well with the findings of Lundegard and LaBrecque (1995) for air sparging in fine-grained dune sand. They measured 30 to 40% air saturation in the pore spaces 41 hours after cessation of sparging. It is also interesting that if you look at the typical relative permeability graph presented in Figure 4-26, a non-wetting fluid saturation of 0.42 (0.58 water saturation), corresponds to a roughly 75% decline in aqueous phase permeability, which is the decline measured by the DeGlee distance-drawdown method. Even though the graph in Figure 4-26 was not developed using sand from the Satilla formation, it is nonetheless generally representative of the behavior of sands.

The validity of the assumption that nearly all the water removed from storage during the first 10 minutes of the post-sparging aquifer test was attributable to CO_2 gas expansion can be demonstrated by calculating the amount of water released from storage by the two conventional mechanisms of early-time unconfined aquifer test storativity—aquifer compression and water expansion. The combined storativity produced by these two mechanisms was calculated in the pre-sparging aquifer test to be 1.4×10^{-3}. Dividing this early-time storativity by the early-time thickness of the aquifer affected by the pumping, 20 feet, yields a specific storage of 7.0×10^{-5} ft^{-1}. We can then multiply the total affected area of the aquifer at 10 minutes by this storativity and the approximate average drawdown of 0.2 feet to get the volume of water released from storage by the conventional storativity mechanisms (V_S), as follows:

$$V_S = \text{Aquifer Volume} \times \text{Specific Storage} \times \text{Drawdown} \qquad (4\text{-}21)$$

$$V_S = 25{,}132\ ft^3 \times 7.0\text{x}10^{-5}\ ft^{-1} \times 0.2\ \text{feet} \qquad (4\text{-}22)$$

$$V_S = 0.35\ ft^3 \qquad (4\text{-}23)$$

This volume of water represents only 3.6% of the total volume of water released from storage during the first 10 minutes of the post-sparging aquifer test indicating that our original assumption that nearly all the storativity was associated with CO_2 gas expansion was reasonable.

Another means to estimate the residual saturation of CO_2 gas in the proof of concept test zone of influence is by attempting to reproduce the early-time drawdown data measured in the post-sparging aquifer test. This can be done using the Theis equation, the above-calculated post-sparging transmissivity, and a storativity term that incorporates the additional storativity created by the presence of the CO_2 gas residual saturation. The storativity of a confined, semi-confined, or an unconfined aquifer during early-time behavior (before the onset of delayed gravity drainage) is attributable to two mechanisms—aquifer compression and water expansion. The equation for conventional storativity attributable to these two mechanisms is given by Walton (1970):

$$S = \overbrace{\eta\gamma m\beta}^{\text{water expansion term}} + \overbrace{\alpha\gamma m}^{\text{aquifer compression term}} \qquad (4\text{-}24)$$

Where: S = Storativity

η = porosity

γ = unit weight of water

m = aquifer thickness

β = water compressibility

α = aquifer compressibility

We can derive an expanded storativity equation to take into account the impact of CO_2 gas expansion on aquifer storativity. The derivation is based upon the Ideal Gas Law and is provided in Appendix G. The expanded storativity equation is given below:

$$S = \overbrace{(1 - s_{CO_2})n\gamma m\beta}^{\text{water expansion term}} + \overbrace{\alpha\gamma m}^{\text{aquifer compression term}} + \overbrace{\frac{s_{CO_2} nms}{h_{p,total}}}^{CO_2\text{ expansion term}} \qquad (4\text{-}25)$$

Where: s_{CO2} = residual saturation of CO_2

s = drawdown

$h_{p,total}$ = total pressure head including atmospheric pressure

In the above equation, the water expansion term has been modified by changing the total porosity (*n*) to the water-filled saturation $(1 - s_{CO2})n$ to properly reflect the fact that CO_2 occupies a portion of the total porosity. However, because the water expansion term is de minimis compared to the CO_2 expansion term, the equation can be simplified by using the total porosity in this term without sacrificing any significant accuracy, as shown below:

$$S = n\gamma m\beta + \alpha\gamma m + \frac{s_{CO_2} nms}{h_{p_{Total}}} \tag{4-26}$$

The above equation can be substituted for the conventional storativity (S) in the Theis equation to calculate drawdown in the proof of concept zone of influence under the influence of CO_2 gas residual saturation. However, because drawdown (s) is both the dependent variable and an independent variable, the Theis equation must be solved iteratively. A spreadsheet solution to the Theis equation, with the expanded storativity term, was developed in Excel using the solver function in Excel. A copy of this spreadsheet is available upon request.

The quality of the match is very much dependent upon the CO_2 gas residual saturation. Using the value of post-sparging transmissivity of 450 gpd/ft, calculated by the DeGlee Method, we can estimate the CO_2 residual saturation by fitting the calculated drawdown to the observed drawdown. Figures 4-28 through 4-31 show the drawdown matching and the calculated CO_2 residual saturation. In each case, the calculated CO_2 residual saturation declines with increasing time. This reflects the physical reality that CO_2 saturation decreases with increasing radial distance from the sparge well, especially beyond a radial distance of 20 feet, where most of the pH reduction occurred. Therefore, as the post-sparging aquifer test cone of influence expands, it increasingly encompasses portions of the aquifer, beyond the 20-foot radius of the principal zone of influence of the CO_2 sparging test, that contain progressively less CO_2 residual saturation. The calculated CO_2 residual saturations suggest that in close proximity to the sparge well residual saturations may be as high as 0.3 to 0.5, but rapidly decrease at radial distances beyond the approximately 20-foot radius within which pH declined to circumneutral values.

The findings of the SW-1 pre- and post-sparging aquifer tests are presented in Table 4-9 and can be summarized as follows:

1. The Satilla Aquifer behaves as an unconfined aquifer. As with most unconfined aquifers, during pumping it transitions from early-time, confined aquifer behavior, though an intermediate period of near steady-state conditions due to delayed gravity drainage from the upper portion of the aquifer, and finally to a late-time, unconfined aquifer behavior. The transition to unconfined behavior begins after about 1,000 minutes of pumping.
2. The basal portion of the aquifer, specifically the lower 20 feet of the aquifer (which roughly corresponds with the high pH, high density CBP waters), had a pre-sparging transmissivity of 1,325 gpd/ft and a mean early-time storativity of 1.4×10^{-3}. After the CO_2 sparging, the transmissivity of the basal portion of the aquifer declined by 66% to 450 gpd/ft. This corresponds to a reduction in hydraulic conductivity from 8.9 to 2.4 ft/day.
3. The decline in transmissivity and hydraulic conductivity is believed to be principally the result of a residual saturation of CO_2 in aquifer that was estimated to range from 0.1 to 0.5 (10% to 50% of the pore space).

4. The presence of a substantial residual saturation of CO_2 gas in the aquifer also increased the storativity of the aquifer due to the drawdown-induced expansion of the CO_2 gas.
5. The pre-sparging specific storage of the basal portion of the aquifer is 7.0×10^{-5} ft^{-1}, which is consistent with typical values of specific storage of medium-dense sands.

Table 4-9: Summary of the Pre- and Post-Sparging Aquifer Testing Analyses

Parameter	Analytical Methodology	Results
Pre-Sparging Transmissivity of the Basal Satilla Aquifer (Lower 20 feet)	Mean of Cooper-Jacob method analysis of early-time drawdown data	1,325 gpd/ft
Pre-Sparge Transmissivity of the basal Satilla Aquifer	DeGlee Method	1,800 gpd/ft
Post-Sparge Transmissivity of the basal Satilla Aquifer	DeGlee Method	450 gpd/ft
Early-time storativity of basal Satilla Aquifer	Mean of Cooper-Jacob method analysis of early-time drawdown data	1.4×10^{-3}
Mean hydraulic conductivity of basal Satilla Aquifer	Mean transmissivity of basal Satilla aquifer divided by the early-time aquifer thickness of 20 feet	8.9 ft/day
Specific Storage of basal Satilla Aquifer	Early-time storativity divided by the early-time aquifer thickness of 20 feet	7.0×10^{-5}ft^{-1}
CO2 residual saturation in the basal portion of the sparge test zone of influence	Matching early-time drawdown with Theis Method and modified storativity term to account for expansion of CO2 gas	0.1 to 0.5

4.7. Groundwater Mounding

Potentiometric levels in all of the observation wells were monitored by Solinst data loggers during the course of the entire CO_2 sparging Proof of Concept test. As with the pre- and post-sparging aquifer tests, MW-517B was substituted for EW-11. The transducers were generally programmed for 15-minute frequency readings during the Proof of Concept test. For a few days in the middle of the test, the frequency was increased to one minute intervals. As described earlier, a number of monitoring well screens were intercepted by CO_2 gas channels in the subsurface leading to CO_2 escape through the monitoring well. This phenomenon was observed on day one of the test in MW-1B. The escape of CO2 in MW-1B was accompanied by significant foaming. Thereafter, all observation wells were fitted with special caps that would prevent escape of gas or foam during active sparging, but would also allow withdrawal and replacement of the Hach pH electrodes, as necessary, to check their calibration and to clean them. With these caps in place, once gas channels had intercepted a well screen, pressure readings in that well no longer represented groundwater levels, but rather a combination of groundwater head and pressure head in the well casing. Therefore, in interpreting water level mounding and recession data, we have carefully avoided using those portions of the data impacted by gas pressure build up in the monitoring well casings.

The daily CO_2 sparging during the Proof of Concept test created significant mounding, particularly in the deep, more permeable, stratigraphic zone at the base of the Satilla Formation. Wells screened in the intermediate vertical position within the aquifer experienced less mounding. Wells screened in the shallow interval, nearer the groundwater table, experienced considerably less mounding during the course of the test. This pattern was observed in all the well clusters and is illustrated in Figure 4-31, which shows the hydrographs of Wells MW-2A, MW-2B, and MW-2C during the first three days of sparging. This time period was chosen because it precedes the time at which a gas channel reached MW-2B and pressurized the well. This figure is generally illustrative of the relative degree of mounding exhibited by the deep Satilla wells, the intermediate Satilla wells, and the upper Satilla wells, although higher levels are reached later in the test. Several aspects of this figure are worth noting:

1. In well MW-2C, representing the basal zone of the Satilla formation, piezometric levels rise almost immediately following initiation of sparging and reach a peak about 2 to 2 ½ hours later. This is believed to represent the time during which CO_2 channels are expanding outward through the zone of saturation, displacing water, before ultimately reaching the vadose zone and coming into a quasi-equilibrium state. Thereafter, the mound in piezometric levels created by intrusion of the CO_2 channels begins to slowly decline. Once the sparging is suspended at the end of each day, piezometric levels decline precipitously to levels well below the original static piezometric level. This collapse of the piezometric surface is a common phenomenon in air sparging and occurs as the air (or in this CO_2) channels collapse and groundwater flows back in to reoccupy those previously air-filled pore spaces (Lundegard and LaBrecque, 1995).
2. The intermediate and shallow wells exhibit progressively less mounding much like the vertical extent of drawdown measured in the aquifer testing. The shallow well, MW-2A, nominally representing the groundwater table, shows about one foot of mounding. However, as the test progressed, mounding of the shallow wells increased to two or three feet and routinely brought the water table up to within one foot of the ground surface during active sparging.

The water level data for all of the observation wells is included in Appendix C.

Figure 4-32 shows the maximum level of the piezometric surface during the first day of sparging on November 29, 2012. The piezometric surface in the basal Satilla near the sparge well rose from a static elevation of about 4 to 5 feet above sea level to a level of 11.1 feet above sea level. As depicted in that figure, piezometric level mounding declined with increasing radial distance from the sparge well, but extended out to (and beyond) well MW-517B, which experienced a 3.5 feet rise in the piezometric surface at a distance of over 100 feet from the sparge well. Upon secession of sparging, the piezometric surface declined rapidly to levels well below the original static piezometric surface, as described above. This depression in the piezometric surface at its maximum extent is depicted in Figure 4-33. Near the sparge well, the piezometric surface fell to more than two feet *below* mean sea level and then began a recovery to near static levels before the next day's sparging. This cyclic pattern of mounding, followed by collapsing of the piezometric surface, and then slow recovery, was repeated each day during the Proof of Concept test.

The cyclic mounding had a minimal effect of the migration of the CBP around the periphery of the test site. As shown in Figure 4-34, the hydraulic head difference between MW-519B and MW-517B during the sparge period was 1.8 feet. The distance between the two wells is 90 feet. Therefore, the outward radial hydraulic gradient during the sparge period is about 0.02 (1.8 feet/90 feet). Using the hydraulic conductivity of the basal Satilla measured in the aquifer test of 8.9 feet per day and an effective porosity of 0.25, the average linear groundwater velocity can be calculated as follows:

$$\bar{v} = \frac{Ki}{n_e} \tag{4-27}$$

Where: $\bar{v}$ = average linear groundwater velocity

K = hydraulic conductivity

i = hydraulic gradient

n_e = effective porosity

$$\bar{v} = \frac{8.9 \text{ ft/day } (0.02)}{0.25} = 0.71 \text{ ft/day} \tag{4-28}$$

Assuming that this gradient persisted throughout the entire 9 hour and 15 minute sparge period of Day 1 (0.39 days), the outward distance traveled would have been:

$$\text{Distance traveled} = 0.71 \text{ feet/day} \times 0.39 \text{ days} = 0.28 \text{ feet} \tag{4-29}$$

As depicted in Figure 4-33, once the sparging ceases, the piezometric mounding collapses into a deep depression. The hydraulic gradient is reversed and groundwater in the basal zone of the Satilla Aquifer flows backward toward the sparge well. The net impact on CBP migration is negligible.

The groundwater table also cyclically rose and fell during cyclic sparging. However, the magnitude of these fluctuations is less than in the intermediate or basal Satilla. The maximum elevation reached by the groundwater table (as defined by the shallow wells) on any date during the sparging test is depicted on Figure 4-34. Water table mounding reaches a peak of greater than nine feet above mean sea level near the sparge well. This means that the groundwater table rose to within one foot of the ground surface near the sparge well.

The monitoring of groundwater levels and the above analysis indicates that the impact of sparging on lateral groundwater migration is quite small. However, the mounding extends laterally more than 50 feet and near the sparge well is sufficient to bring the groundwater table up close to ground surface. This observed behavior has implications for full-scale implementation. It may not be feasible to simultaneously sparge into multiple wells or even two adjacent wells in a single area as the mounds from each well will superimpose upon each other increasing the likelihood of bringing the groundwater table to the surface. This issue would have to be carefully addressed in design of a full-scale CO_2 sparging system.

5. CONCLUSIONS

This Proof of Concept test demonstrated that CO_2 sparging can reduce pH levels in the CBP to circumneutral and concomitantly lower concentrations of mercury and other trace metals such as chromium, arsenic, and vanadium. Furthermore, all of the specific test objectives stated in the Proof of Concept workplan (Section 2) were met, except for completion of long-term, post-sparge rebound monitoring. These monitoring events will occur in February and May of 2013 in accordance with the workplan. The following conclusions can be drawn from the test:

1. CO_2 sparging into the Satilla Formation is feasible without the need for fracturing.
2. Significant pH reductions from pH 11-12 in the deep Satilla were achievable in 5 to 7 days sparging at circa 50 scfm.
3. Hg levels in the high pH CBP fully-impacted by the sparging declined from 110-120 μg/L to 11-33 μg/L (70 to 90% reductions)
4. Limited evidence of silica precipitation was observed in wells within the zone of influence of the sparge test.
5. The pH of deep Satilla wells was not lowered to below 6.5 at any point during sparging, which indicates that potential dissolution of the sandstone aquitard is not a risk that would bar use of the CO_2 approach.
6. A radius of influence of at least 20 feet was achieved at the top of the CBP and greater than 60 feet at the water table surface.
7. Some CO_2 gas channels extended out more than 100 feet from the sparge wells.
8. The CO_2 sparging resulted in a significant residual saturation of CO_2 gas in the zone of influence. This CO_2 residual saturation did have the effect of lowering the transmissivity of the Satilla by 66% and substantially increasing the storativity of the aquifer. These impacts are expected to diminish over time as the entrapped CO_2 gas residual saturation dissolves into the surrounding groundwater. The observed residual saturation also provides an opportunity for improvement in process efficiency.
9. During sparging, significant mounding of the potentiometric surface was measured, particularly in the deep wells. Less mounding was observed in the intermediate zone and even less in the shallow zone. Nonetheless, during the course of the sparging test the groundwater table did rise to within a foot of the surface within a 20-foot radius of the sparge wells (SW-1 and MW-1C). Also the piezometric surface in the deep zone rose as much as 6.5 feet at MW-517B, which is over 100 feet from the sparge well. Control over mounding and the anticipated superposition of mounding from adjacent sparge wells will be an important factor in design of any full-scale implementation. Seasonal or other fluctuations in the level of the groundwater table will also be a factor in a full-scale implementation.

The Proof of Concept test indicated that CO_2 sparging would be an effective, innovative technology, suitable for full-scale implementation at the site. Observations made during testing further indicate that full-scale implementation of CO_2 sparging be conducted over a multiple-year, sequential effort. The principal drivers for this sequential implementation are:

- Management of groundwater mounding caused by superposition of multiple, closely-spaced sparge wells; and
- Maximization of sparging efficiency to reduce emissions of CO_2.

Groundwater mounding during full scale implementation is particularly critical as mounding during the Proof of Concept test was substantial. The groundwater table rose to within 1 foot of the ground surface during the testing. This mounding will be exacerbated by superposition of mounding from multiple nearby sparging wells and by seasonal rises of the groundwater table. Moreover, in some areas of the CBP, the water table is even closer to the surface than in the test site. Conducting the implementation over multiple years will allow active sparge wells to be further apart, thereby reducing the superposition of groundwater mounding. The optimal time for sparging is when the groundwater table is at its lowest during the drier summer and early fall months.

The Proof of Concept test results suggest that CO_2 sparge efficiency can be enhanced by a sparge regimen that emphasizes short bursts of sparging (anywhere from ½ to 4 hrs.) followed by relatively lengthy rest periods. The rest periods would allow CO_2 gas residual saturation remaining in the formation to both dissolve and diffuse into the surrounding CBP waters. It is proposed that in the first year of sparging, different sparge regimens be tested in an effort to optimize sparge efficiency. In subsequent years, the optimized sparge regimen would be adopted.

Taking these factors into consideration, it is believed that full scale implementation could be accomplished over approximately three years, with four to five months of sparging during the late summer and early fall followed by a seven- to eight-month period of relaxation of sparging. During the relaxation period, data collected from the site would be analyzed using a three-dimensional visualization program. These analyses would permit planning of the next year of the sparge program.

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FIGURES

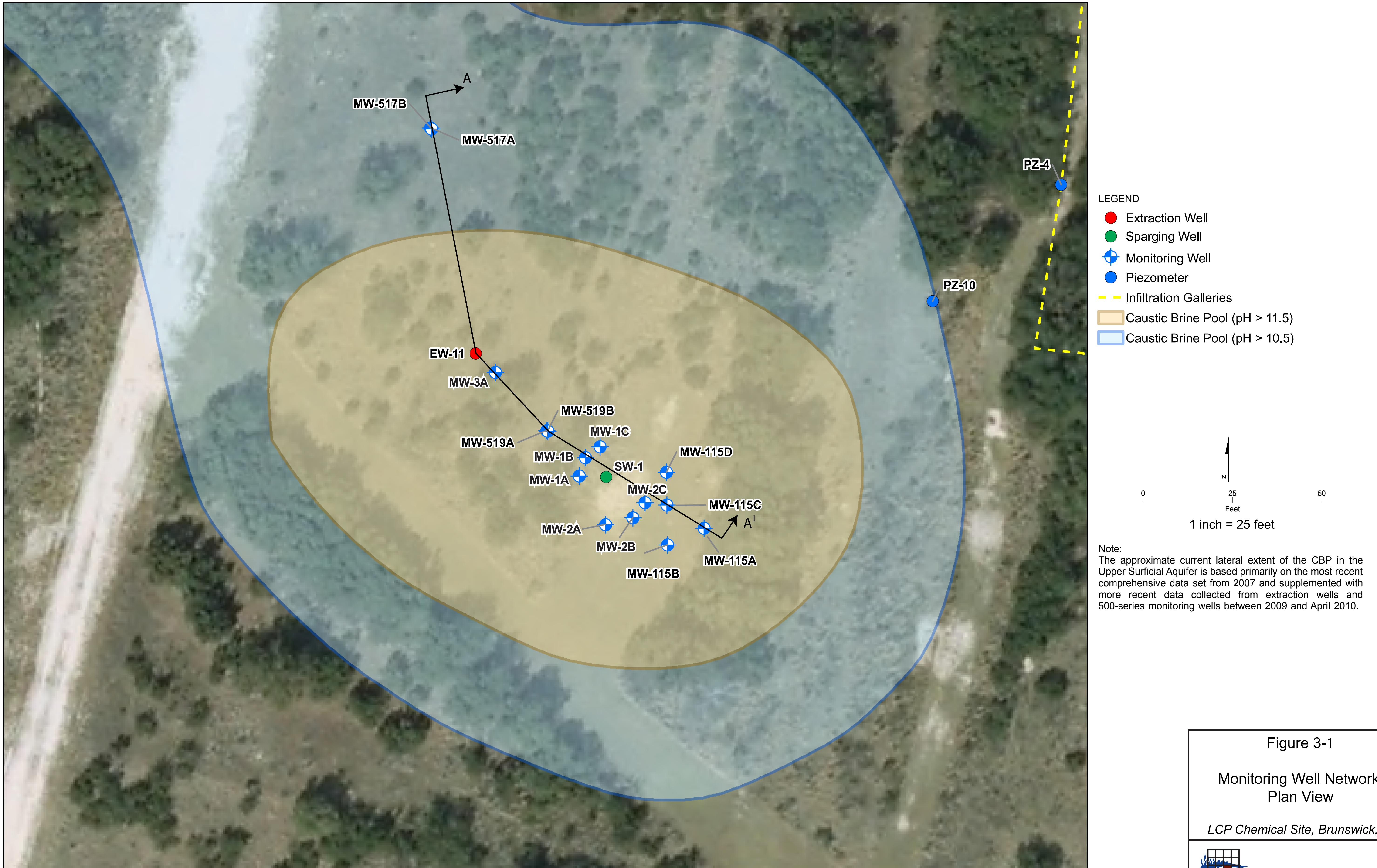


Figure 3-1

Monitoring Well Network:
Plan View

LCP Chemical Site, Brunswick, GA

Mutch Associates, LLC
Environmental Engineers and Scientists

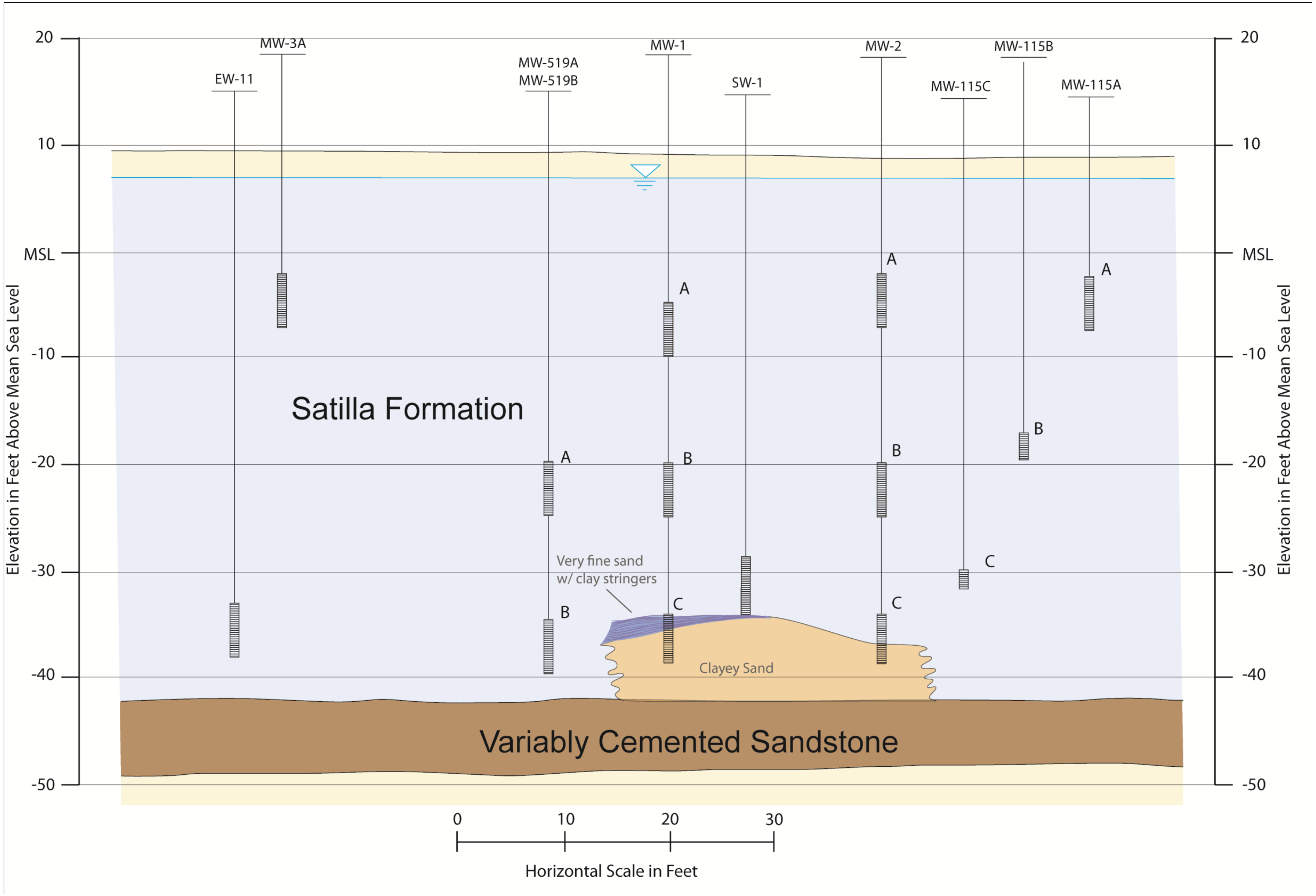
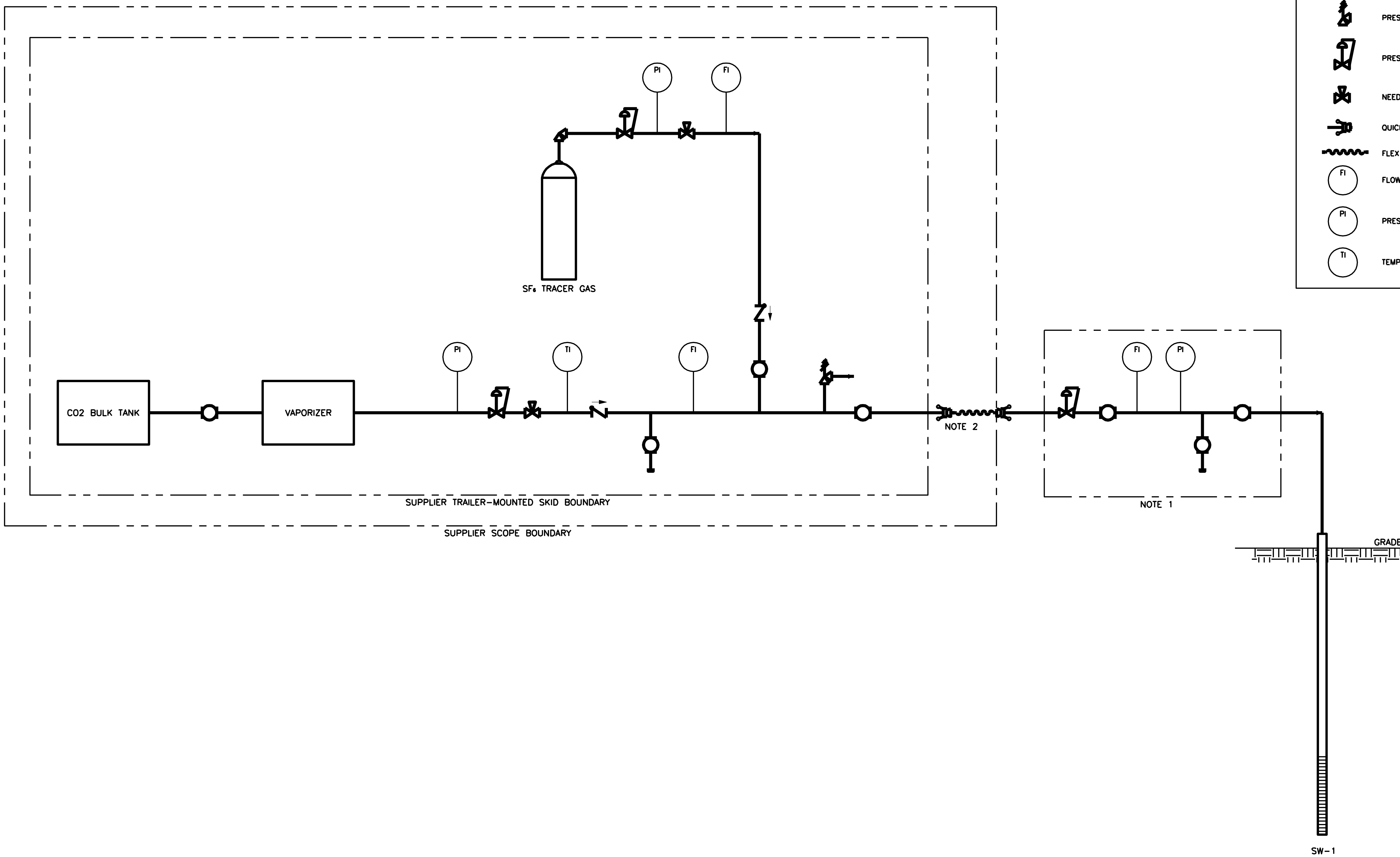


Figure 3-2

Monitoring Well Network:
Cross Section A-A'

Mutch Associates, LLC
Environmental Engineers and Scientists



LEGEND:

- ANGLE VALVE
- BALL VALVE
- CHECK VALVE
- PRESSURE RELIEF VALVE
- PRESSURE REGULATING VALVE
- NEEDLE VALVE
- QUICK CONNECT COUPLING
- FLEX HOSE
- FI FLOW INDICATOR
- PI PRESSURE INDICATOR
- TI TEMPERATURE INDICATOR

NOTES:

1. EQUIPMENT DOWNSTREAM OF HOSE LOCATED AT WELLHEAD.
2. 100-FT LENGTH OF HOSE TO CONNECT TRAILER-MOUNTED SKID TO WELL HEAD.

NO.	DESCRIPTION	DATE	DRAWN	CHK'D	APPV'D
B	ISSUED FOR REPORT	1/16/13	JHG	AN	

DRAWN BY	DATE	SEAL
CHECKED BY	DATE	
APPROVED BY	DATE	
PROJECT MGR.	DATE	

PARSONS
ENVIRONMENT AND INFRASTRUCTURE

OFFICE
301 PLAINFIELD ROAD
SYRACUSE, NY 13212
(315) 451-9560

JOB 447567
WBS 02123

PROJECT TITLE
BRUNSWICK LCP FACILITY
BRUNWICK, GEORGIA

DRAWING TITLE
PROCESS FLOW DIAGRAM
CARBON DIOXIDE SPARGE
TEST

SCALE: NO SCALE

DRAWING NO. **FIGURE 3.3** REV. **B**

FILE NAME: P:\HONEYWELL\447422 BRUNSWICK SUPPORT\CAD\447422-100-D-001.DWG
PLOT DATE: 1/18/2013 3:50 PM PLOTTED BY: GOLDTHWAIT, JAMES

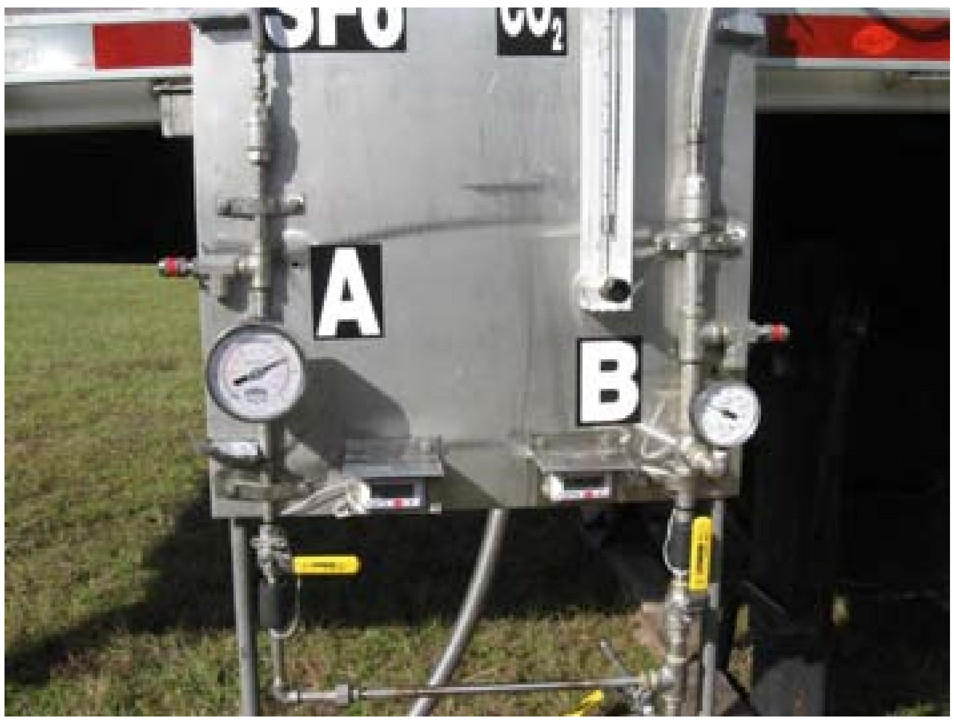


Figure 3-4

CO_2 Trailer and Control Panel

LCP Chemical Site, Brunswick, GA

Mutch Associates, LLC
Environmental Engineers and Scientists

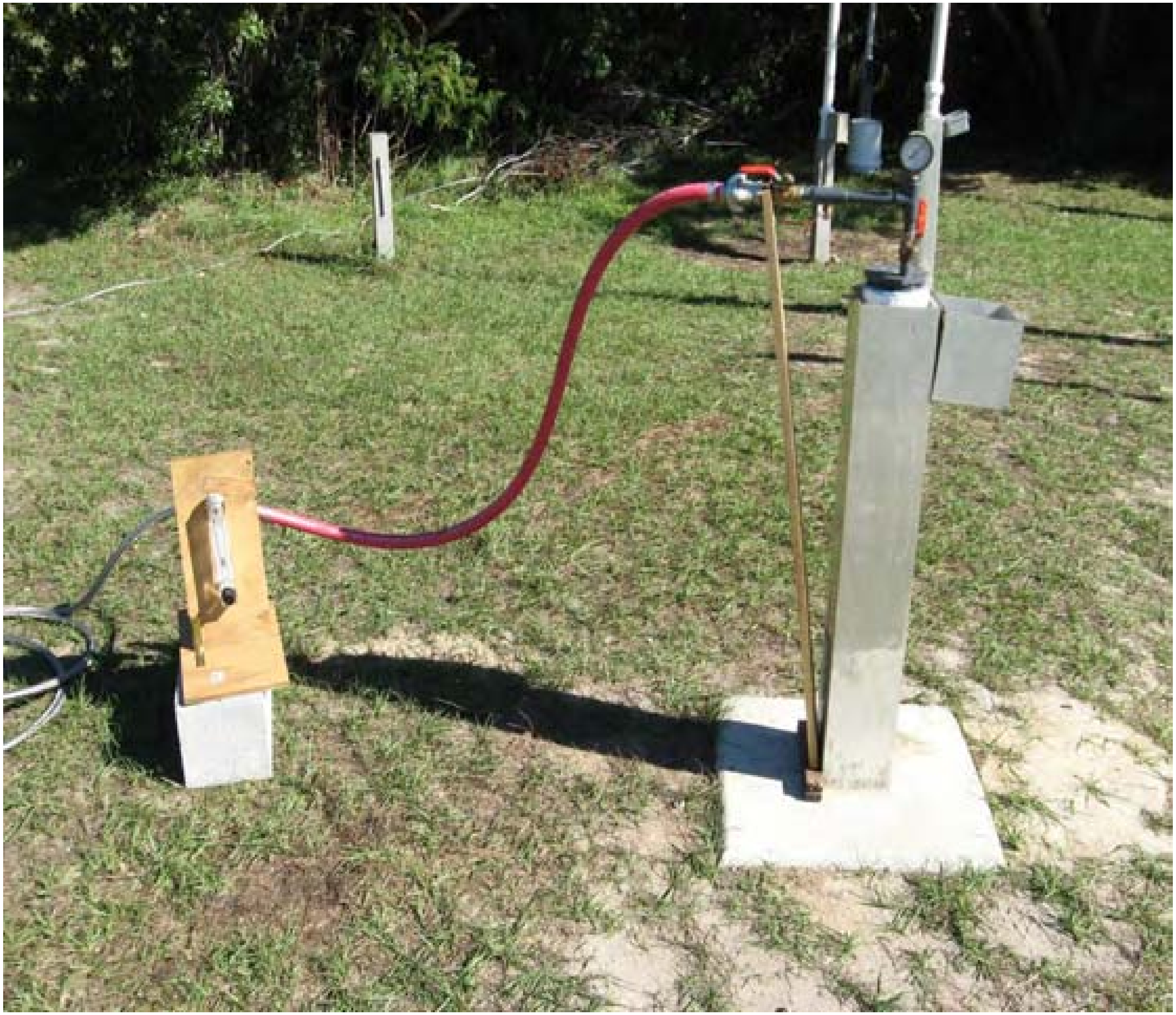


Figure 3-5

Sparge Well Setup (SW-1)

LCP Chemical Site, Brunswick, GA

Mutch Associates, LLC
Environmental Engineers and Scientists

Figure 3-6

Monitoring Well Network
With Well Extensions

LCP Chemical Site, Brunswick, GA

Mutch Associates, LLC
Environmental Engineers and Scientists

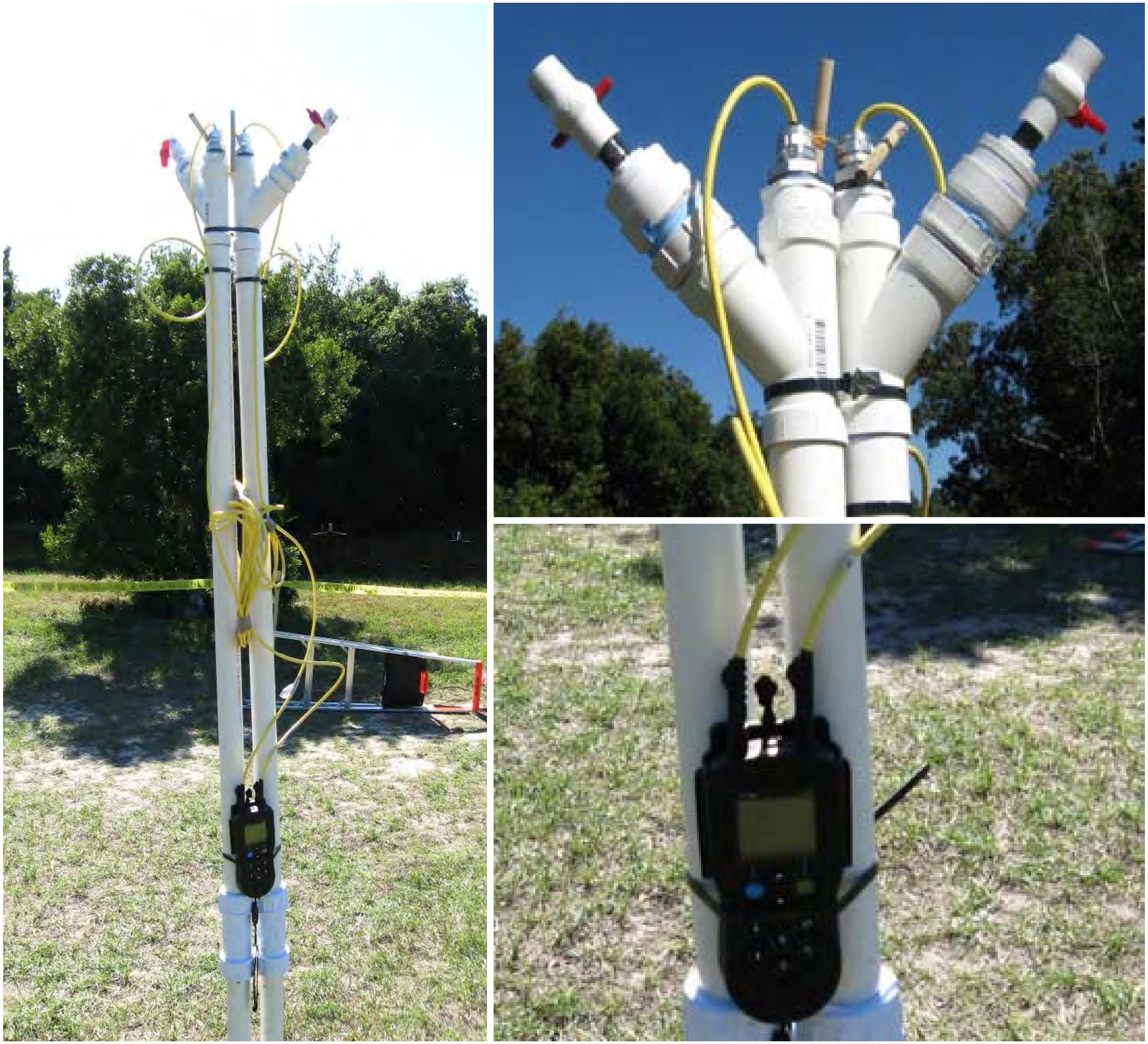


Figure 3-7

Monitoring Well Components
Of MW-519A and MW-519B

LCP Chemical Site, Brunswick, GA

Mutch Associates, LLC
Environmental Engineers and Scientists

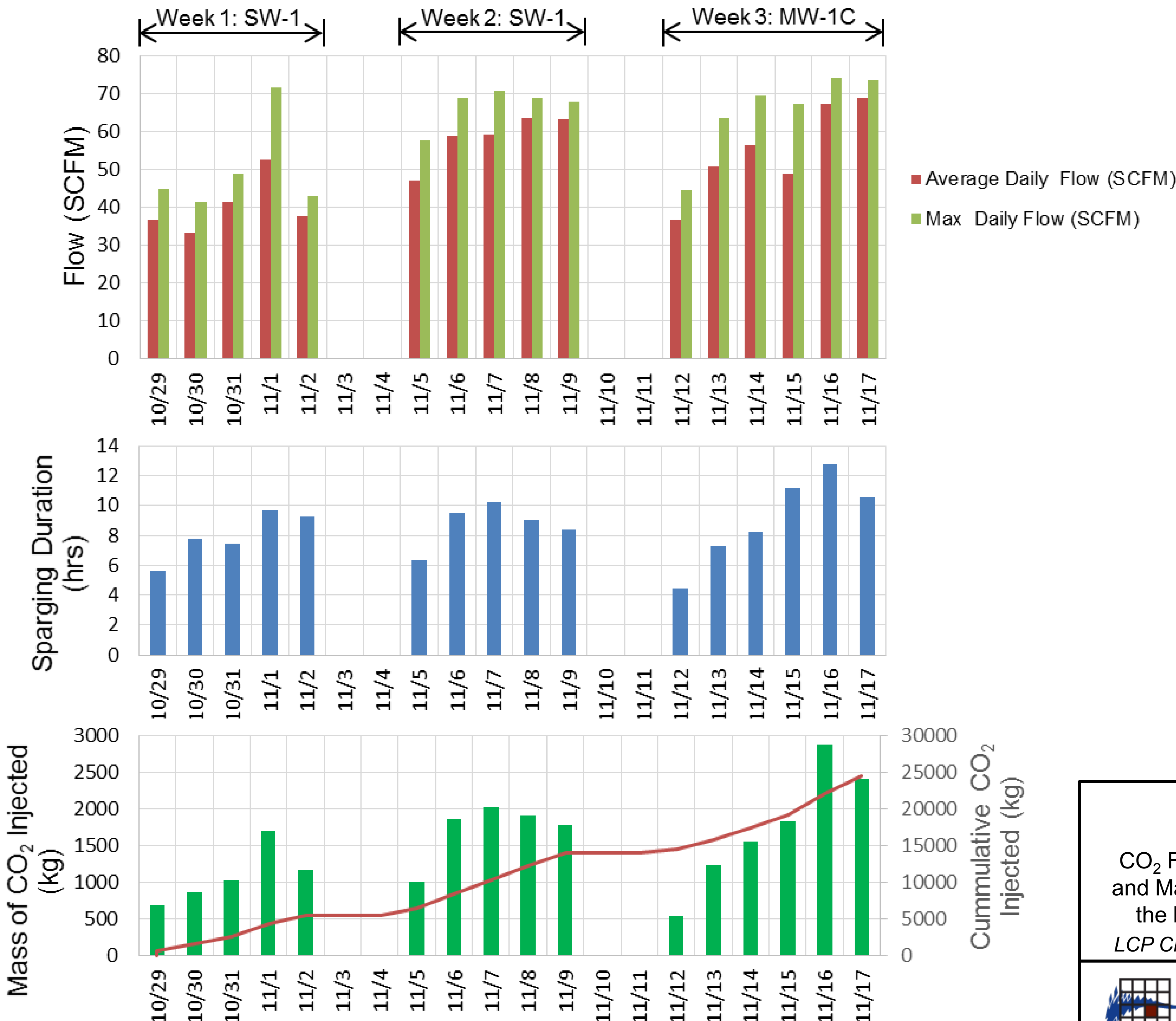


Figure 4-1

CO_2 Flow, Sparging Duration and Mass Injected Throughout the Proof of Concept Test

LCP Chemical Site, Brunswick, GA

Mutch Associates, LLC
Environmental Engineers and Scientists

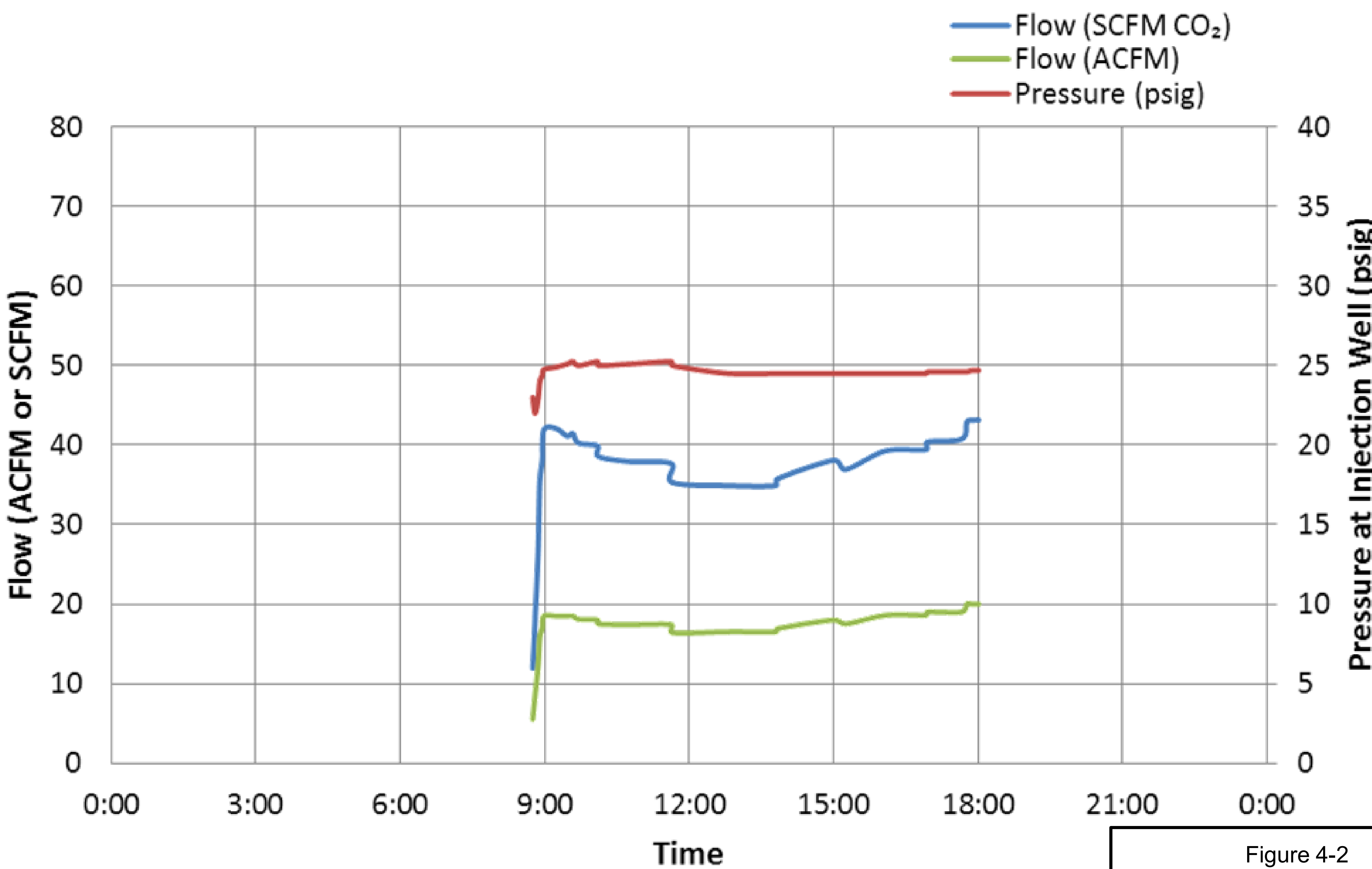


Figure 4-2

Typical Sparging Daily Program (from November 2, 2012)

LCP Chemical Site, Brunswick, GA

Mutch Associates, LLC
Environmental Engineers and Scientists

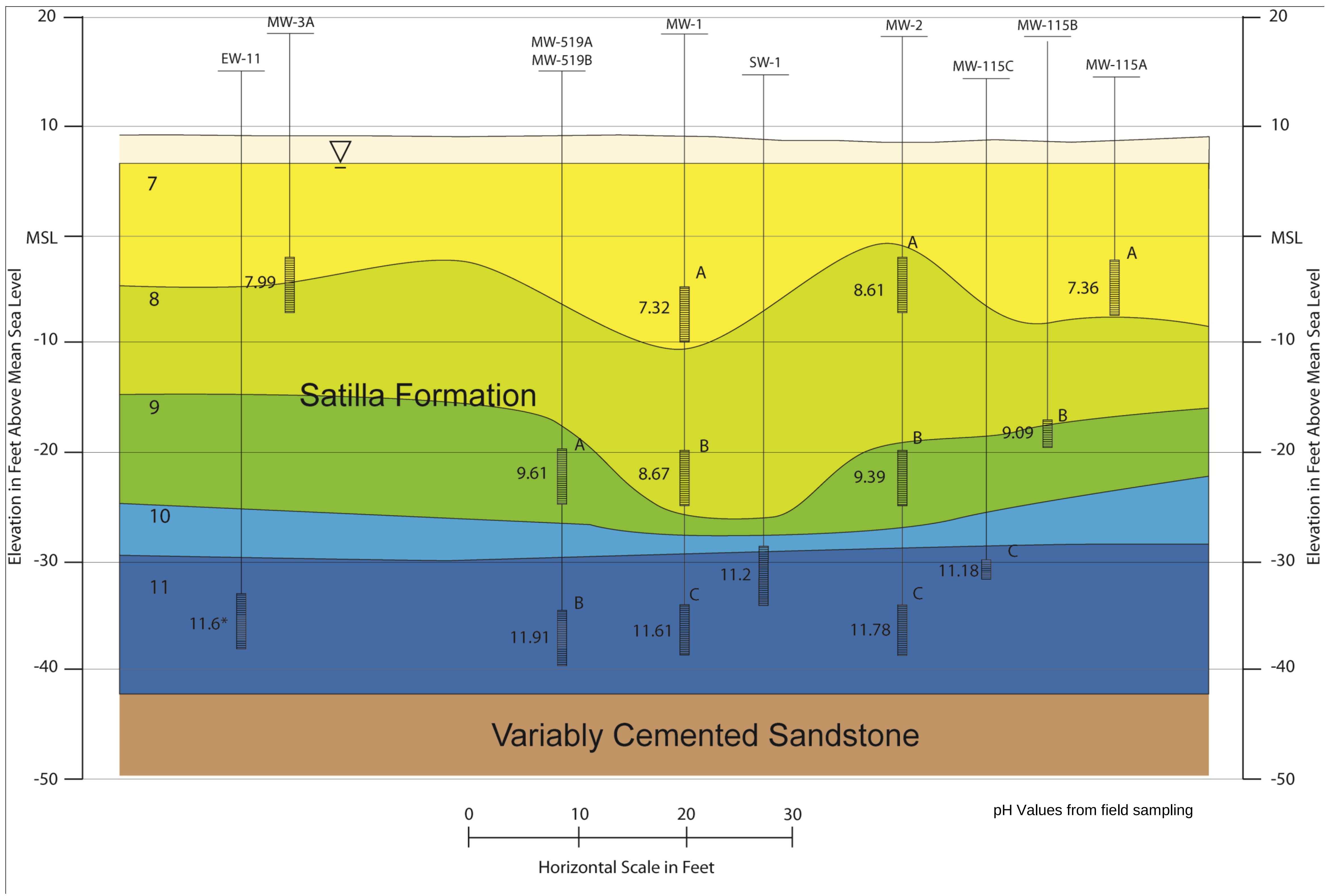
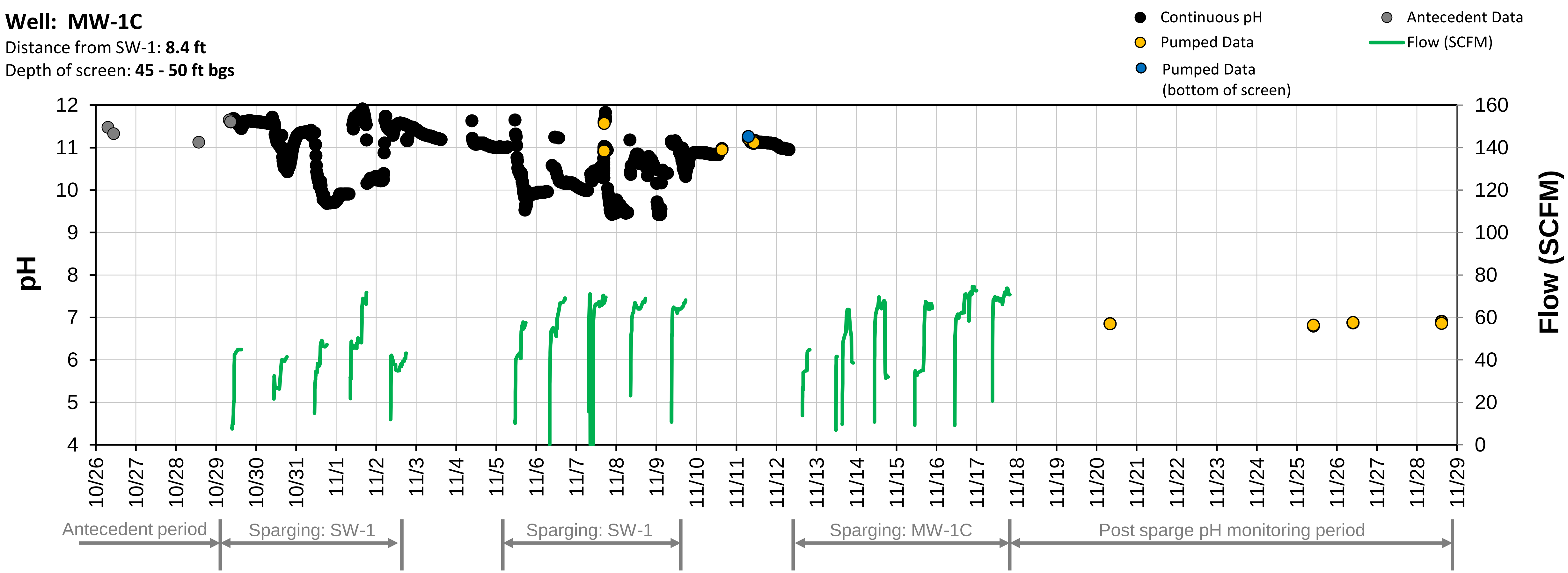


Figure 4-3

Pre-Sparge pH Levels
(10/29/12 8:45 AM)

LCP Chemical Site, Brunswick, GA

Mutch Associates, LLC
Environmental Engineers and Scientists



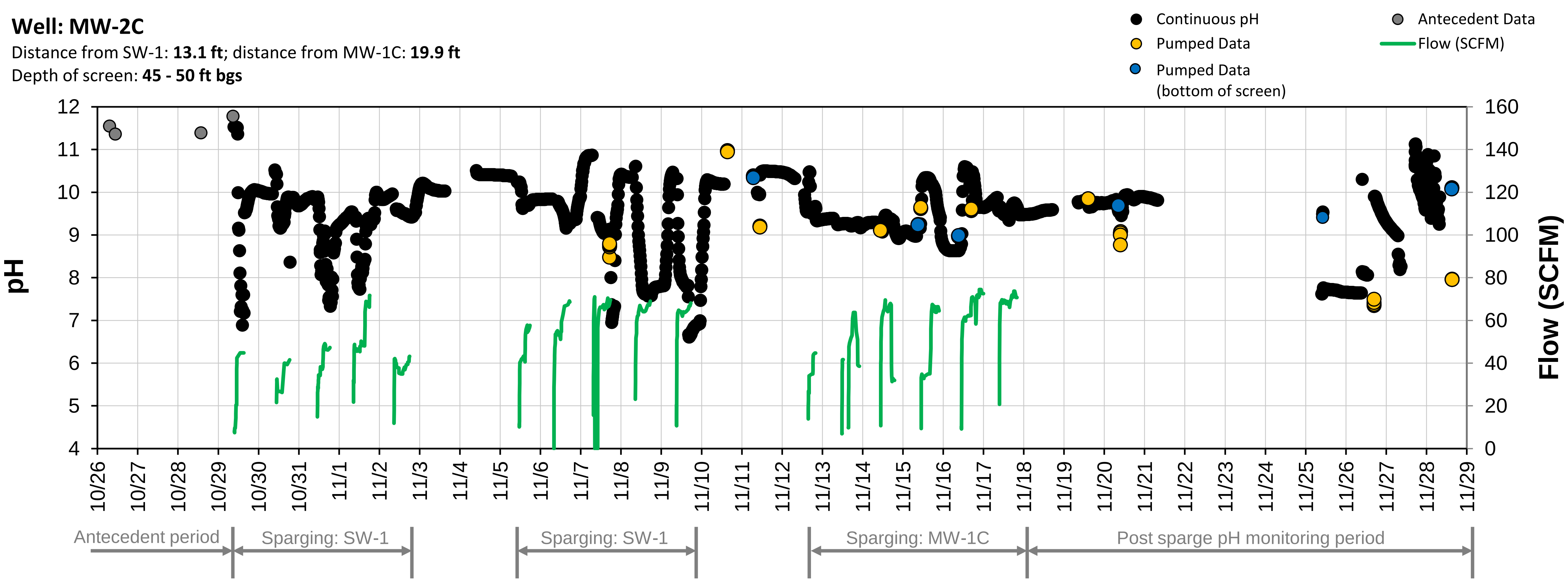


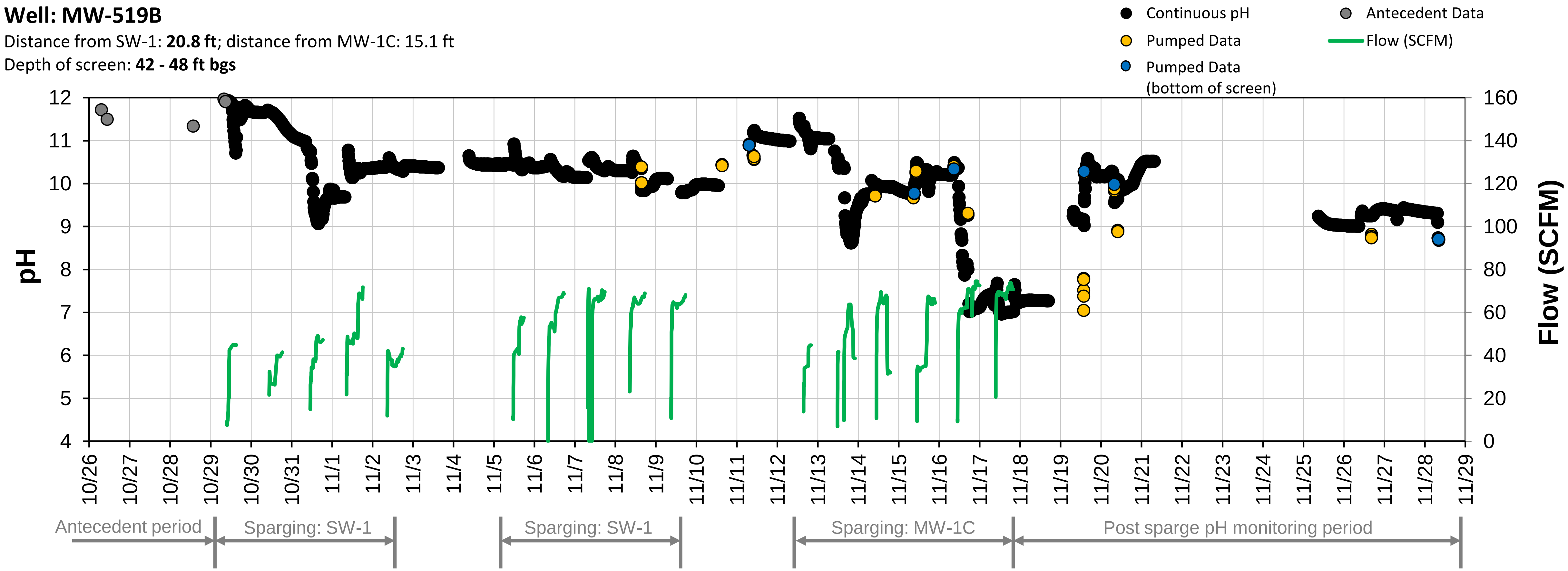
Figure 4-4

Continuous pH data for
MW-1C & MW-2C

LCP Chemical Site, Brunswick, GA

Mutch Associates, LLC
Environmental Engineers and Scientists

Well: MW-519B
Distance from SW-1: **20.8 ft**; distance from MW-1C: 15.1 ft
Depth of screen: **42 - 48 ft bgs**



Well: MW-115C
Distance from SW-1: **18.7 ft**; distance from MW-1C: **24.6 ft**
Depth of screen: **40 - 42 ft bgs**

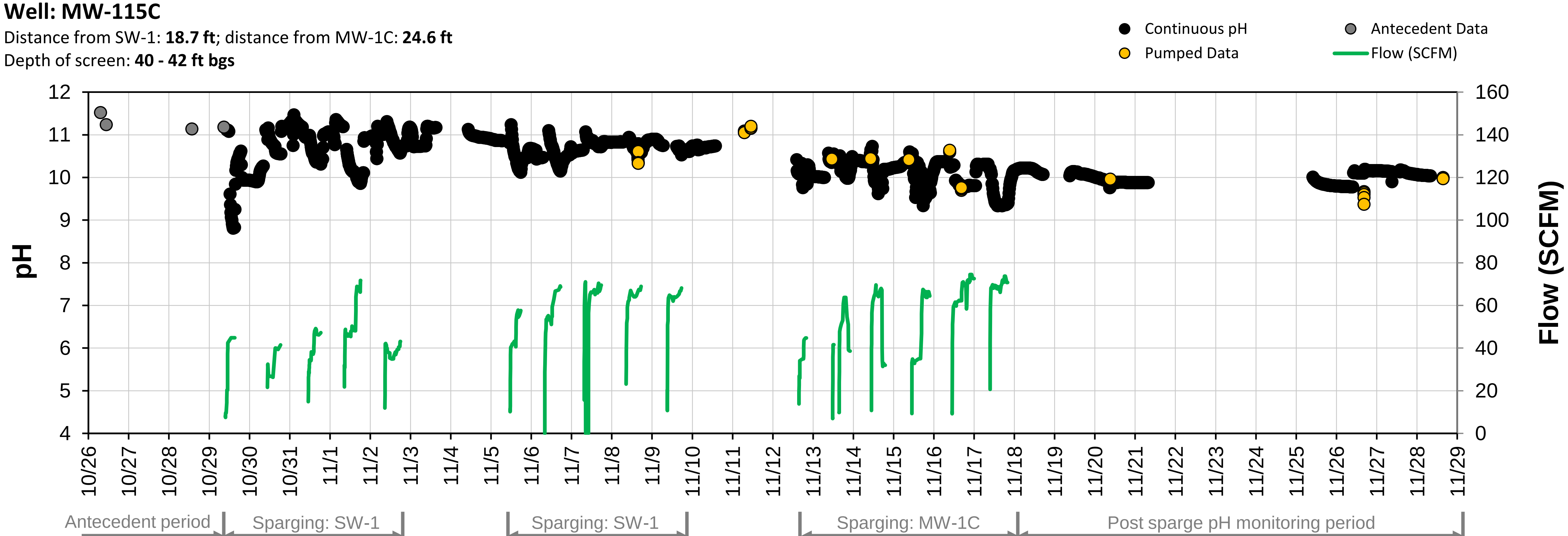


Figure 4-5

Continuous pH data for MW-519B & MW-115C

LCP Chemical Site, Brunswick, GA

Mutch Associates, LLC
Environmental Engineers and Scientists

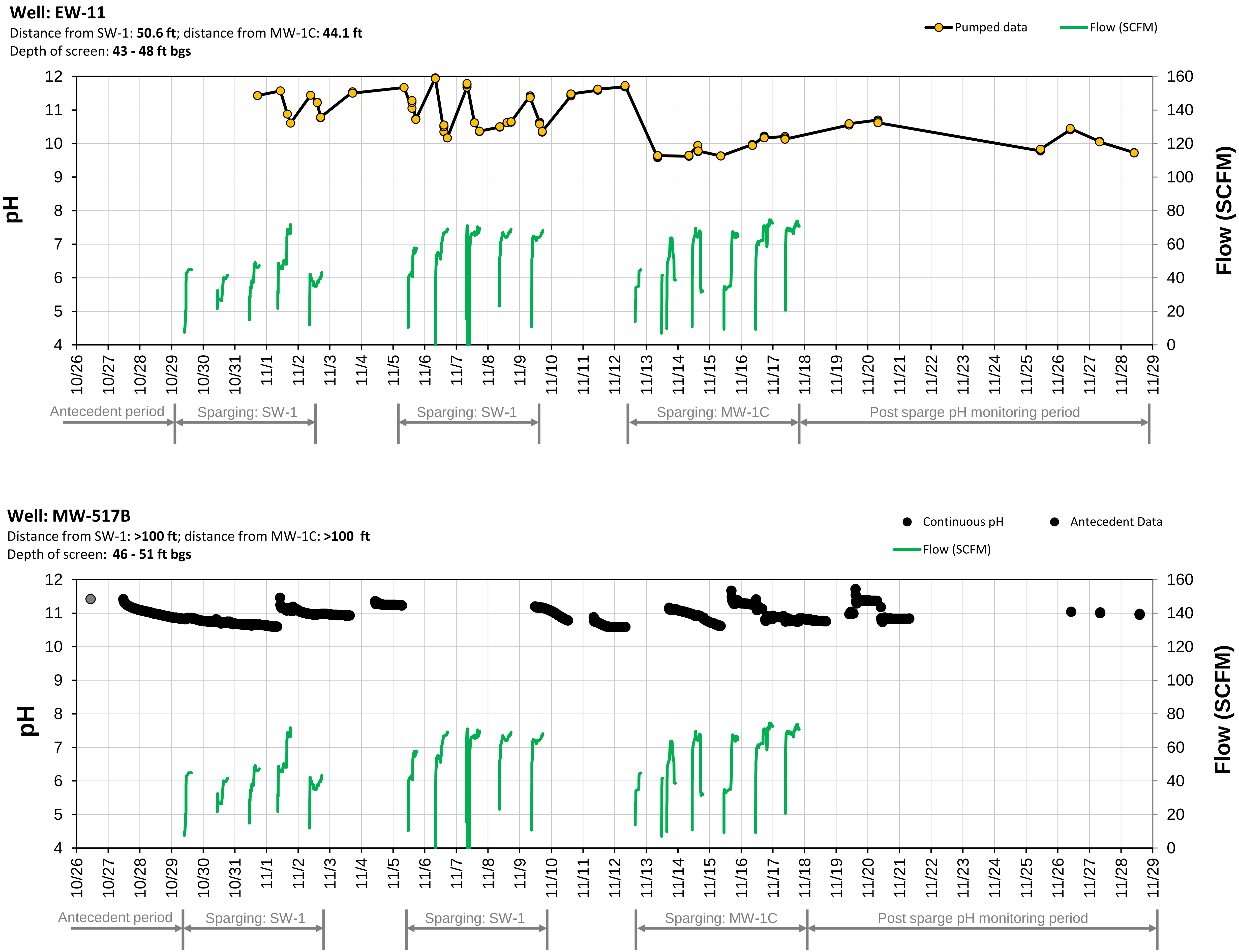
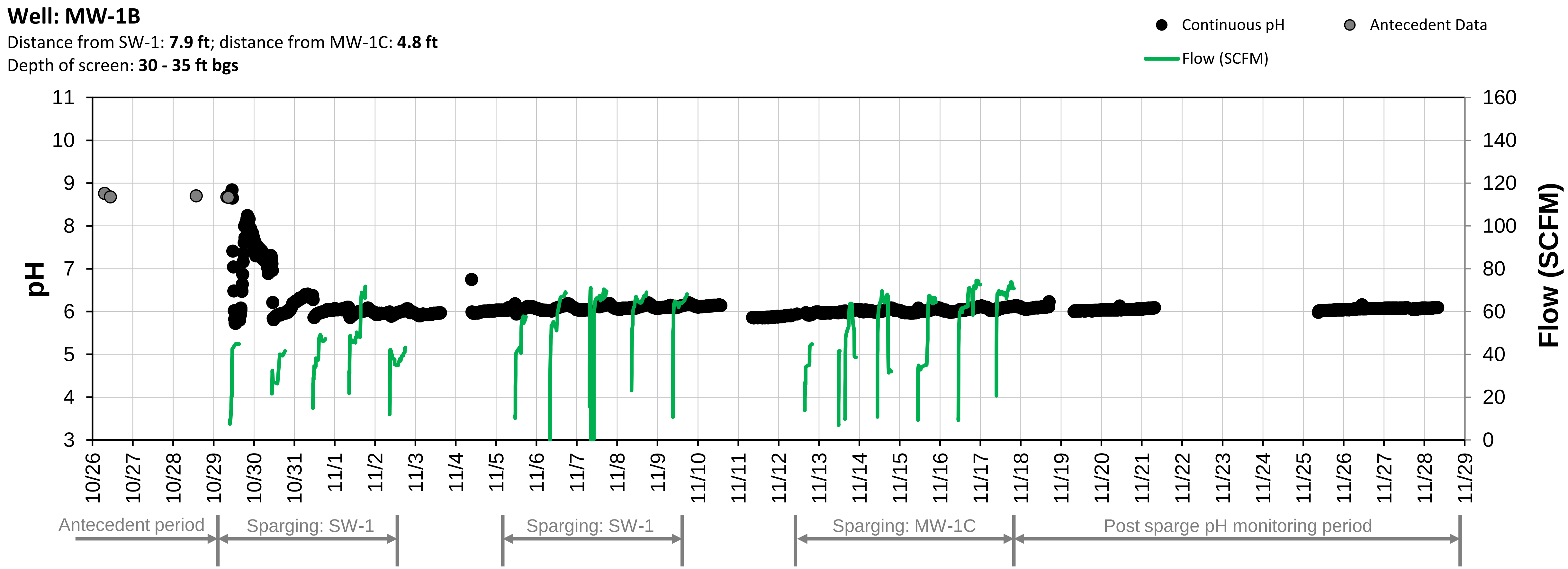


Figure 4-6

Continuous pH data for EW-11 & MW-517B

LCP Chemical Site, Brunswick, GA

Mutch Associates, LLC
Environmental Engineers and Scientists



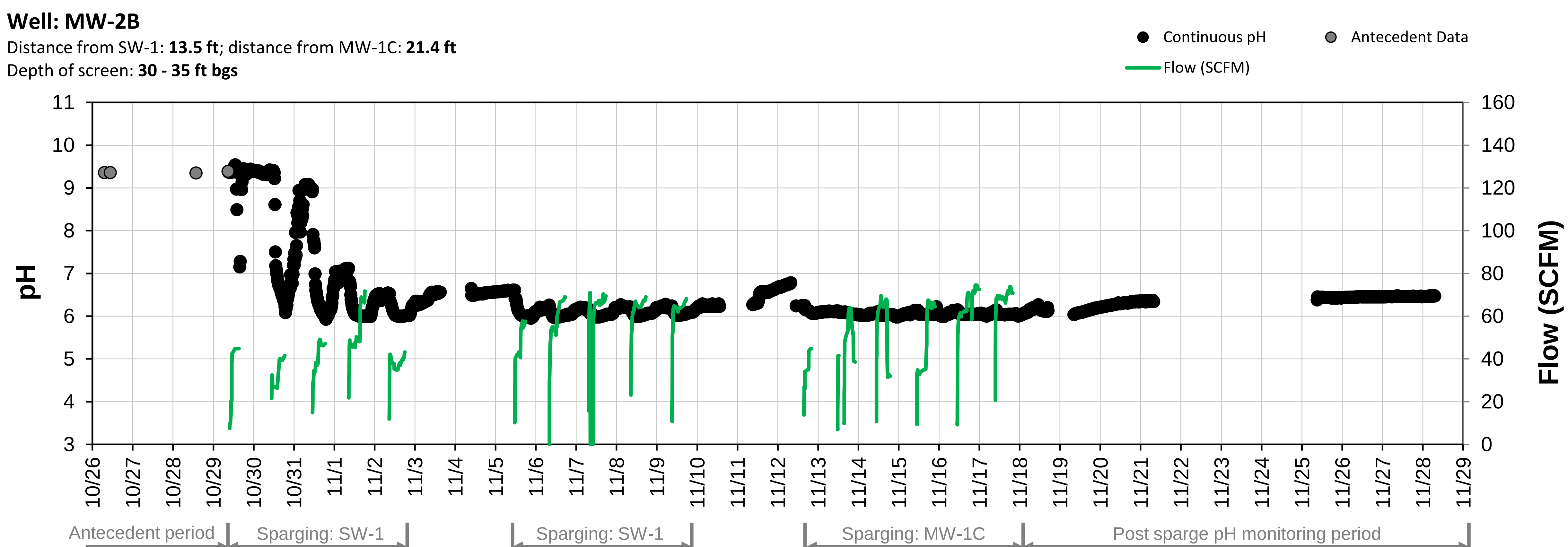


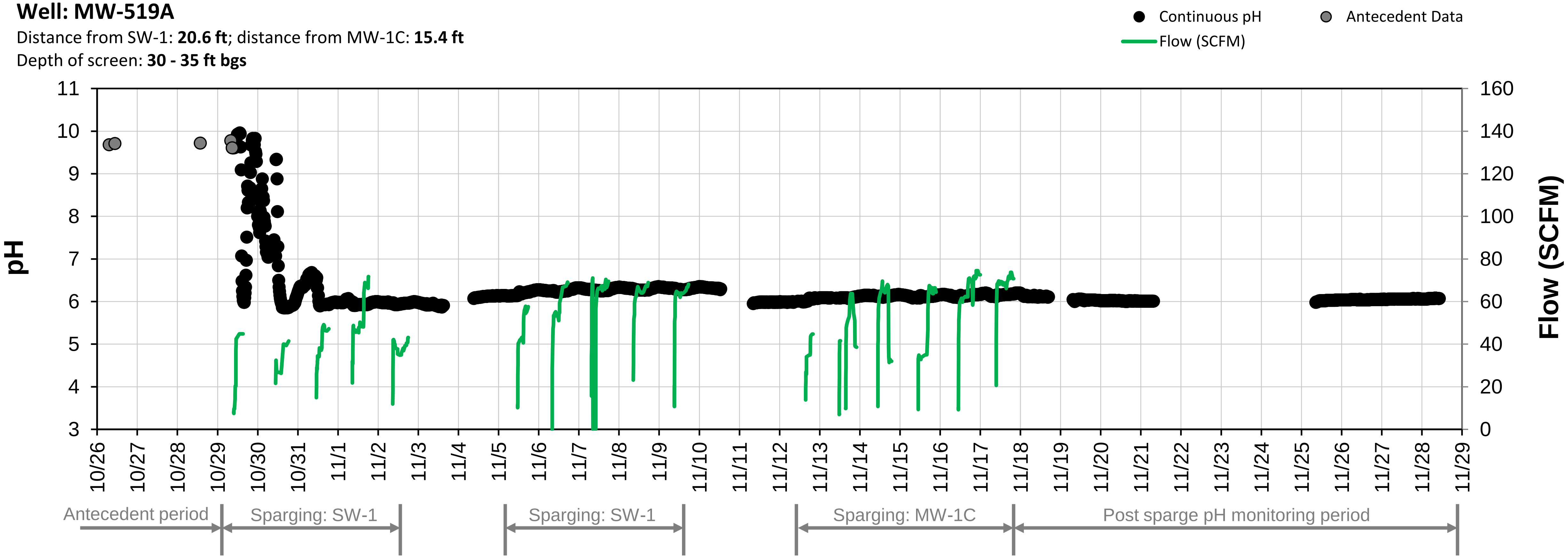
Figure 4-7

Continuous pH data for
MW-1B & MW-2B

LCP Chemical Site, Brunswick, GA

Mutch Associates, LLC
Environmental Engineers and Scientists

Well: MW-519A
Distance from SW-1: **20.6 ft**; distance from MW-1C: **15.4 ft**
Depth of screen: **30 - 35 ft bgs**



Well: MW-115B
Distance from SW-1: **25.7 ft**; distance from MW-1C: **33.1 ft**
Depth of screen: **27 - 30 ft bgs**

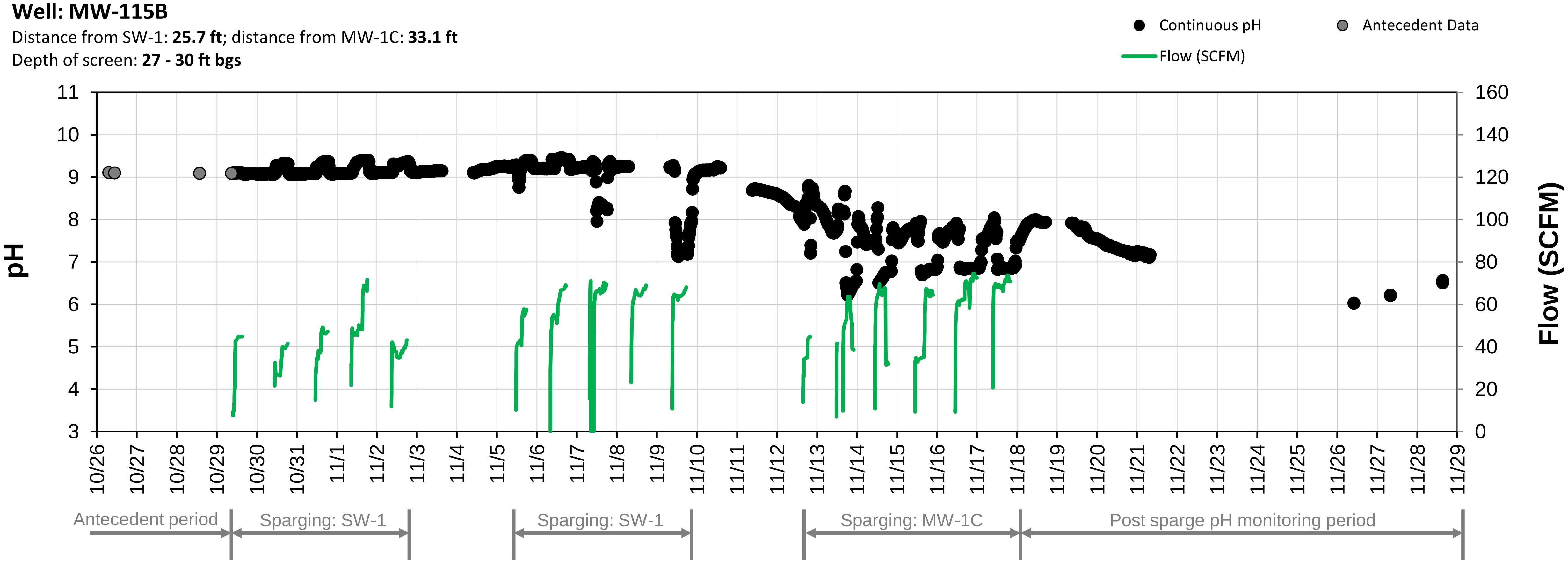


Figure 4-8

Continuous pH data for MW-519A & MW-115B

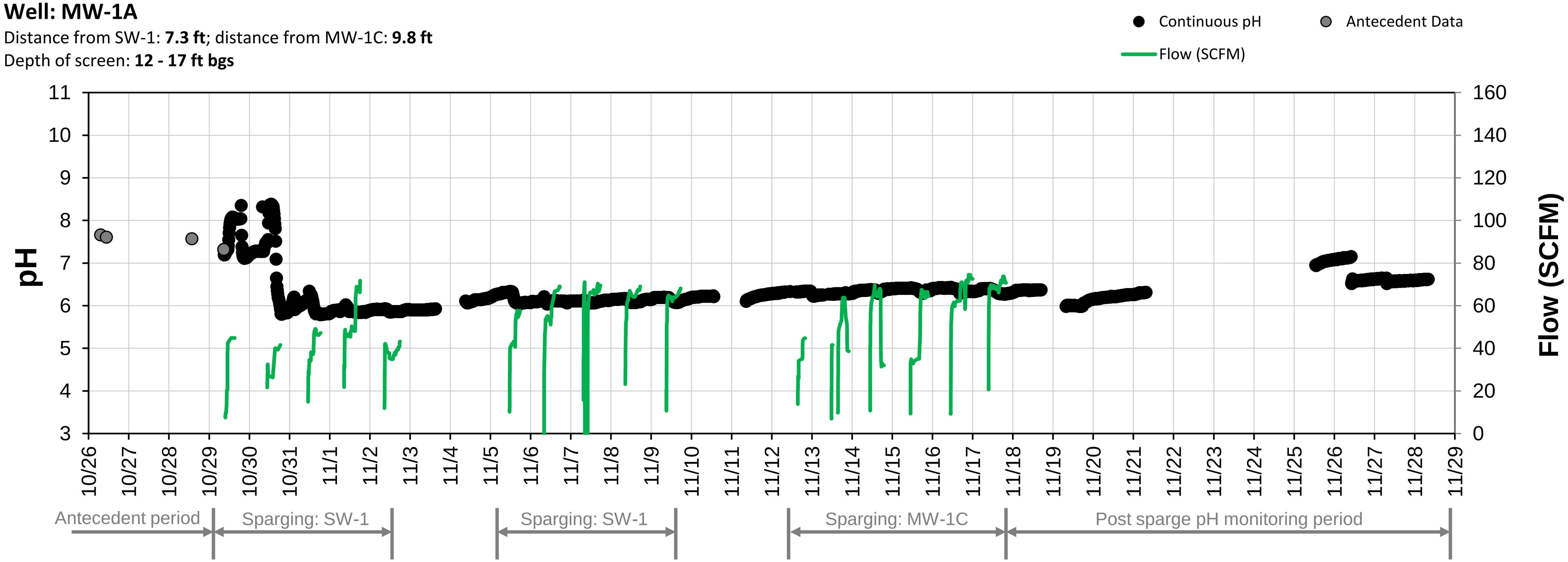
LCP Chemical Site, Brunswick, GA

Mutch Associates, LLC
Environmental Engineers and Scientists

Well: MW-1A

Distance from SW-1: **7.3 ft**; distance from MW-1C: **9.8 ft**

Depth of screen: **12 - 17 ft bgs**



Well: MW-2A

Distance from SW-1: **13.1 ft;** distance from MW-1C: **21.3 ft**

Depth of screen: **12 - 17 ft bgs**

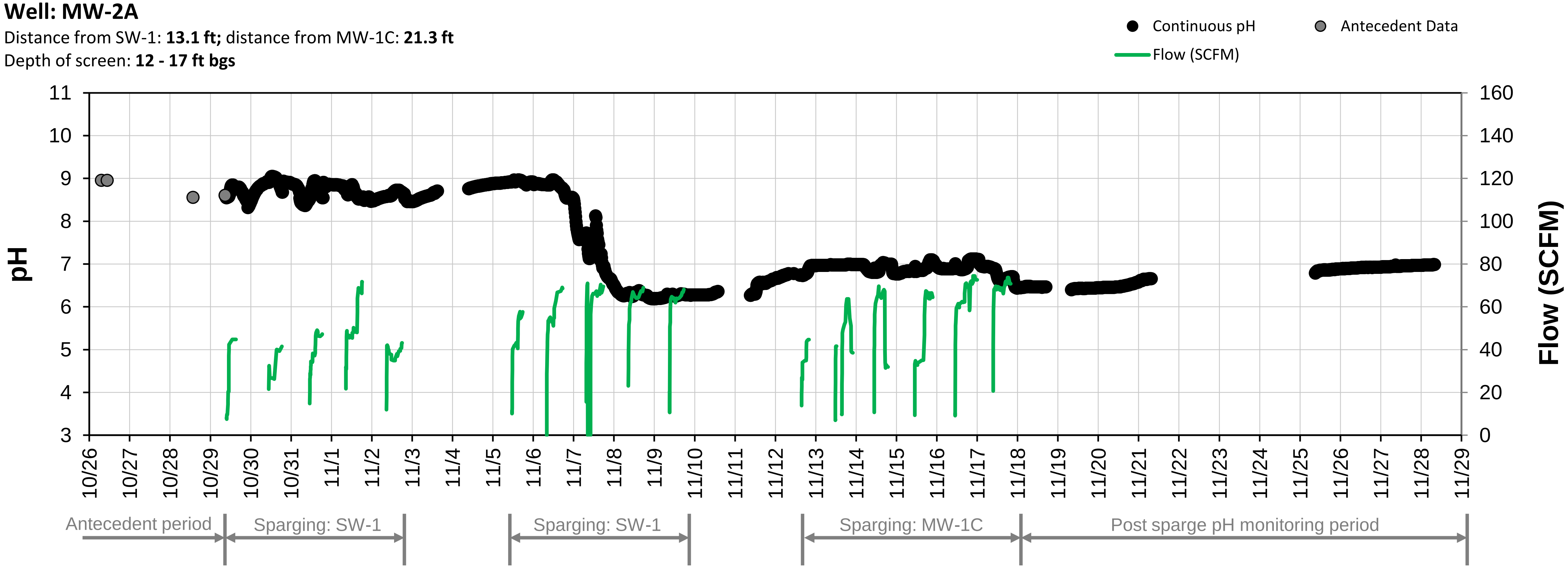


Figure 4-9

Continuous pH data for MW-1A & MW-2A

LCP Chemical Site, Brunswick, GA

Mutch Associates, LLC

Environmental Engineers and Scientists

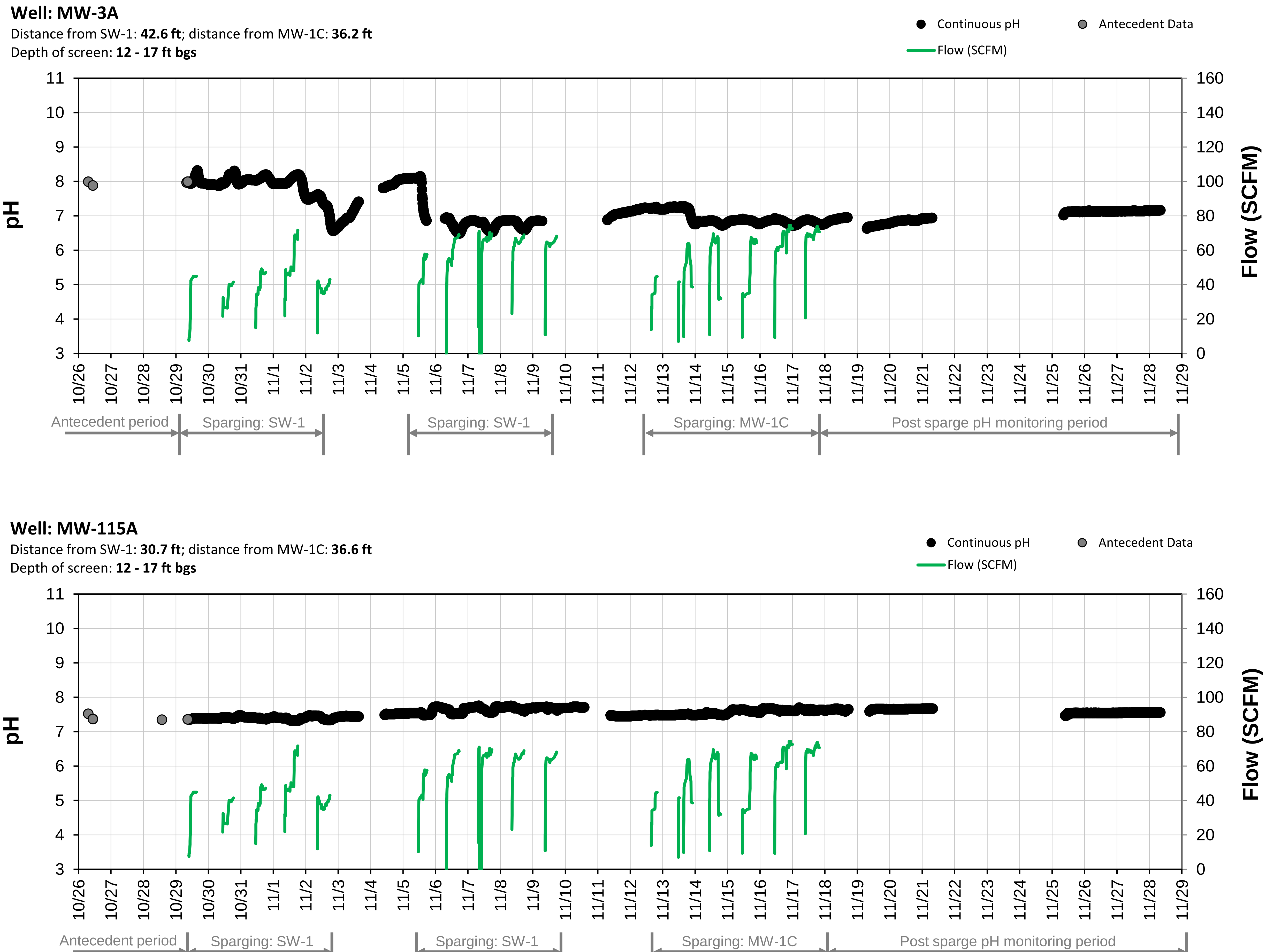


Figure 4-10

Continuous pH data for MW-3A & MW-115A

LCP Chemical Site, Brunswick, GA

Mutch Associates, LLC
Environmental Engineers and Scientists

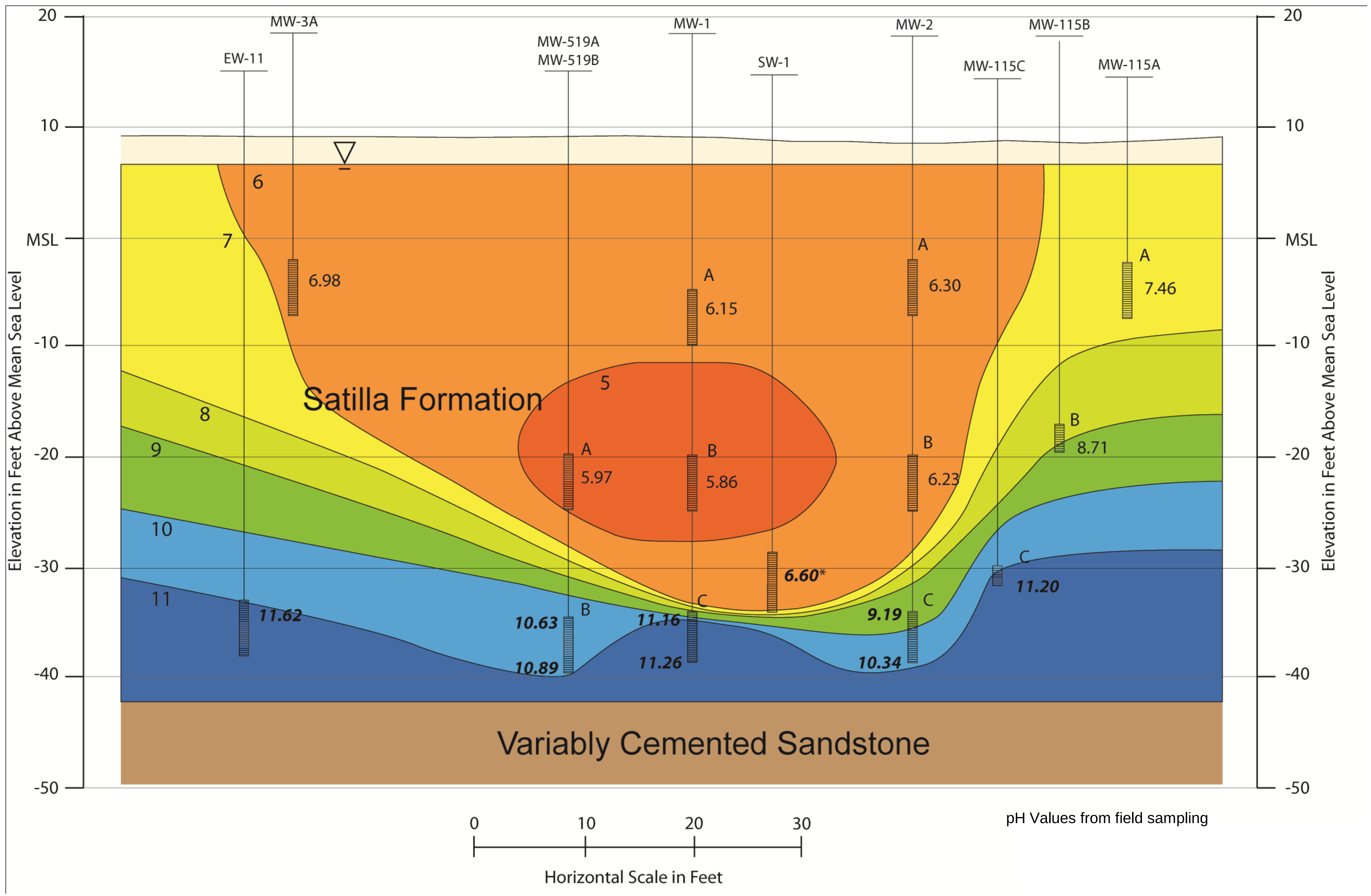


Figure 4-11
pH Levels After 2 Weeks of
Sparging into SW-1
(11/11/12 10:00 AM)

LCP Chemical Site, Brunswick, GA

Mutch Associates, LLC
Environmental Engineers and Scientists

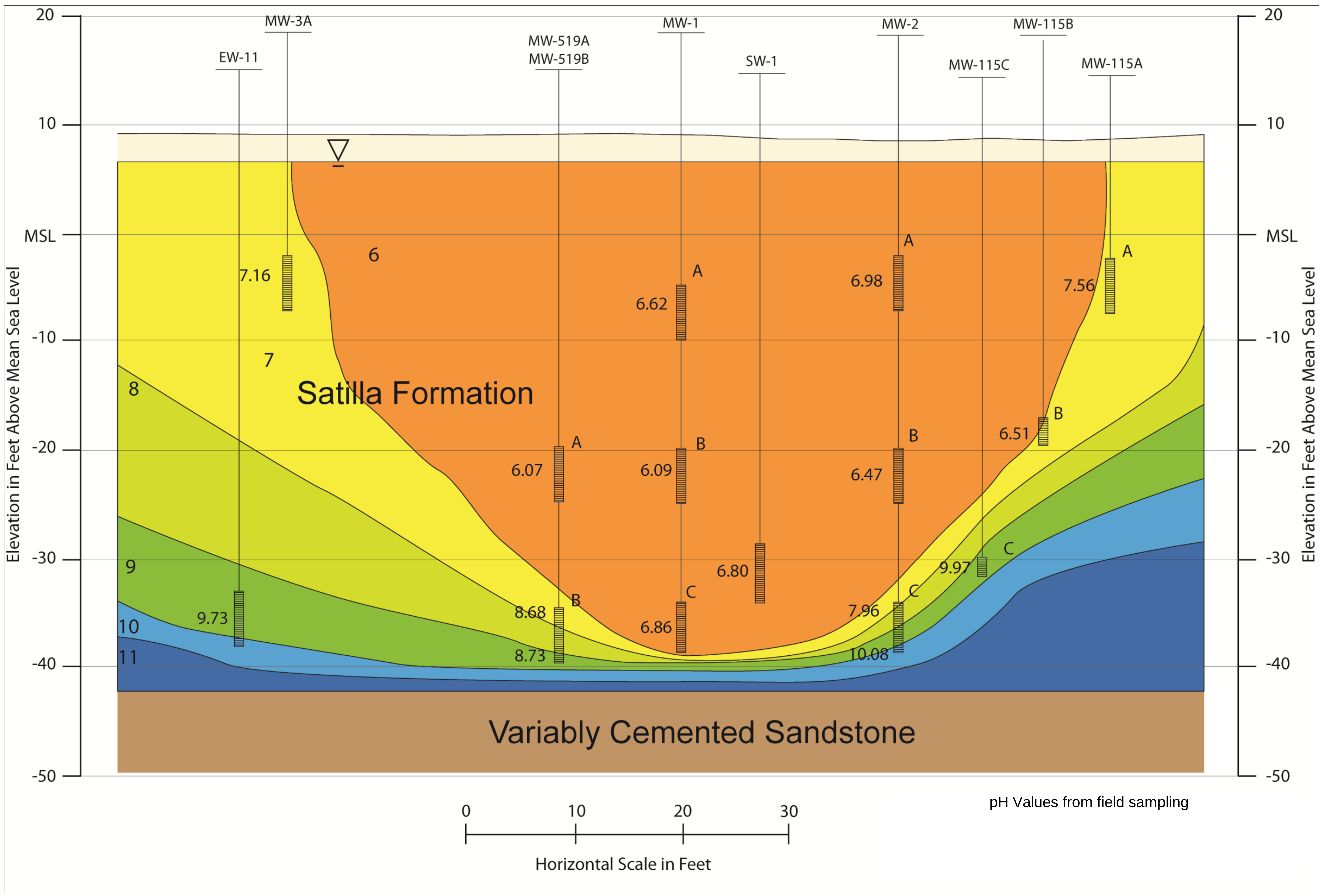
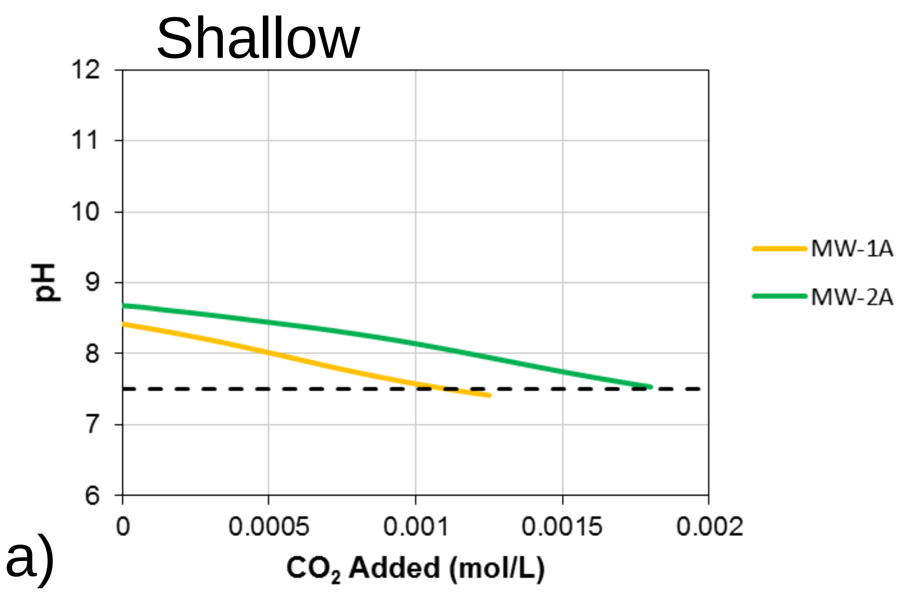
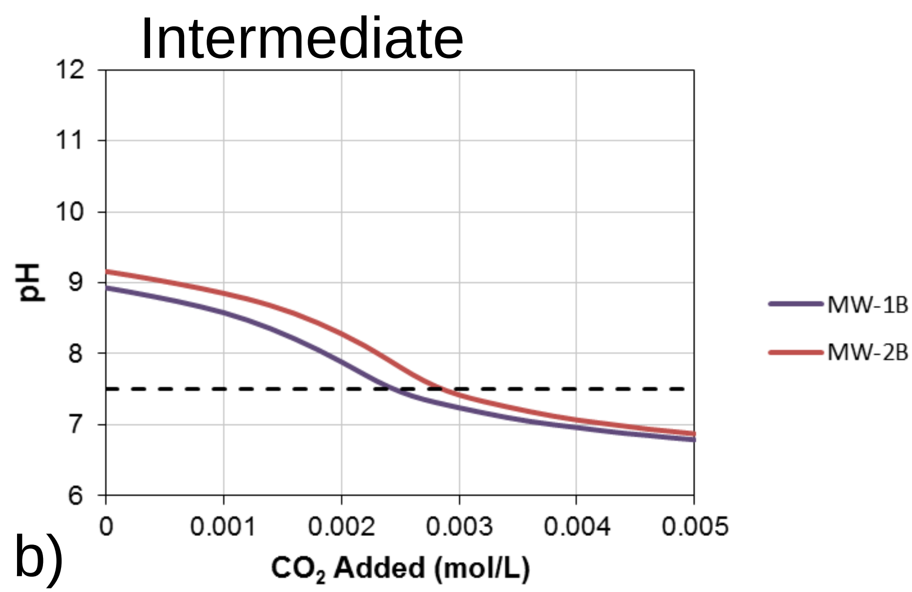


Figure 4-12
pH Levels at End of
Post-Sparge Monitoring
Period (11/28/12)

LCP Chemical Site, Brunswick, GA

Mutch Associates, LLC
Environmental Engineers and Scientists





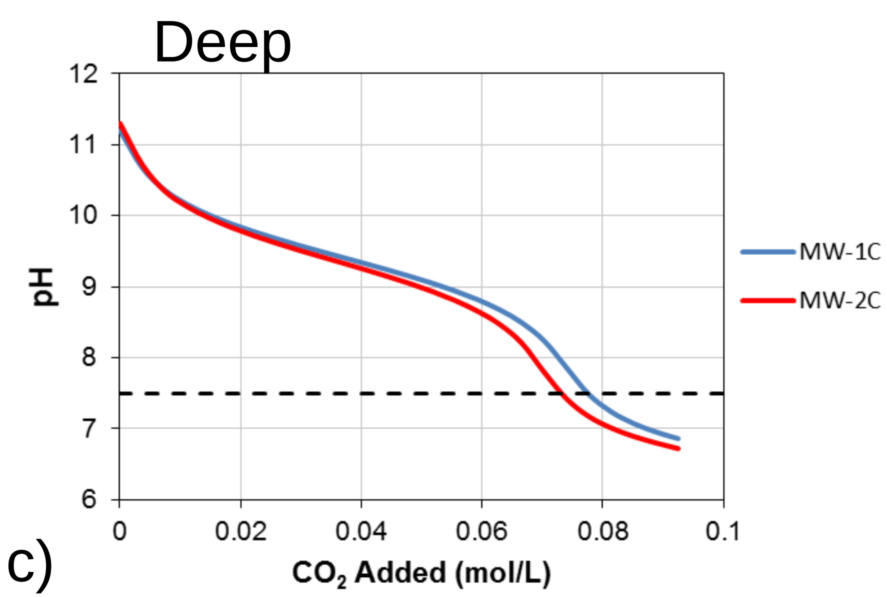


Figure 4-13

Numerical Titration of CBP water with CO_2

LCP Chemical Site, Brunswick, GA

Mutch Associates, LLC

Environmental Engineers and Scientists

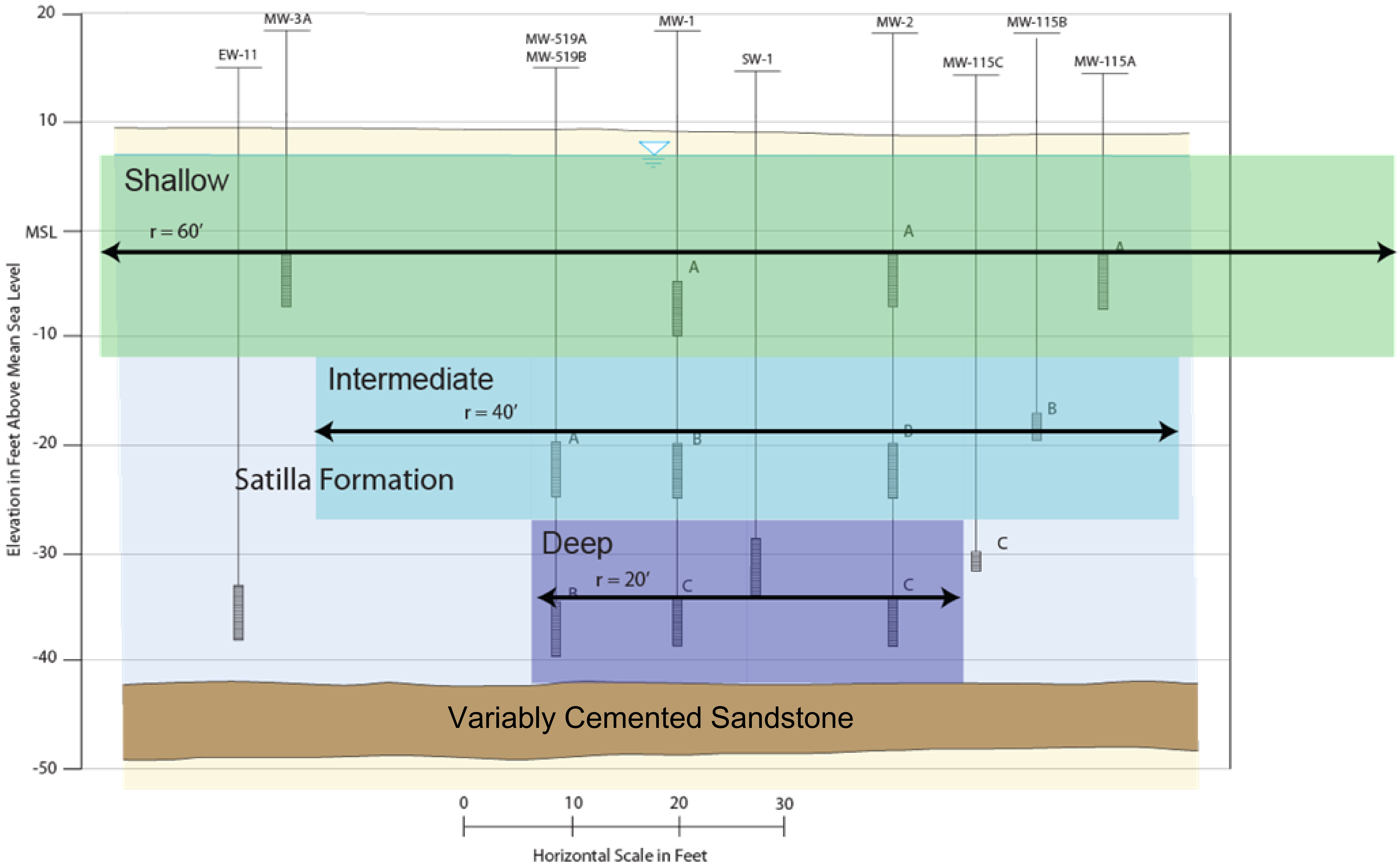


Figure 4-14
Shallow, Intermediate and Deep Satilla Zones Used for CO_2 Demand Calculations

LCP Chemical Site, Brunswick, GA

Mutch Associates, LLC
Environmental Engineers and Scientists

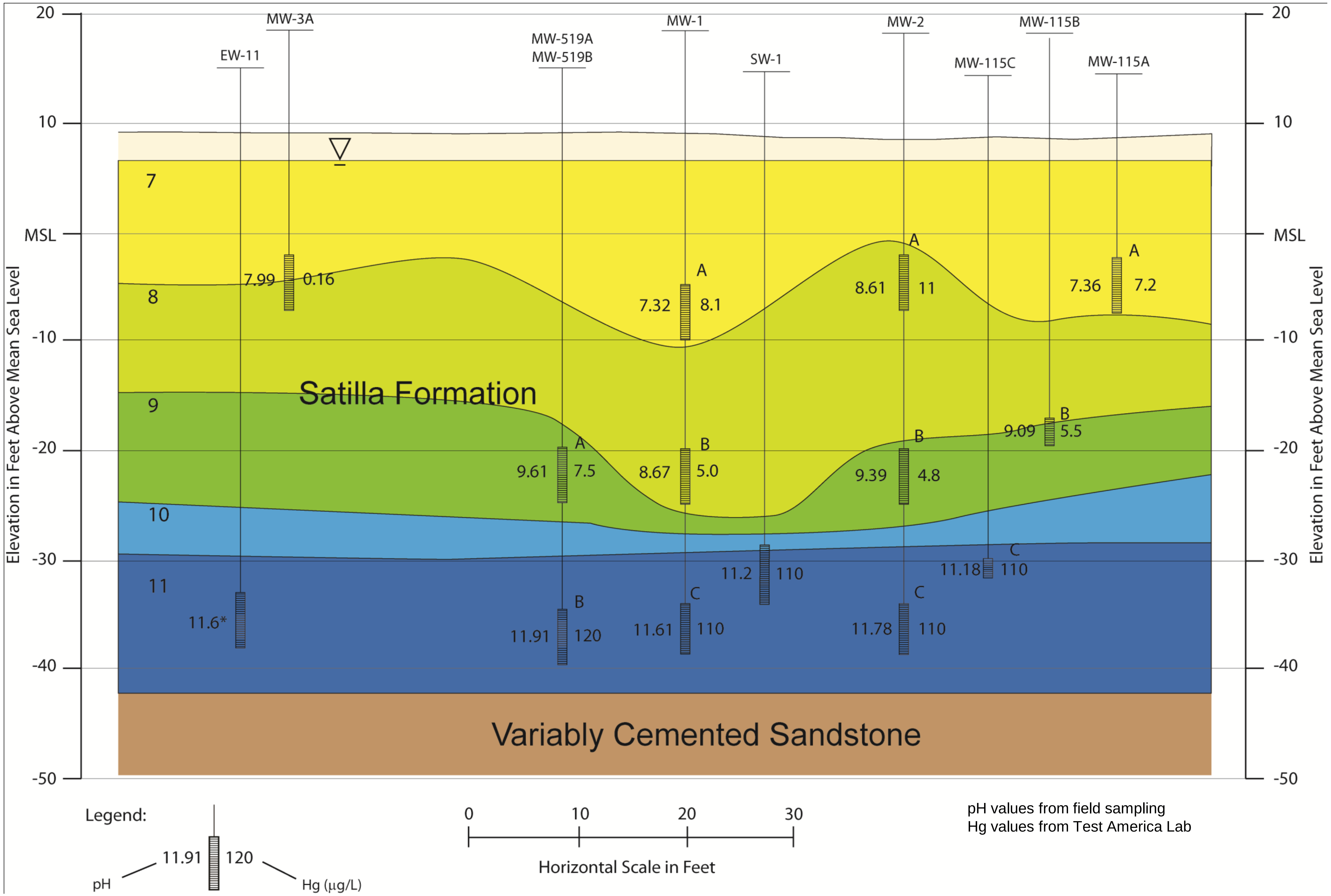
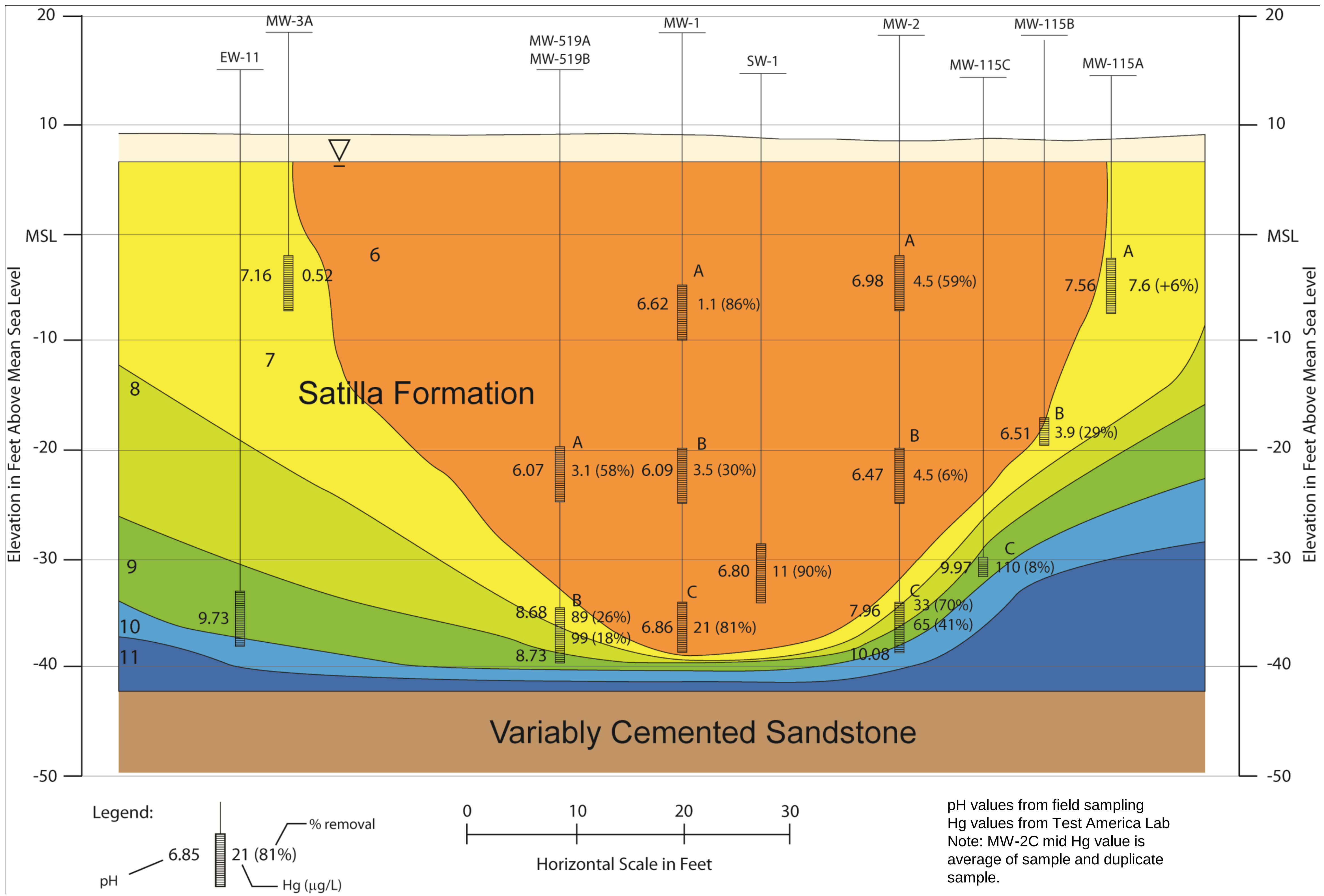


Figure 4-15

Pre-sparge pH and Mercury Concentrations

LCP Chemical Site, Brunswick, GA

Mutch Associates, LLC
Environmental Engineers and Scientists



pH values from field sampling
Hg values from Test America Lab
Note: MW-2C mid Hg value is average of sample and duplicate sample.

Figure 4-16
Post-Sparge pH and Mercury Concentrations
(pH 11/28/12, Hg 11/26/12)

LCP Chemical Site, Brunswick, GA

Mutch Associates, LLC
Environmental Engineers and Scientists

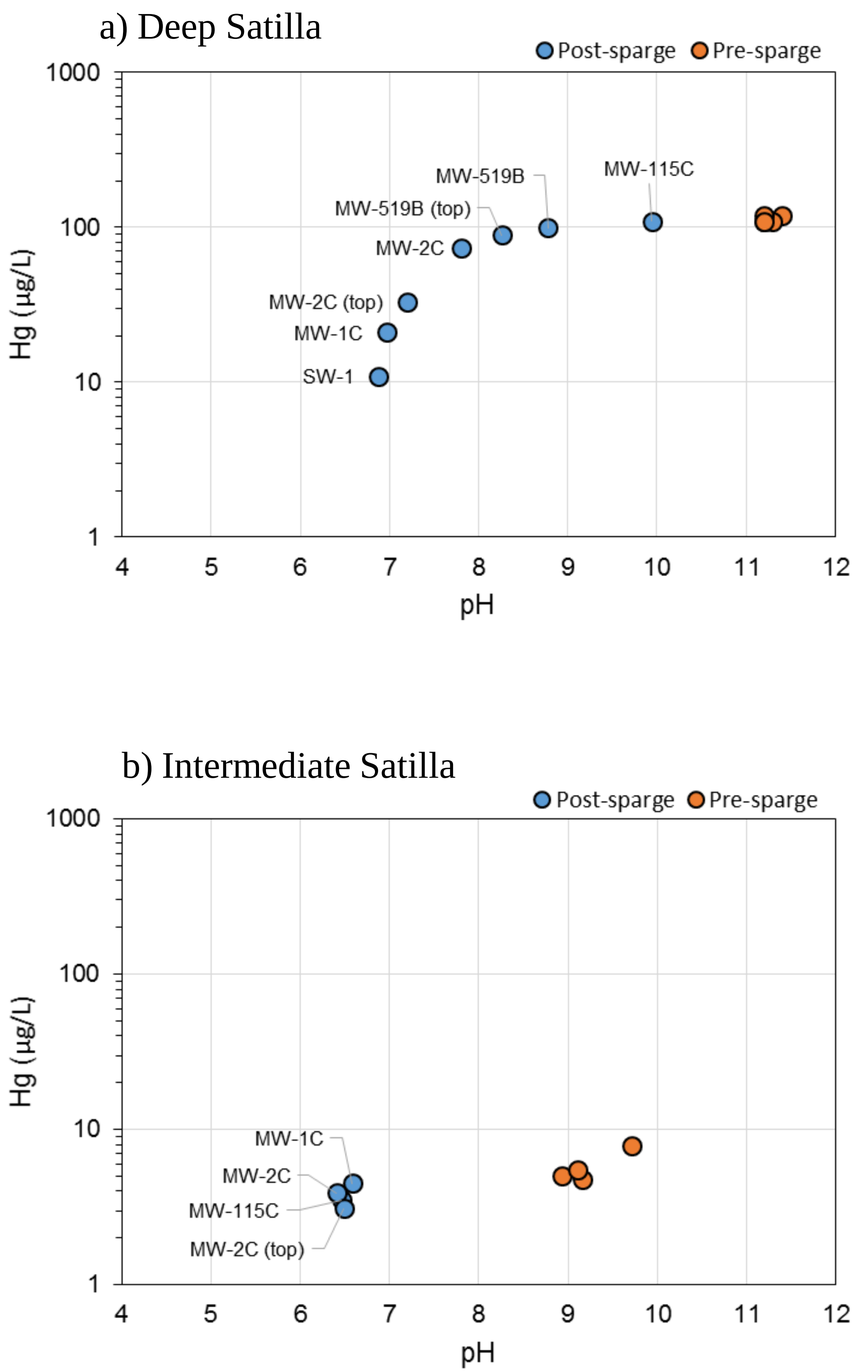
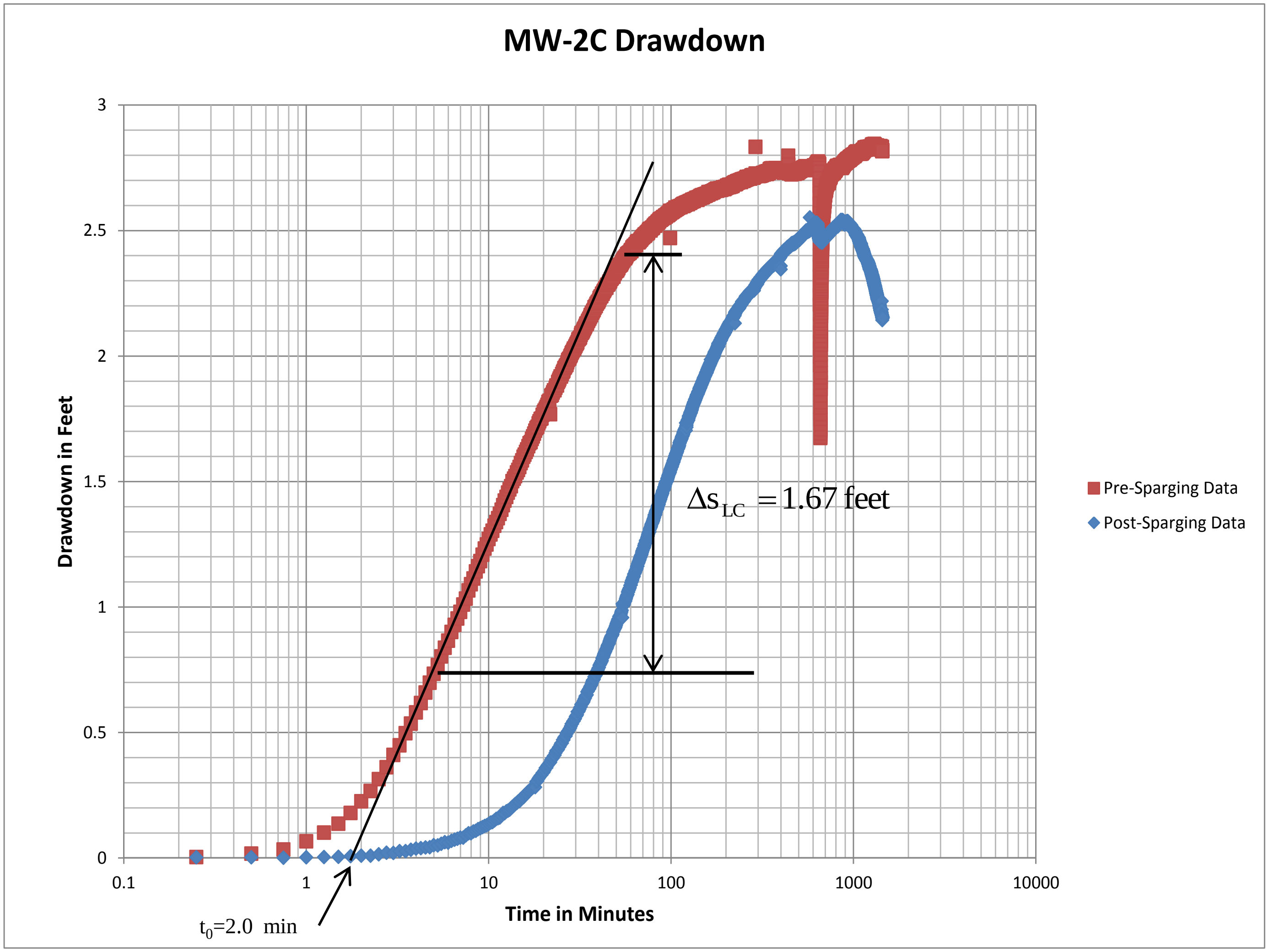


Figure 4-17
Mercury Concentration
Versus pH in a) Deep and b)
Intermediate Satilla Wells

LCP Chemical Site, Brunswick, GA

Mutch Associates, LLC
Environmental Engineers and Scientists

r=13.1 feet
Q=7.2 gpm



$$T = \frac{264Q}{\Delta s_{LC}} = \frac{264(7.2)}{1.67}$$

$$T = 1{,}150 \text{ gpd/ft}$$

$$S = \frac{Tt_0}{4800r^2} = \frac{1{,}150 \text{ gpd/ft}(2.0 \text{ min})}{4800(13.1 \text{ ft})^2}$$

$$S = 2.8x10^{-3}$$

Figure 4-18

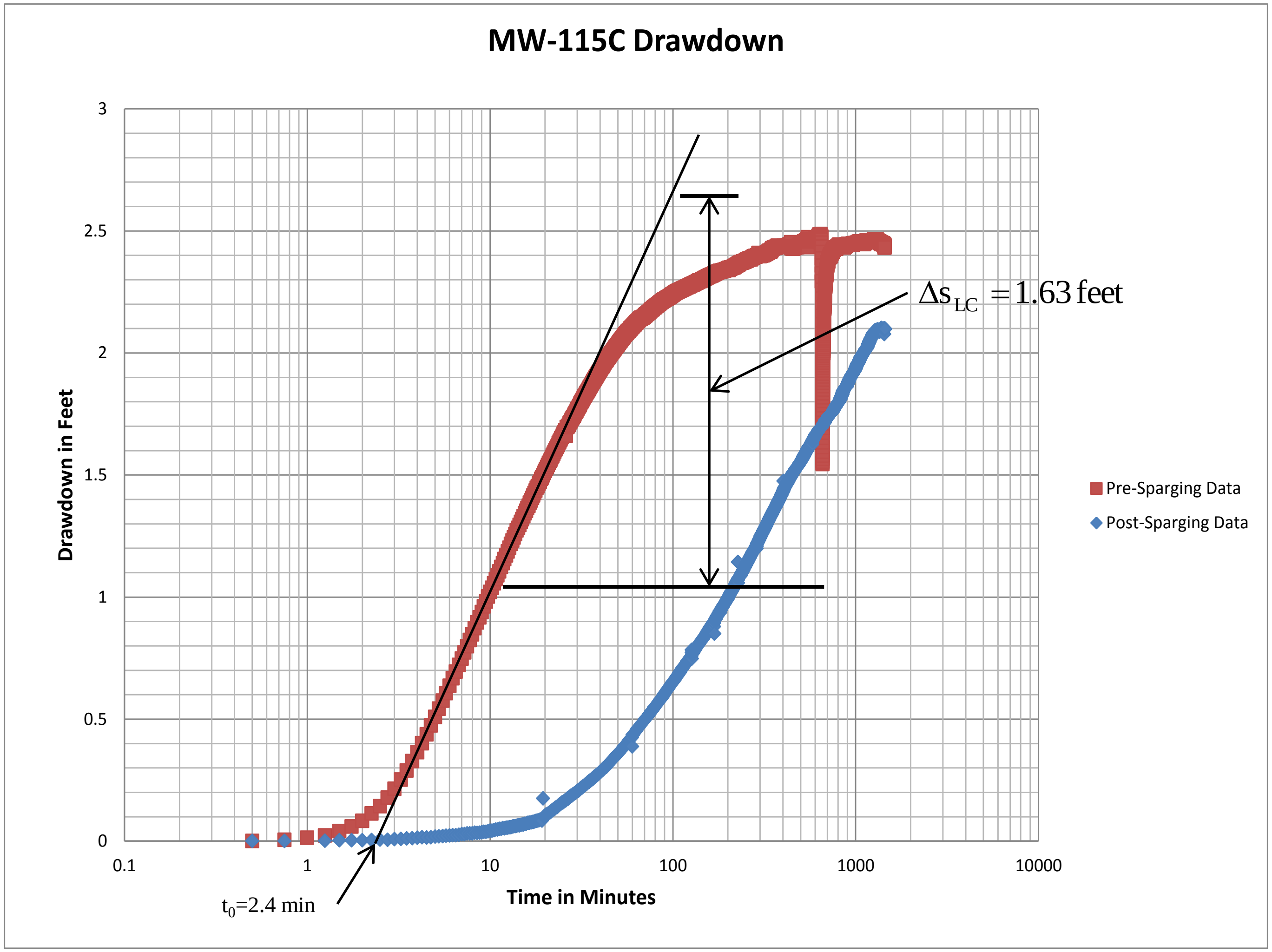
Cooper-Jacob Time-Drawdown Analysis of Early-Time Data from Well MW-2C

LCP Chemical Site, Brunswick, GA

Mutch Associates, LLC

Environmental Engineers and Scientists

r=18.7 feet
Q=7.2 gpm



$$T = \frac{264Q}{\Delta s_{LC}} = \frac{264(7.2)}{1.63}$$

$$T = 1{,}150 \text{ gpd/ft}$$

$$S = \frac{Tt_0}{4800r^2} = \frac{1{,}150 \text{ gpd/ft}(2.4 \text{ min})}{4800(18.7 \text{ ft})^2}$$

$$S = 1.6x10^{-3}$$

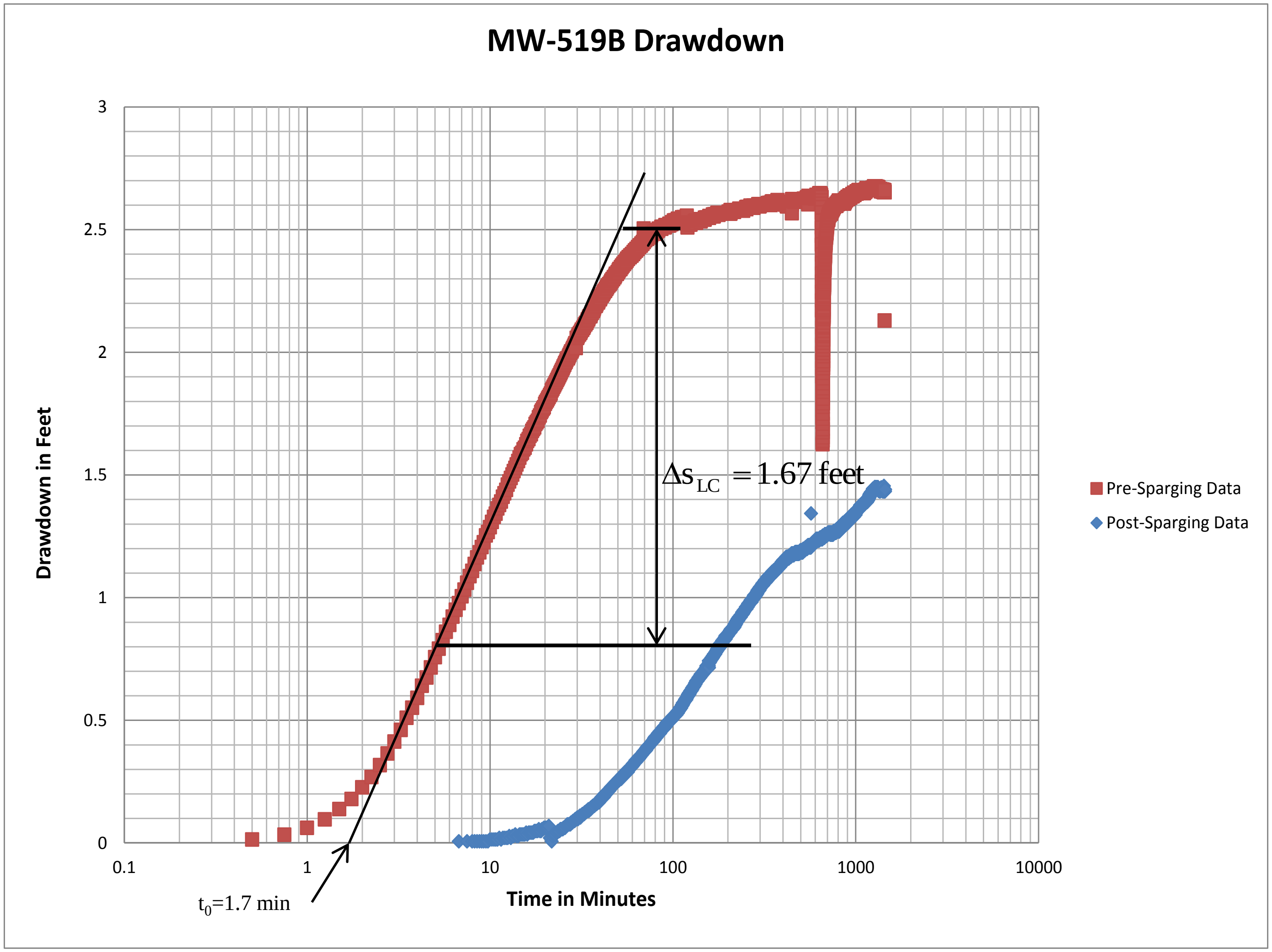
Figure 4-19

Cooper-Jacob Time-Drawdown Analysis of Early-Time Data from Well MW-115C

LCP Chemical Site, Brunswick, GA

Mutch Associates, LLC
Environmental Engineers and Scientists

r=20.6 feet
Q=7.2 gpm



$$T = \frac{264Q}{\Delta s_{LC}} = \frac{264(7.2)}{1.67}$$

$$T = 1{,}150 \text{ gpd/ft}$$

$$S = \frac{Tt_0}{4800r^2} = \frac{1{,}150 \text{ gpd/ft}(1.7 \text{ min})}{4800(20.6 \text{ ft})^2}$$

$$S = 9.6x10^{-4}$$

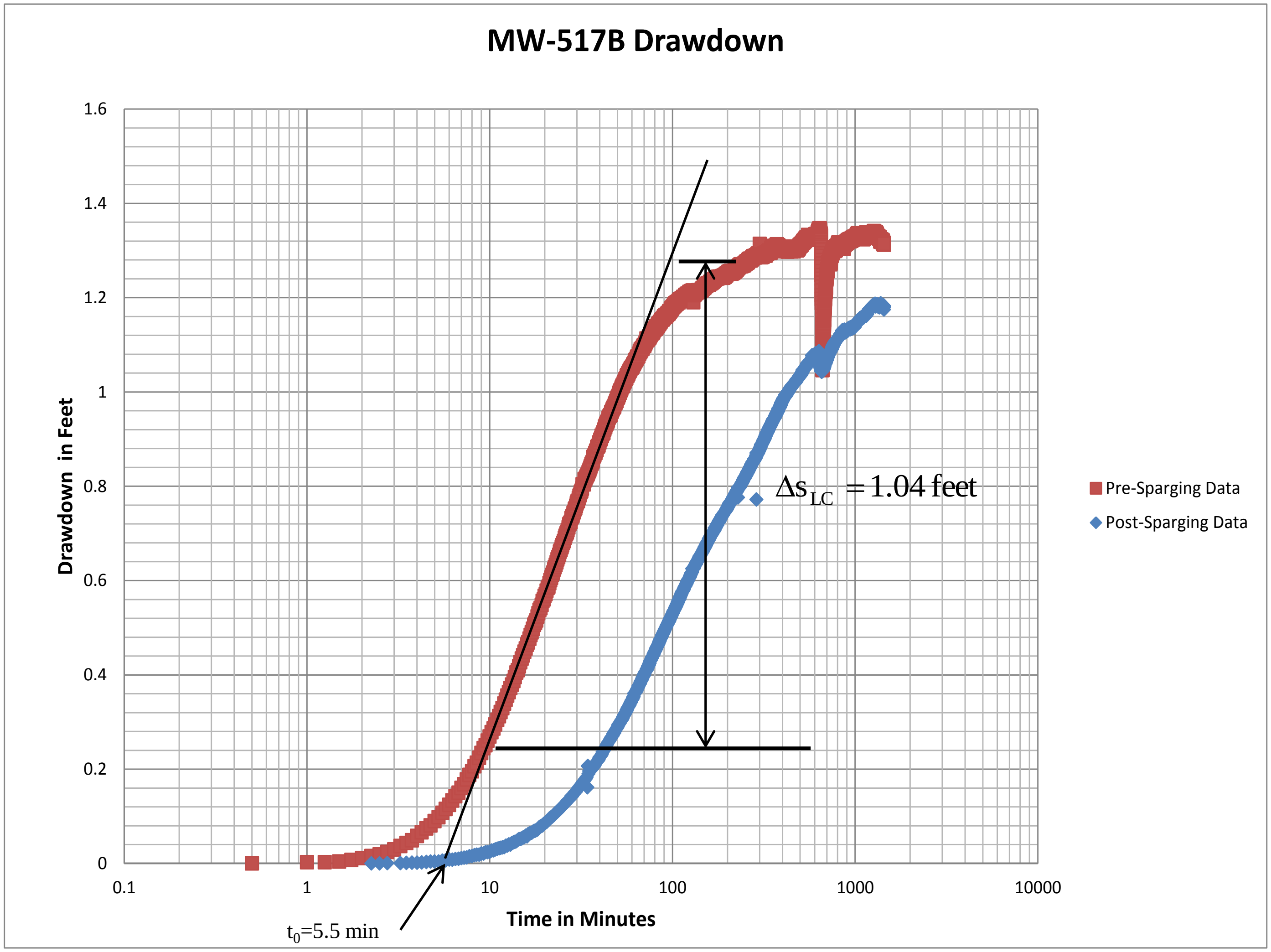
Figure 4-20

Cooper-Jacob Time-Drawdown Analysis of Early-Time Data from Well MW-519B

LCP Chemical Site, Brunswick, GA

Mutch Associates, LLC
Environmental Engineers and Scientists

r=104.9 feet
Q=7.2 gpm



$$T = \frac{264Q}{\Delta s_{LC}} = \frac{264(7.2)}{1.04}$$

$$T = 1{,}825 \text{ gpd/ft}$$

$$S = \frac{Tt_0}{4800r^2} = \frac{1{,}825 \text{ gpd/ft}(5.5 \text{ min})}{4800(104.9 \text{ ft})^2}$$

$$S = 1.9x10^{-4}$$

Figure 4-21

Cooper-Jacob Time-Drawdown Analysis of Early-Time Data from Well MW-517B

LCP Chemical Site, Brunswick, GA

Mutch Associates, LLC
Environmental Engineers and Scientists

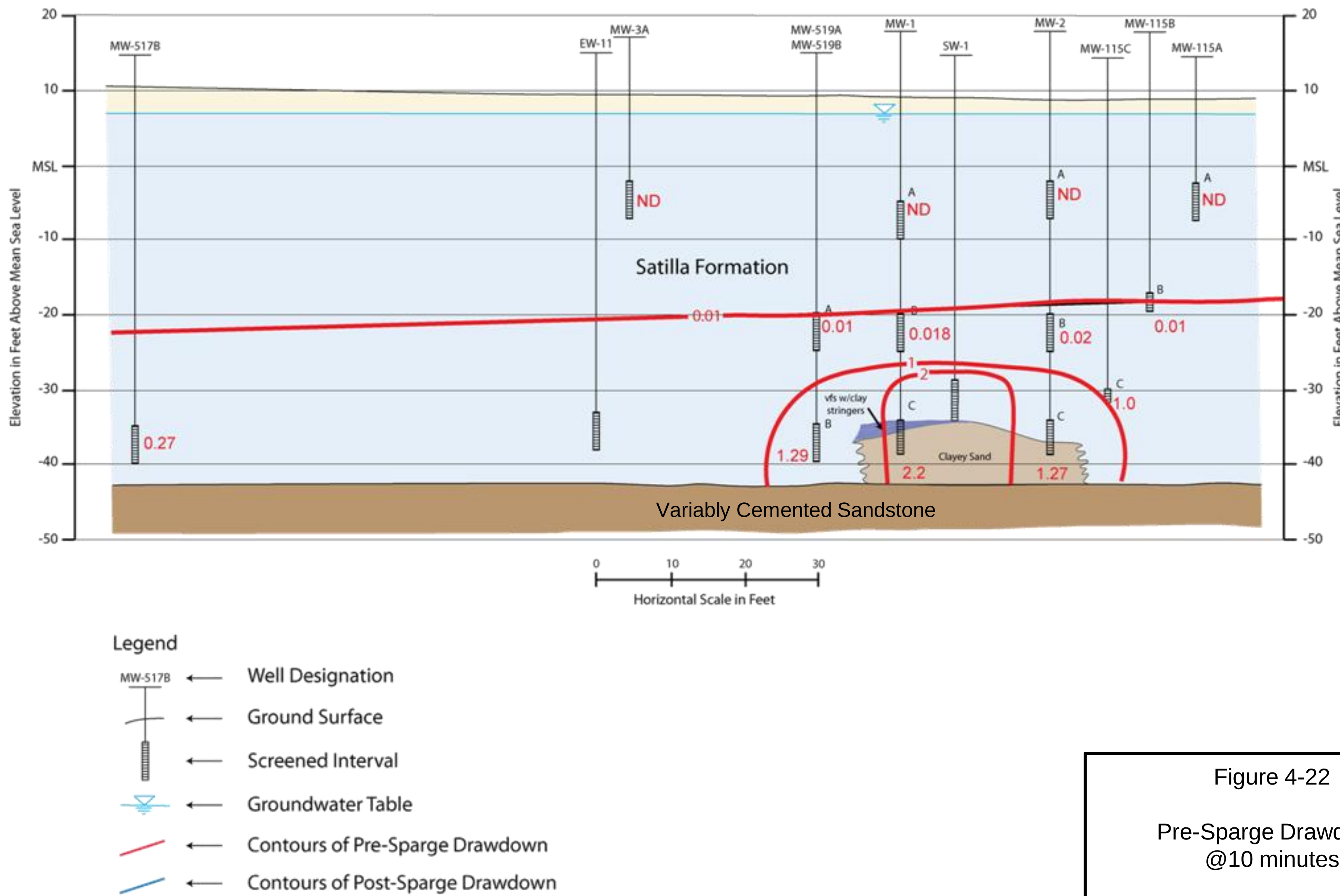
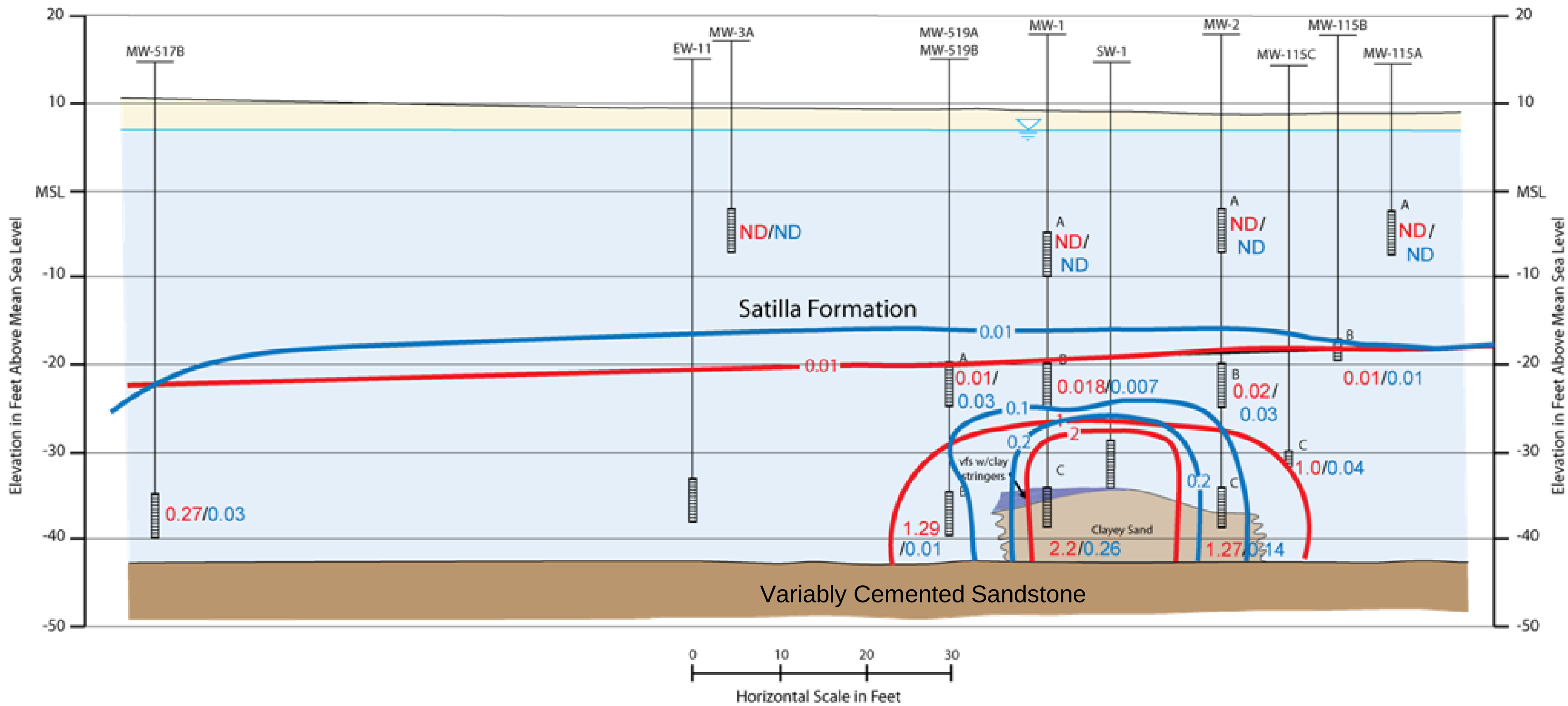


Figure 4-22

Pre-Sparge Drawdown
@10 minutes

LCP Chemical Site, Brunswick, GA

Mutch Associates, LLC
Environmental Engineers and Scientists



Legend

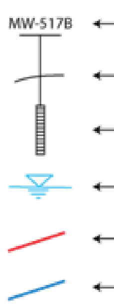
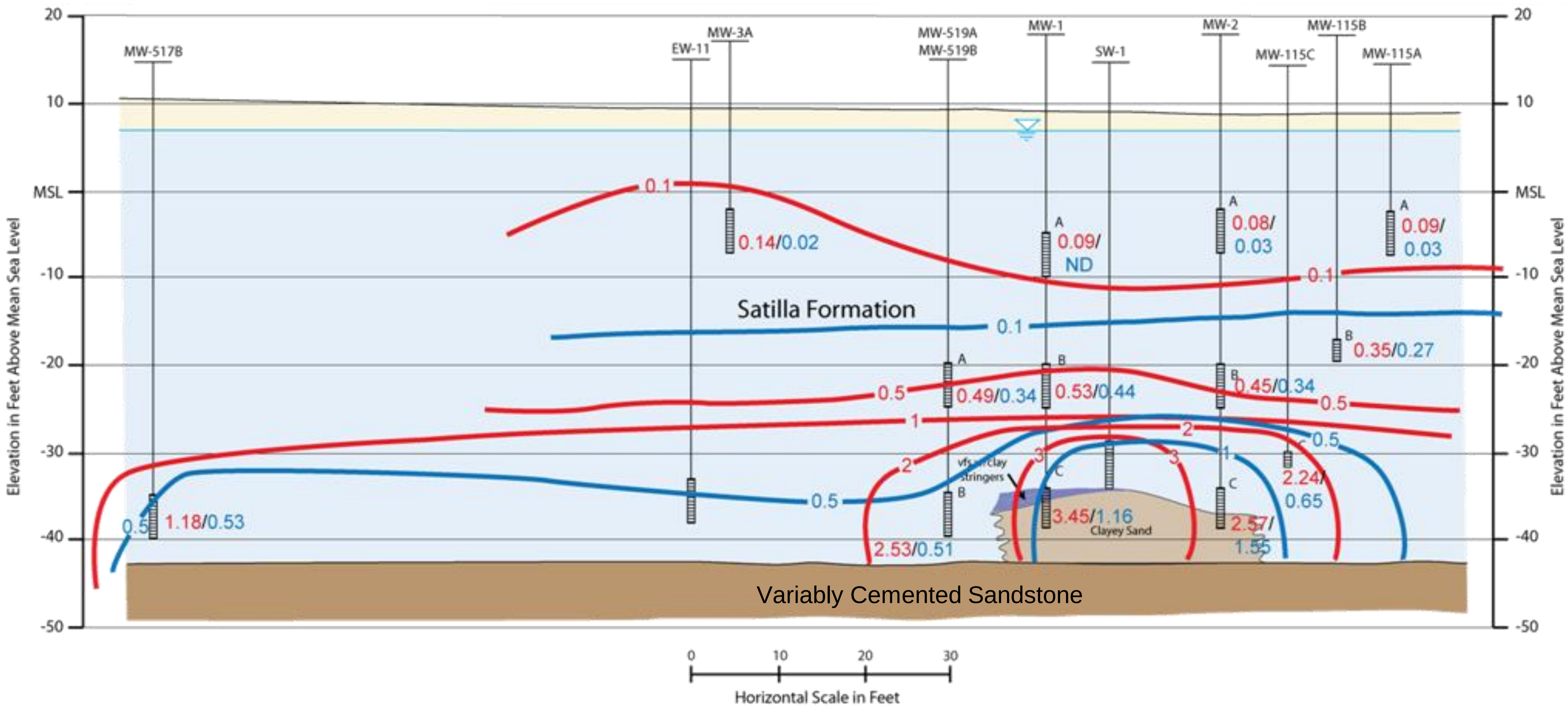


Figure 4-23

Pre- and Post-Sparge Drawdown @10 minutes

LCP Chemical Site, Brunswick, GA

Mutch Associates, LLC
Environmental Engineers and Scientists



Legend

MW-517B	←	Well Designation
	←	Ground Surface
	←	Screened Interval
	←	Groundwater Table
	←	Contours of Pre-Sparge Drawdown
	←	Contours of Post-Sparge Drawdown

Figure 4-24

Pre- and Post-Sparge Drawdown @100 minutes

LCP Chemical Site, Brunswick, GA

Mutch Associates, LLC
Environmental Engineers and Scientists

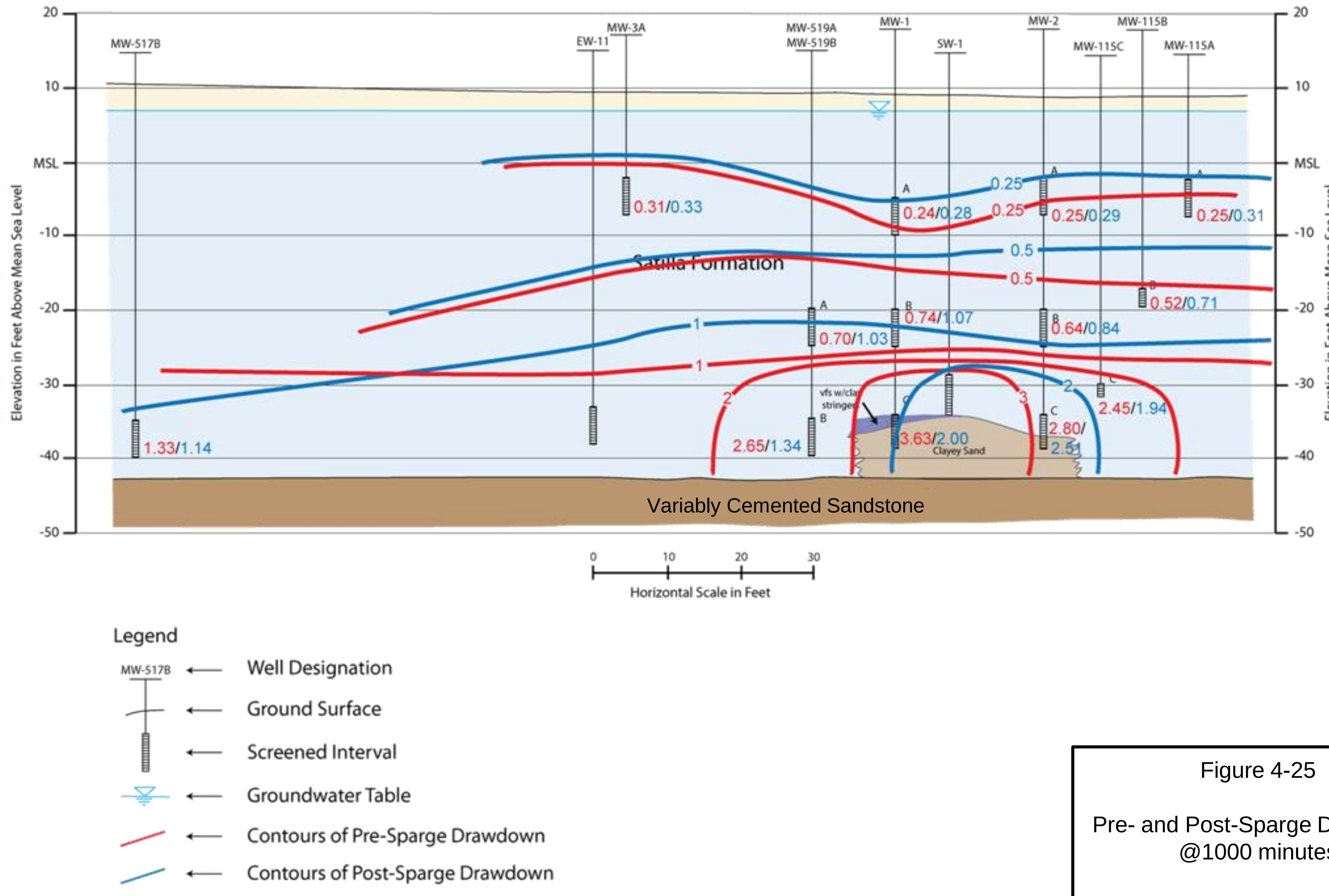
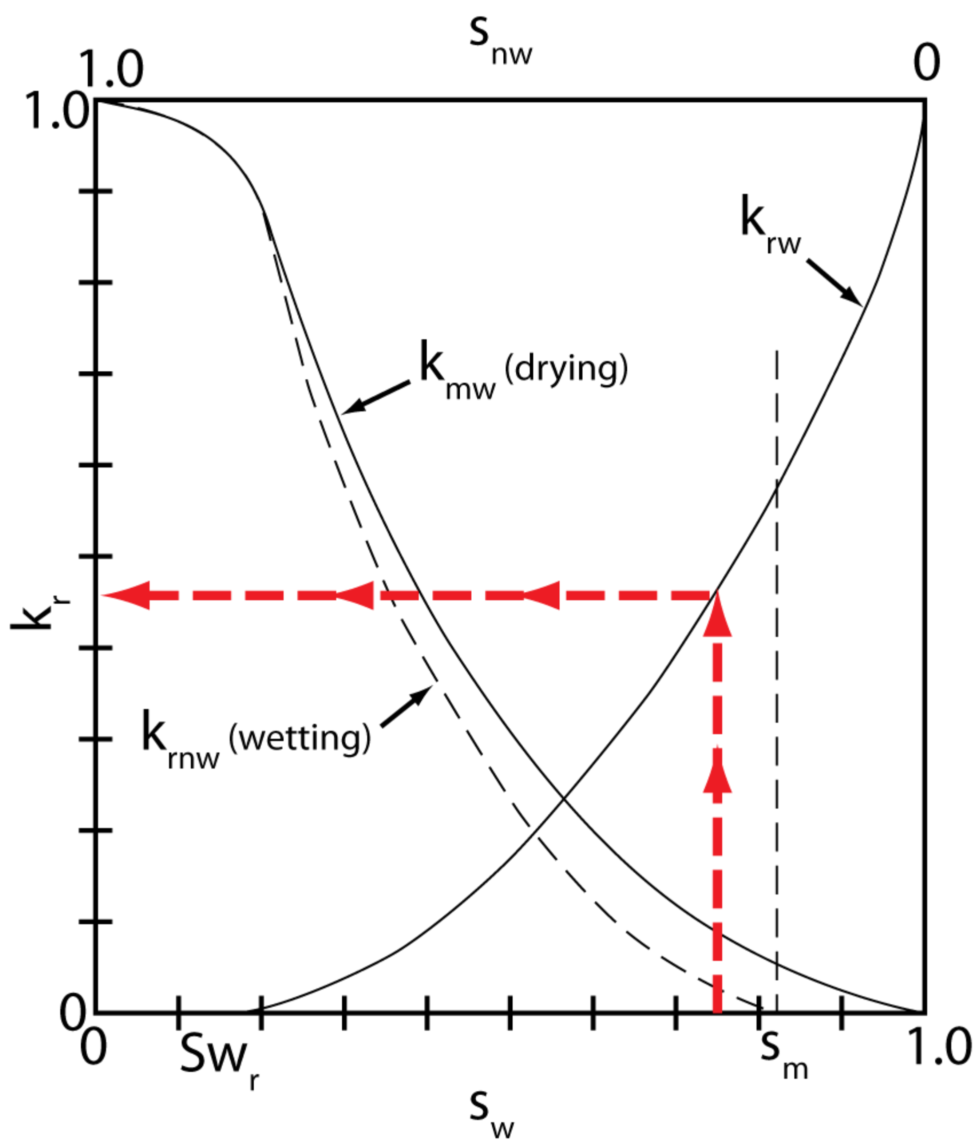


Figure 4-25

Pre- and Post-Sparge Drawdown @1000 minutes

LCP Chemical Site, Brunswick, GA

Mutch Associates, LLC
Environmental Engineers and Scientists



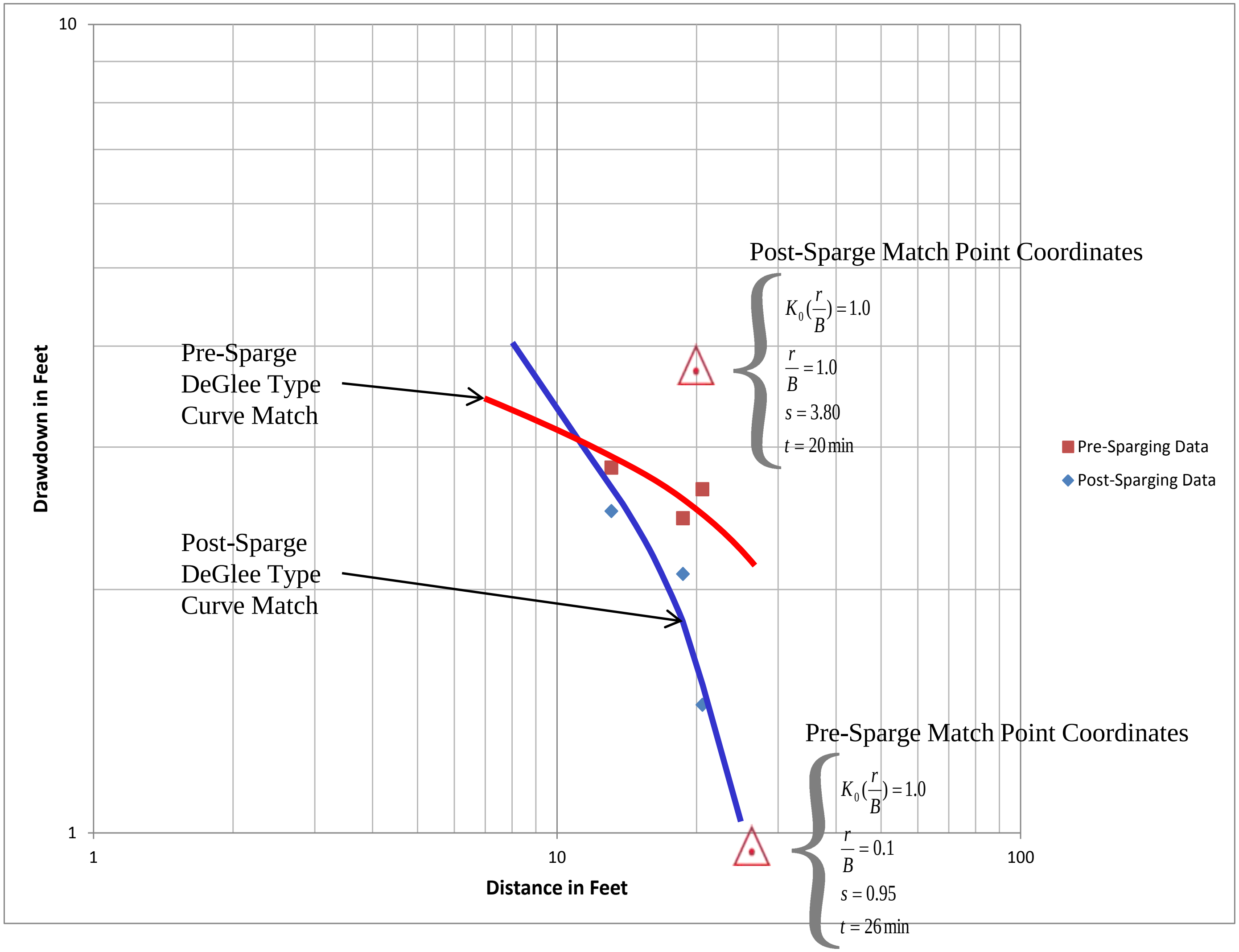
(Adapted from Pankow and Cherry, 1995)

Figure 4-26

Typical Reflective Permeability Curves

LCP Chemical Site, Brunswick, GA

Mutch Associates, LLC
Environmental Engineers and Scientists



<u>Pre-Sparge Transmissivity</u>

$$T = \frac{229QK_0(\frac{r}{B})}{s} = \frac{229(7.5\,gpm)1.0}{0.95\,feet}$$

$$T = 1{,}800\,gpd/ft$$

<u>Post-Sparge Transmissivity</u>

$$T = \frac{229QK_0(\frac{r}{B})}{s} = \frac{229(7.5\,gpm)1.0}{3.80\,feet}$$

$$T = 450\,gpd/ft$$

Figure 4-27
DeGlee Method
Distance-Drawdown Analysis
of Wells in Principal
Hydrostratigraphic Zone
LCP Chemical Site, Brunswick, GA

Mutch Associates, LLC
Environmental Engineers and Scientists

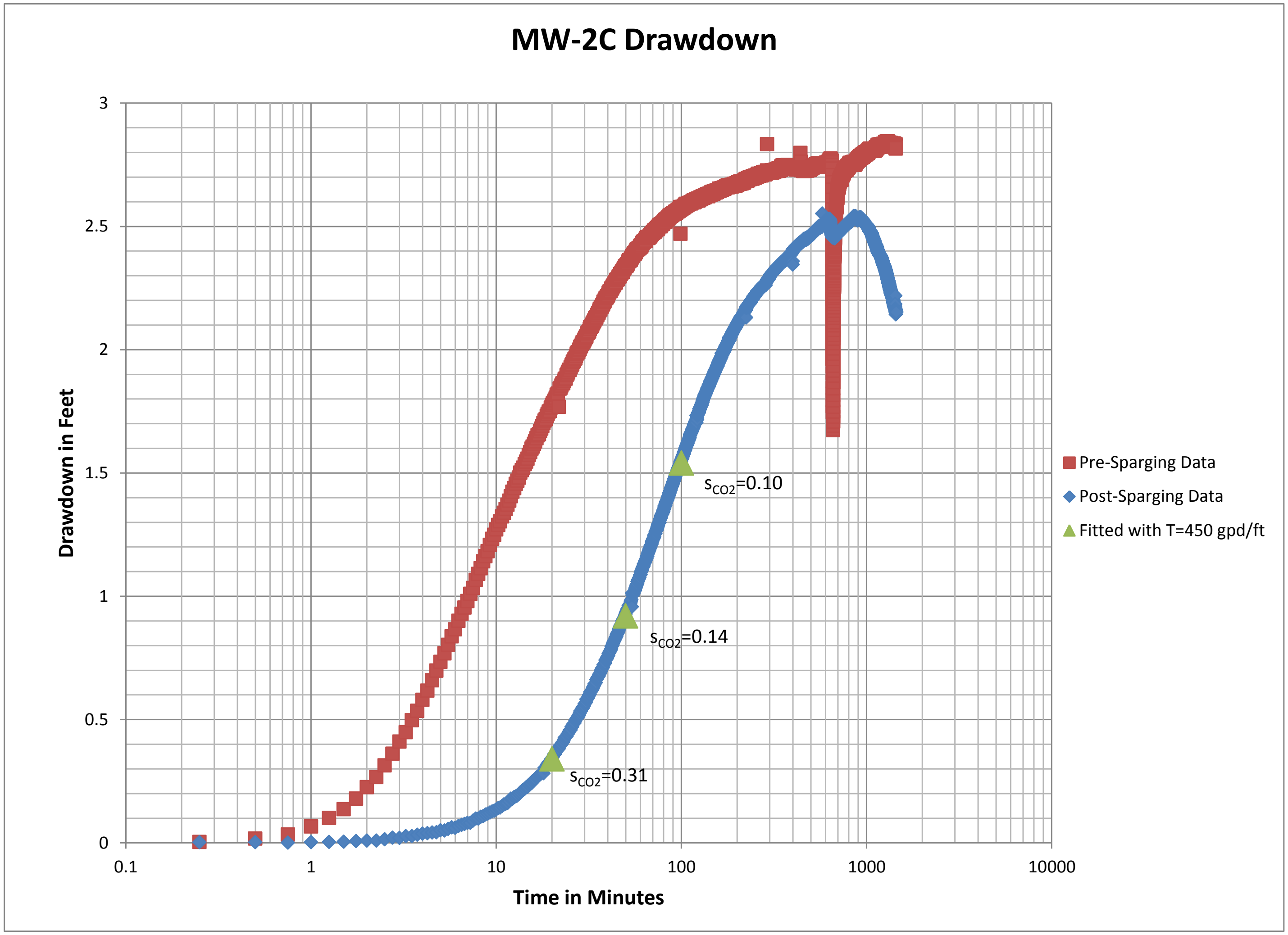


Figure 4-28
Predicted CO_2 Residual Saturations by Matching Drawdown in MW-2C using the Modified Storativity Equation
LCP Chemical Site, Brunswick, GA

Mutch Associates, LLC
Environmental Engineers and Scientists

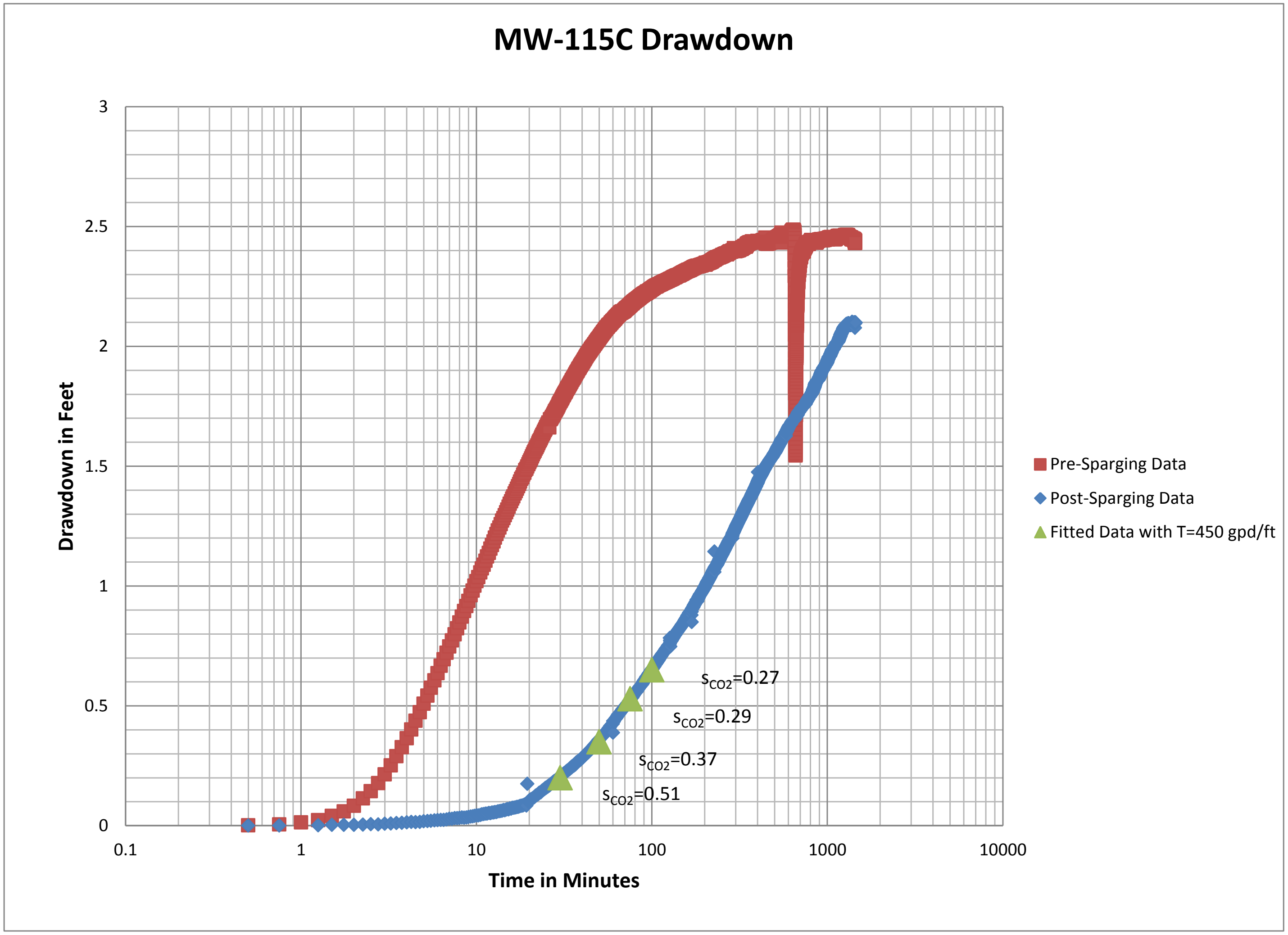


Figure 4-29
Predicted CO_2 Residual Saturations by Matching Drawdown in MW-115C using the Modified Storativity Equation

LCP Chemical Site, Brunswick, GA

Mutch Associates, LLC
Environmental Engineers and Scientists

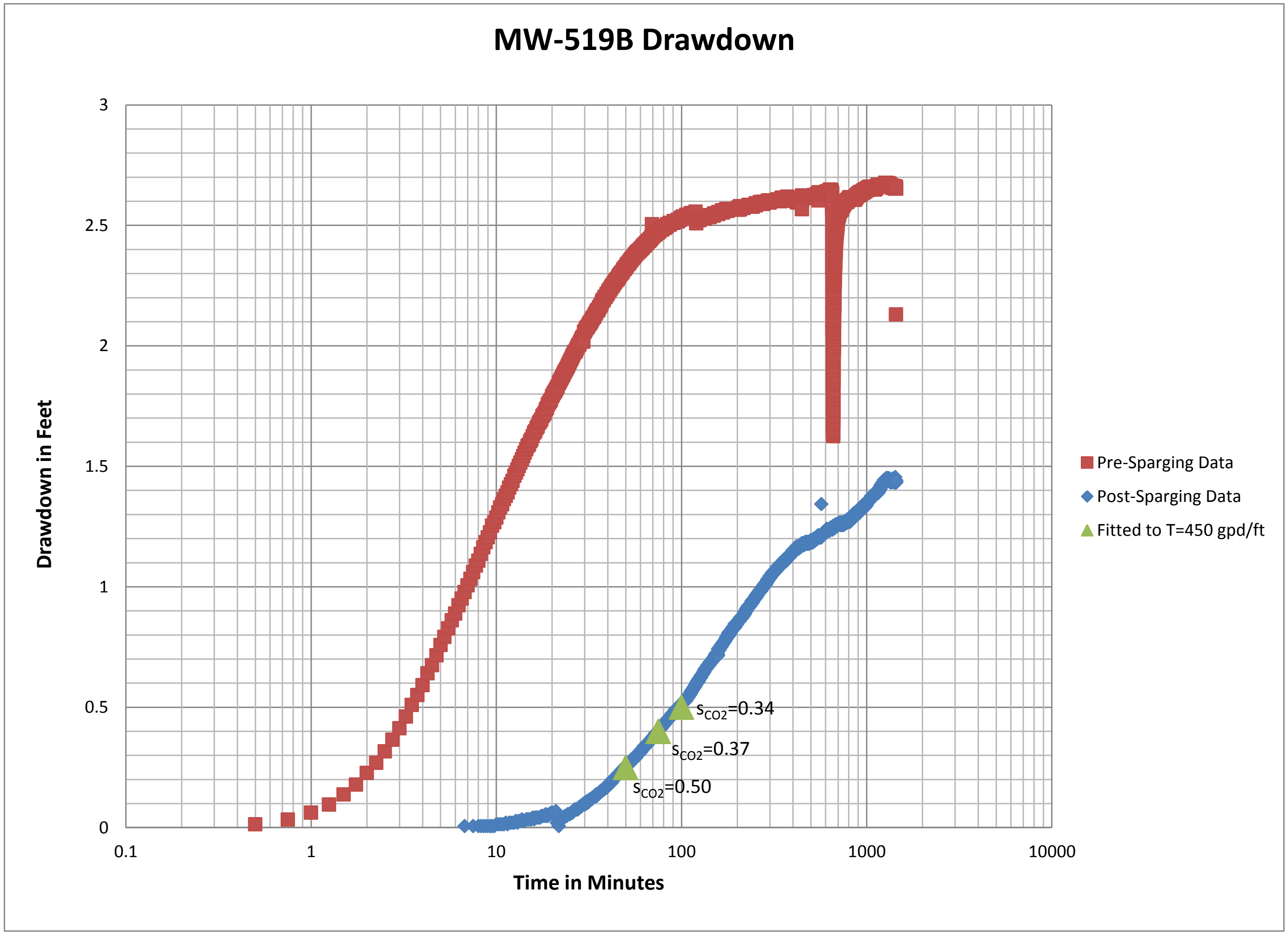


Figure 4-30
Predicted CO_2 Residual Saturations by Matching Drawdown in MW-519B using the Modified Storativity Equation

LCP Chemical Site, Brunswick, GA

Mutch Associates, LLC
Environmental Engineers and Scientists

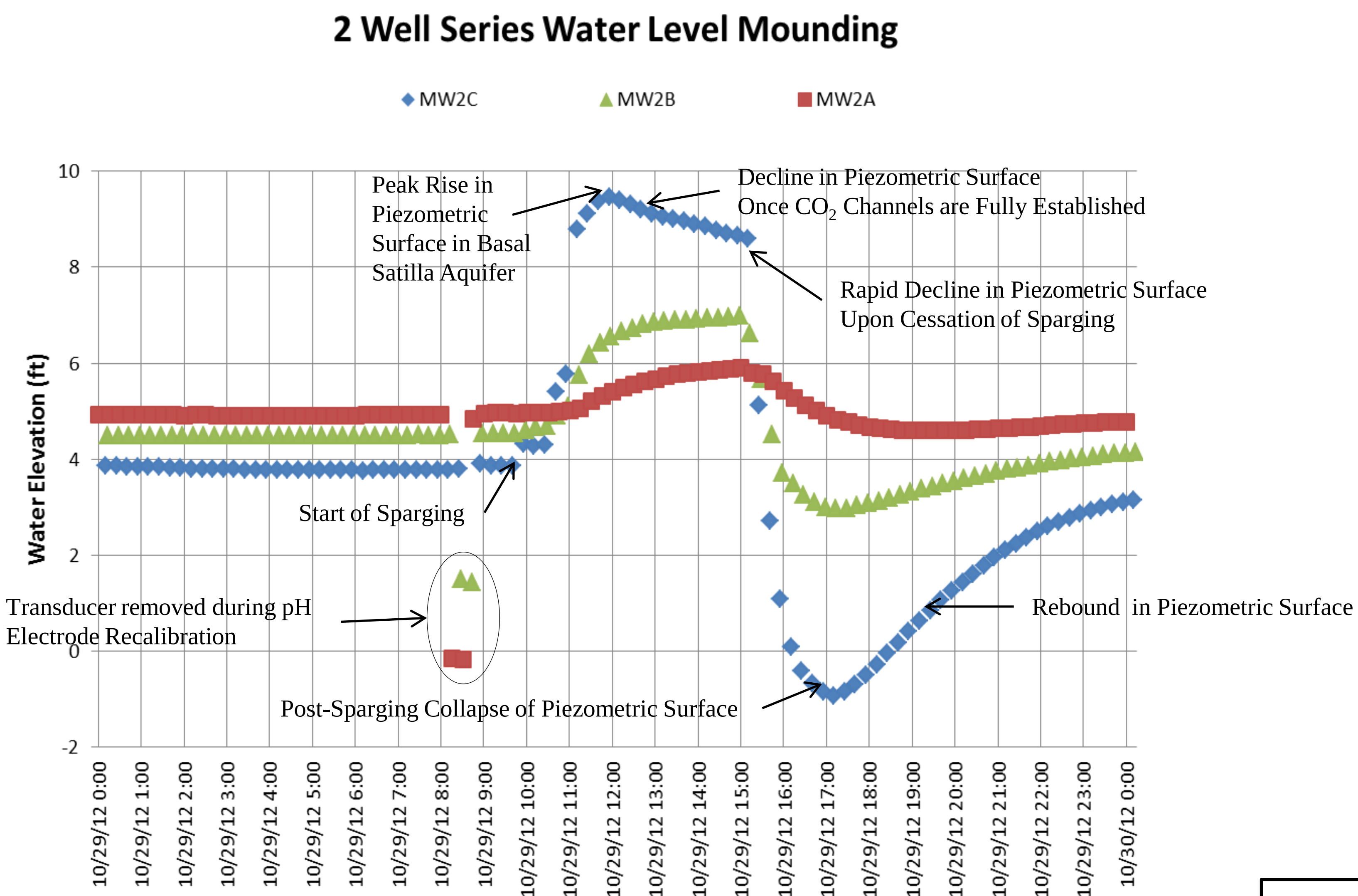


Figure 4-31

Mounding Water Level Behavior in the 2 Series Wells on the 10/29/12 Day 1 of Sparging

LCP Chemical Site, Brunswick, GA

Mutch Associates, LLC

Environmental Engineers and Scientists

LEGEND

- Extraction Well
- Sparging Well
- Monitoring Well
- Piezometer
- Infiltration Galleries
- Caustic Brine Pool (pH > 11.5)
- Caustic Brine Pool (pH > 10.5)
- 9 Piezometric Contour of Basal Satilla Aquifer Zone
- 10.3 Piezometric Surface of Basal Satilla Aquifer Zone

N

0 25 50
Feet

1 inch = 25 feet

Note:
The approximate current lateral extent of the CBP in the Upper Surficial Aquifer is based primarily on the most recent comprehensive data set from 2007 and supplemented with more recent data collected from extraction wells and 500-series monitoring wells between 2009 and April 2010.

Figure 4-32

Maximum Level of Piezometric Surface During Sparging on 10/29/12

LCP Chemical Site, Brunswick, GA

Mutch Associates, LLC
Environmental Engineers and Scientists

LEGEND

- Extraction Well
- Sparging Well
- Monitoring Well
- Piezometer
- Infiltration Galleries
- Caustic Brine Pool (pH > 11.5)
- Caustic Brine Pool (pH > 10.5)
- 9 Piezometric Contour of Basal Satilla Aquifer Zone
- 10.3 Piezometric Surface of Basal Satilla Aquifer Zone

N

0 25 50
Feet

1 inch = 25 feet

Note:
The approximate current lateral extent of the CBP in the Upper Surficial Aquifer is based primarily on the most recent comprehensive data set from 2007 and supplemented with more recent data collected from extraction wells and 500-series monitoring wells between 2009 and April 2010.

Figure 4-33

Peak Decline in Piezometric Surface Following Sparging on 10/29/12

LCP Chemical Site, Brunswick, GA

Mutch Associates, LLC
Environmental Engineers and Scientists

LEGEND

- Extraction Well
- Sparging Well
- Monitoring Well
- Piezometer
- Infiltration Galleries
- Caustic Brine Pool (pH > 11.5)
- Caustic Brine Pool (pH > 10.5)
- 8.39 (11/1) Groundwater Table Elevation and Date of Observation

0 25 50
Feet

1 inch = 25 feet

Note:
The approximate current lateral extent of the CBP in the Upper Surficial Aquifer is based primarily on the most recent comprehensive data set from 2007 and supplemented with more recent data collected from extraction wells and 500-series monitoring wells between 2009 and April 2010.

1:
The groundwater table as approximated by the shallow "A" wells. The actual groundwater table would be slightly higher in elevation.

Figure 4-34

Maximum Observed Rise in the Groundwater Table

LCP Chemical Site, Brunswick, GA

Mutch Associates, LLC
Environmental Engineers and Scientists

APPENDIX A. BORING LOGS/ WELL CONSTRUCTION DIAGRAMS

BORING LOG

Honeywell

Site: LCP Brunswick
Boring No: MW-1A
Diameter: 6 in
Date: 09/19/2012

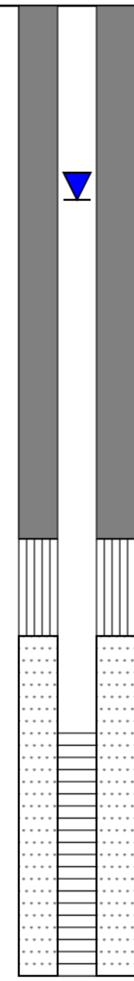
Northing: 431518.42
Easting: 861711.77
Elevation: 12.80
Datum: NAVD88

Driller: Billy Moss (Groundwater Protection Inc)
Method: Sonic
Consultant: Christine Jaynes (PARSONS)
Field Book No: Parsons #1

Total Depth: 20.0 Ft
GW Depth: 4.0 Ft

Depth Ft	Recov.	Soil Code	Pattern	Soil Description
0				
		SM		Dry, loose, brown, fine to medium SAND, some silt, with odor.
5		SM		Moist, loose, light gray/white, fine to medium SAND, some silt, odor.
10		CL		Wet, soft, CLAY and SILT, some wood/tree root material, odor.
		SM		Wet, medium stiff, dark gray/black SILT, and very fine-fine sand, odor.
		SW		Wet, loose, tan very fine to coarse SAND, odor.
15		SW		Wet, loose, tan, very fine to coarse SAND, odor.
		SM		Wet, loose, gray, very fine to medium SAND, trace silt.
		SW		Wet, loose, gray, very fine to coarse SAND, slight odor.
20.0				

MW-1A Diagram



▼ Boring GW Depth

BORING LOG	Site: LCP Brunswick
Page 1 of 2	Boring No: MW-1B
Honeywell	Diameter: 6 in
	Date: 09/19/2012

Northing: 431523.74	Driller: Billy Moss (Groundwater Protection Inc)	Total Depth: 35.0 Ft
Easting: 861713.44	Method: Sonic	GW Depth: 4.0 Ft
Elevation: 12.90	Consultant: Christine Jaynes (PARSONS)	
Datum: NAVD88	Field Book No: Parsons #1	

Depth Ft	Recov.	Soil Code	Pattern	Soil Description	MW-1B Diagram
0					
5		SM		Wet, loose, dark gray/black, fine to medium SAND and silt.	
10		SM		Wet, loose, gray, fine to medium SAND, trace silt.	
		CL		Moist, stiff, gray, CLAY, some silt, tree root material noted, odor.	
		SM		Wet, medium dense, black, very fine to fine SAND and Silt, root material noted, organic odor.	
		SP/SM		Wet, medium dense, light brown, very fine to medium SAND, trace silt, organic odor.	
15		SP		Wet, medium dense, light brown, very fine to medium SAND, organic odor.	
		SP		Wet, medium dense, light gray, very fine to medium SAND, larger tree roots noted, odor.	
		SM		Wet, medium dense, gray, very fine to medium SAND, tree roots noted, odor.	
20					

Boring GW Depth

BORING LOG

Honeywell

Site: LCP Brunswick
Boring No: MW-1B
Diameter: 6 in
Date: 09/19/2012

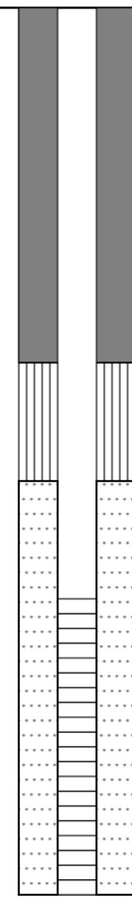
Northing: 431523.74
Easting: 861713.44
Elevation: 12.90
Datum: NAVD88

Driller: Billy Moss (Groundwater Protection Inc)
Method: Sonic
Consultant: Christine Jaynes (PARSONS)
Field Book No: Parsons #1

Total Depth: 35.0 Ft
GW Depth: 4.0 Ft

Depth Ft	Recov.	Soil Code	Pattern	Soil Description
20		SW		Wet, loose, gray, fine to coarse SAND.
25				Wet, loose, gray, fine to coarse SAND, odor. Saturated 26-27 ft. Trace clay at 28 ft.
30		SW		Wet, loose, gray, fine to coarse SAND. Borehole terminated at 35 ft bls.
35.0				

MW-1B Diagram



BORING LOG

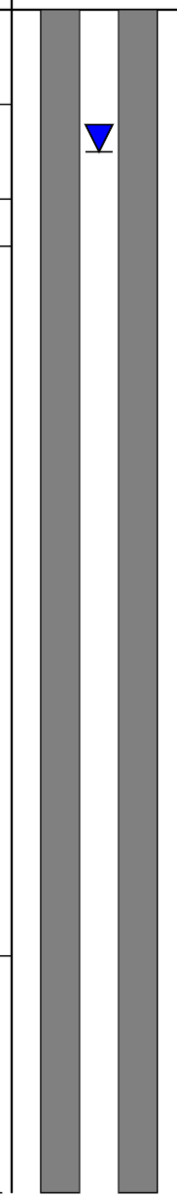
Honeywell

Site: LCP Brunswick
Boring No: MW-1C
Diameter: 2 in
Date: 09/17/2012

Northing: 431526.41	Driller: Billy Moss (Groundwater Protection Inc)	Total Depth: 50.0 Ft
Easting: 861717.45	Method: Sonic	GW Depth: 3.0 Ft
Elevation: 13.03	Consultant: Christine Jaynes (PARSONS)	
Datum: NAVD88	Field Book No: Parsons #1	

Depth Ft	Recov.	Soil Code	Pattern	Soil Description
0		SP		Dry, very soft, mottled light tan to dark brown, fine to medium SAND, no odor.
5		SM		Moist, loose, dark grey, fine to medium SAND some silt, no odor.
10				
15				
20		SM		Per the driller, based on rig performance: fine SAND, compact.
25				

MW-1C Diagram



Boring GW Depth

BORING LOG

Honeywell

Site: LCP Brunswick
Boring No: MW-1C
Diameter: 2 in
Date: 09/17/2012

Northing: 431526.41
Easting: 861717.45
Elevation: 13.03
Datum: NAVD88

Driller: Billy Moss (Groundwater Protection Inc)
Method: Sonic
Consultant: Christine Jaynes (PARSONS)
Project No: Field Book No: Parsons #1

Total Depth: 50.0 Ft
GW Depth: 3.0 Ft

Depth Ft	Recov.	Soil Code	Pattern	Soil Description
25		SM		Per the driller, based on rig performance: fine SAND, compact.
30				
35				
40		SW		Saturated, loose, dark grey/black, fine to course SAND, no odor.
		SC		Moist, firm, dark grey/black, CLAY, and sand.
		CL		Moist, firm, dark grey/black, CLAY, slight odor.
		SP		Saturated, loose, grey, course SAND, slight odor.
		SP		Saturated, loose, grey, very fine to fine SAND, slight odor.
45		SC		Saturated, firm, grey, very fine SAND with clay stringers, slight odor.
		CL		Moist, firm, grey, CLAY (CL), slight odor.
		SC		Saturated, medium dense, grey, very fine SAND with clay, slight odor.
		SC		Moist, medium dense, grey, very fine to medium SAND with clay, slight odor.
50.0				

MW-1C Diagram

BORING LOG

Honeywell

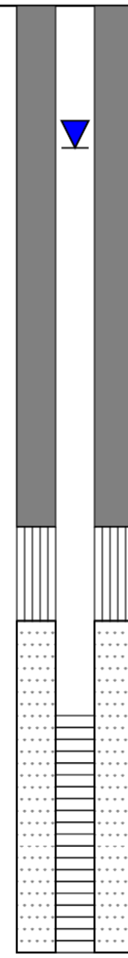
Site: LCP Brunswick
Boring No: MW-2A
Diameter: 2 in
Date: 09/20/2012

Northing: 431505.14
Easting: 861721.72
Elevation: 12.68
Datum: NAVD88

Driller: Billy Moss (Groundwater Protection Inc)
Method: Sonic
Consultant: Christine Jaynes (PARSONS)
Field Book No: Parsons #1

Total Depth: 20.0 Ft
GW Depth: 3.0 Ft

Depth Ft	Recov.	Soil Code	Pattern	Soil Description
0				
10		SP		Saturated, very soft, tan, very fine to medium SAND, odor.
13.5		SW		Saturated, very soft, tan, fine to course SAND, slight odor.
15		SW		Saturated, soft, grey, very fine to course SAND, odor.
20.0				



Boring GW Depth

BORING LOG

Honeywell

Site: LCP Brunswick
Boring No: MW-2B
Diameter: 2 in
Date: 09/18/2012 - 09/19/2012

Northing: 431507.07 Easting: 861726.66 Elevation: 12.77 Datum: NAVD88	Driller: Billy Moss (Groundwater Protection Inc) Method: Sonic Consultant: Christine Jaynes (PARSONS) Field Book No: Parsons #1	Total Depth: 35.0 Ft GW Depth: 3.0 Ft

Depth Ft	Recov.	Soil Code	Pattern	Soil Description	MW-2B Diagram
0					
5					
10					
15					
20					
25					

Boring GW Depth

BORING LOG

Honeywell

Site: LCP Brunswick
Boring No: MW-2B
Diameter: 2 in
Date: 09/18/2012 - 09/19/2012

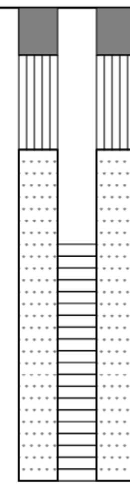
Northing: 431507.07
Easting: 861726.66
Elevation: 12.77
Datum: NAVD88

Driller: Billy Moss (Groundwater Protection Inc)
Method: Sonic
Consultant: Christine Jaynes (PARSONS)
Project No: Field Book No: Parsons #1

Total Depth: 35.0 Ft
GW Depth: 3.0 Ft

Depth Ft	Recov.	Soil Code	Pattern	Soil Description
25				
30		SC		Saturated, soft, grey, fine to medium SAND trace clay, odor.
		CL		CLAY lense
		SC		Saturated, firm, grey, fine to course SAND some clay, odor.
35.0				

MW-2B Diagram



BORING LOG	Page 1 of 2
Honeywell	Site: LCP Brunswick Boring No: MW-2C Diameter: 6 in Date: 09/18/2012

Northing: 431511.18 Easting: 861730.19 Elevation: 12.67 Datum: NAVD88	Driller: Billy Moss (Groundwater Protection Inc) Method: Sonic Consultant: Christine Jaynes (PARSONS) Field Book No: Parsons #1	Total Depth: 50.0 Ft GW Depth: 3.0 Ft

Depth Ft	Recov.	Soil Code	Pattern	Soil Description	MW-2C Diagram
0					
5		SP		Wet, medium dense, gray, fine to medium SAND.	
10		SM		Wet, medium dense, black, fine SAND, and silt, tree roots noted, odor.	
		SP		Wet, med dense, light brown fine to medium SAND, some dark gray silt, odor.	
15		SM		Wet, loose, light tan, fine to coarse SAND, little silt.	
		SM		Wet, loose, light gray, fine to coarse SAND, little silt, odor.	
20		SW		Wet, loose, gray, fine to coarse SAND, odor.	
25					

Boring GW Depth

BORING LOG

Honeywell

Site: LCP Brunswick
Boring No: MW-2C
Diameter: 6 in
Date: 09/18/2012

Northing: 431511.18	Driller: Billy Moss (Groundwater Protection Inc)	Total Depth: 50.0 Ft
Easting: 861730.19	Method: Sonic	GW Depth: 3.0 Ft
Elevation: 12.67	Consultant: Christine Jaynes (PARSONS)	
Datum: NAVD88	Field Book No: Parsons #1	

Depth Ft	Recov.	Soil Code	Pattern	Soil Description
25		SW		Wet, loose, gray, fine to coarse SAND, odor.
30		SW		Wet, loose, gray, fine to coarse SAND.
35		SW		Wet, loose, gray, fine to coarse SAND.
		SP		Wet, loose, gray, fine to medium SAND, slight odor.
40		SC		Wet, medium dense, dark gray, fine to coarse SAND, some stiff clay lenses, odor.
		SC/SM		Wet, medium dense, very fine to medium SAND, some stiff clay and silt lenses, odor.
45		SW		Wet, medium dense, gray, very fine to coarse SAND, odor.
		CL		Wet, stiff, gray CLAY, odor.
		SW/SC		Wet, medium dense, gray, fine to coarse SAND, little clay, odor.
50.0				

MW-2C Diagram

BORING LOG

Honeywell

Site: LCP Brunswick
Boring No: MW-3A
Diameter: 2 in
Date: 09/19/2012

Northing: 431547.14
Easting: 861687.76
Elevation: 13.19
Datum: NAVD88

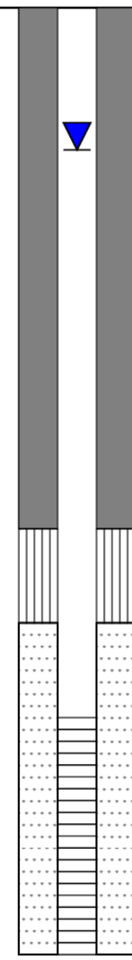
Driller: Billy Moss (Groundwater Protection Inc)
Method: Sonic
Consultant: Christine Jaynes (PARSONS)
Field Book No: Parsons #1

Total Depth: 20.0 Ft
GW Depth: 3.0 Ft

Soil Code	Soil Description
SM	Saturated, very soft, grey, very fine to medium SAND trace silt, odor.
CL	Moist, CLAY and silt, firm, wood/root material noted, strong odor.
SC	Saturated, firm, fine to medium SAND with clay and silt, strong odor.
SP	Saturated, soft, mottled tan to grey, very fine to medium SAND, odor.
SW	Saturated, very soft, grey, fine to course SAND, slight odor.

Depth Ft: 0, 5, 10, 15, 20.0

MW-3A Diagram



Boring GW Depth

BORING LOG

Honeywell

Site: LCP Brunswick
Boring No: SW-1
Diameter: 6 in
Date: 09/18/2012

Northing: 431518.21	Driller: Billy Moss (Groundwater Protection Inc)	Total Depth: 50.0 Ft
Easting: 861719.08	Method: Sonic	GW Depth: 4.0 Ft
Elevation: 13.03	Consultant: Christine Jaynes (PARSONS)	
Datum: NAVD88	Field Book No: Parsons #1	

Depth Ft	Recov.	Soil Code	Pattern	Soil Description	SW-1 Diagram
0					
		SP		Dry, loose, white, very fine to medium SAND.	
		SM		Moist, loose, brown/tan, fine to medium SAND, trace silt.	
5		SM		Wet, loose, dark gray, very fine to medium SAND, some silt.	
		SM		Moist, loose, gray/brown mottled with dark gray, very fine to medium SAND, some silt, trace tree roots.	
10		CL		Wet, medium stiff, dark gray/black, CLAY, some silt, trace root material, odor.	
		SM		Wet, loose, light brown/tan mottled with dark gray lenses, fine to medium SAND, some silt, odor.	
15		SP		Wet, medium dense, light tan, very fine to medium SAND, odor.	
		SW		Wet, medium dense, light gray, fine to coarse SAND, odor.	
20		SW		Wet, loose, gray, fine to coarse SAND, odor.	
25					

▼ Boring GW Depth

BORING LOG

Honeywell

Site: LCP Brunswick
Boring No: SW-1
Diameter: 6 in
Date: 09/18/2012

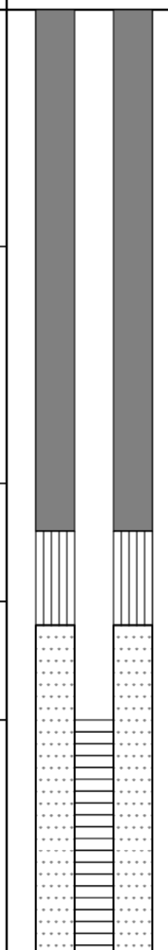
Northing: 431518.21
Easting: 861719.08
Elevation: 13.03
Datum: NAVD88

Driller: Billy Moss (Groundwater Protection Inc)
Method: Sonic
Consultant: Christine Jaynes (PARSONS)
Field Book No: Parsons #1

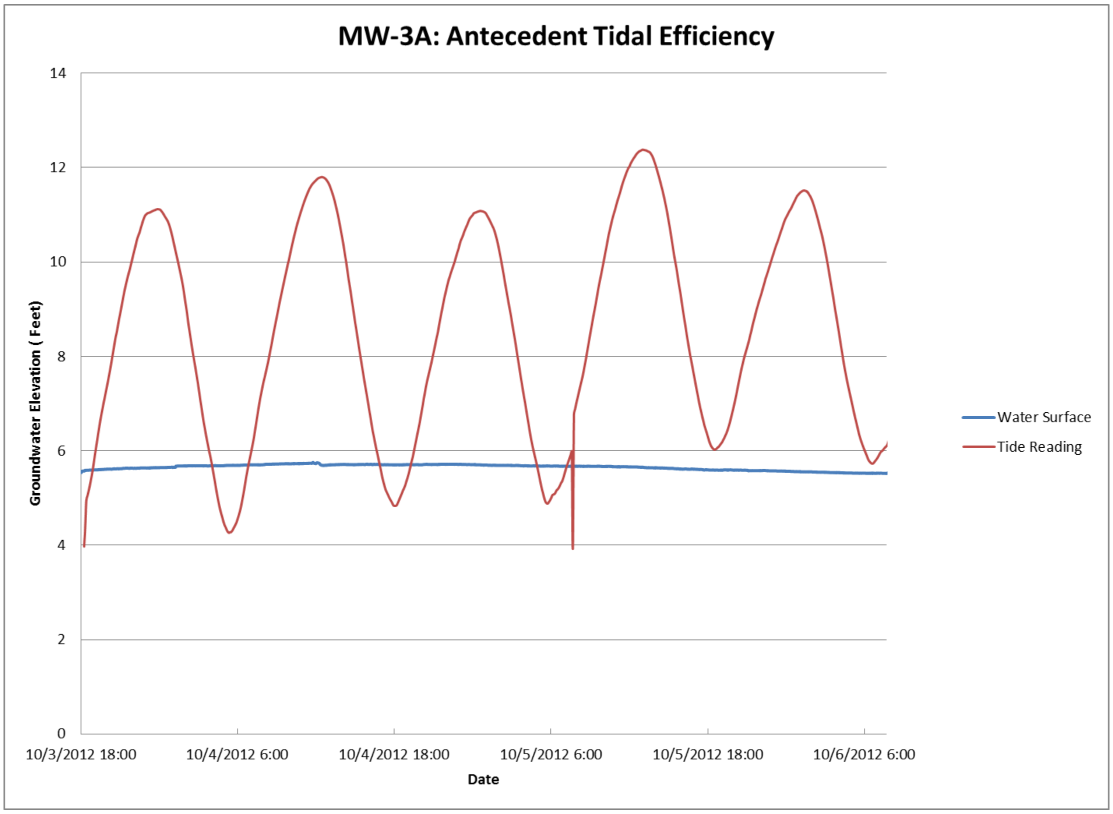
Total Depth: 50.0 Ft
GW Depth: 4.0 Ft

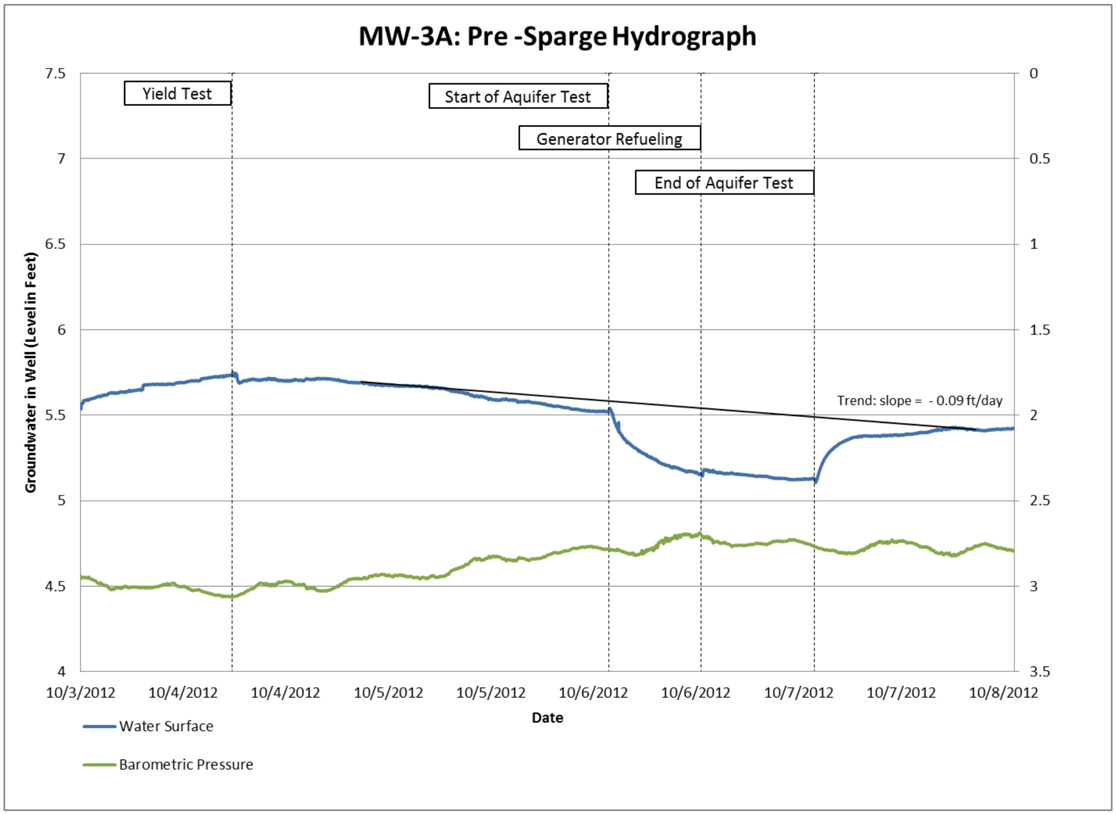
Depth Ft	Recov.	Soil Code	Pattern	Soil Description
25		SW		Wet, loose, gray, fine to coarse SAND, odor.
30				
35		SW		Wet, medium dense, gray, fine to coarse SAND.
		SC		Wet, loose, very fine to medium SAND, some clay stringers, odor.
40		SW/SC		Wet, loose, gray, fine to coarse SAND, little clay stringers at 42.5 ft, odor.
45		SC		Wet, medium dense, gray, fine to coarse SAND, and clay, odor.
50.0				

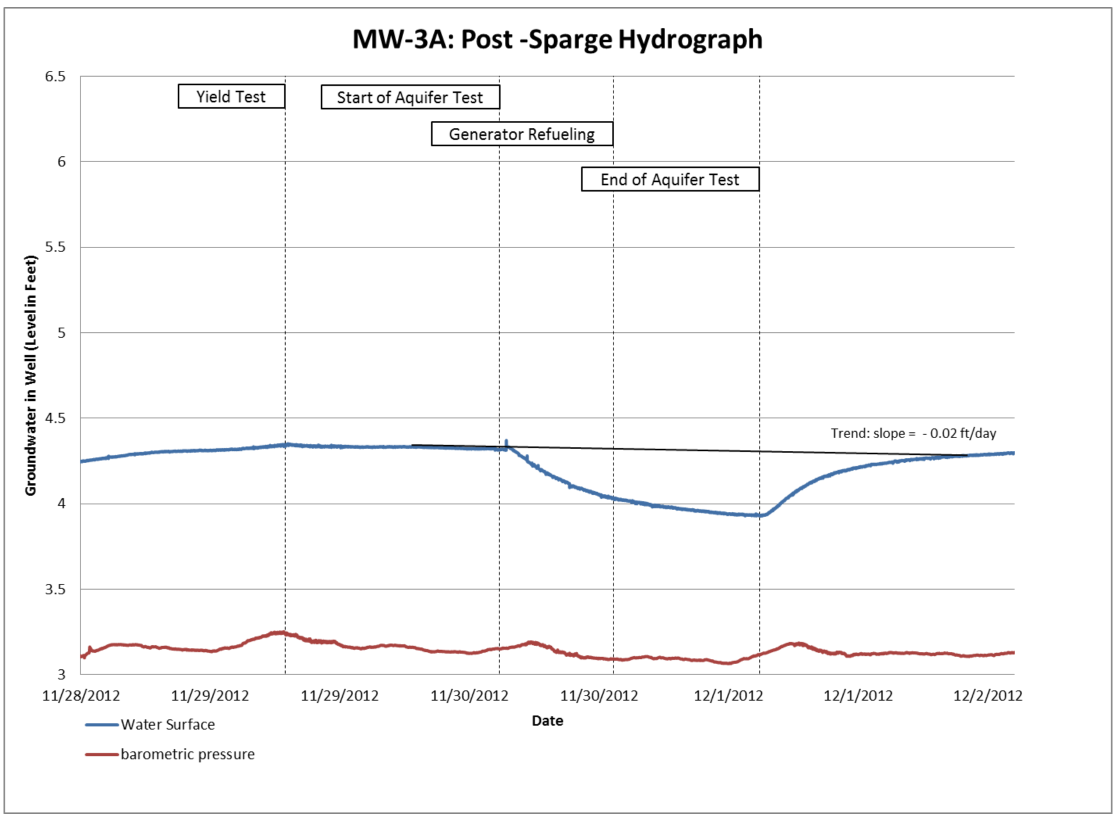
SW-1 Diagram

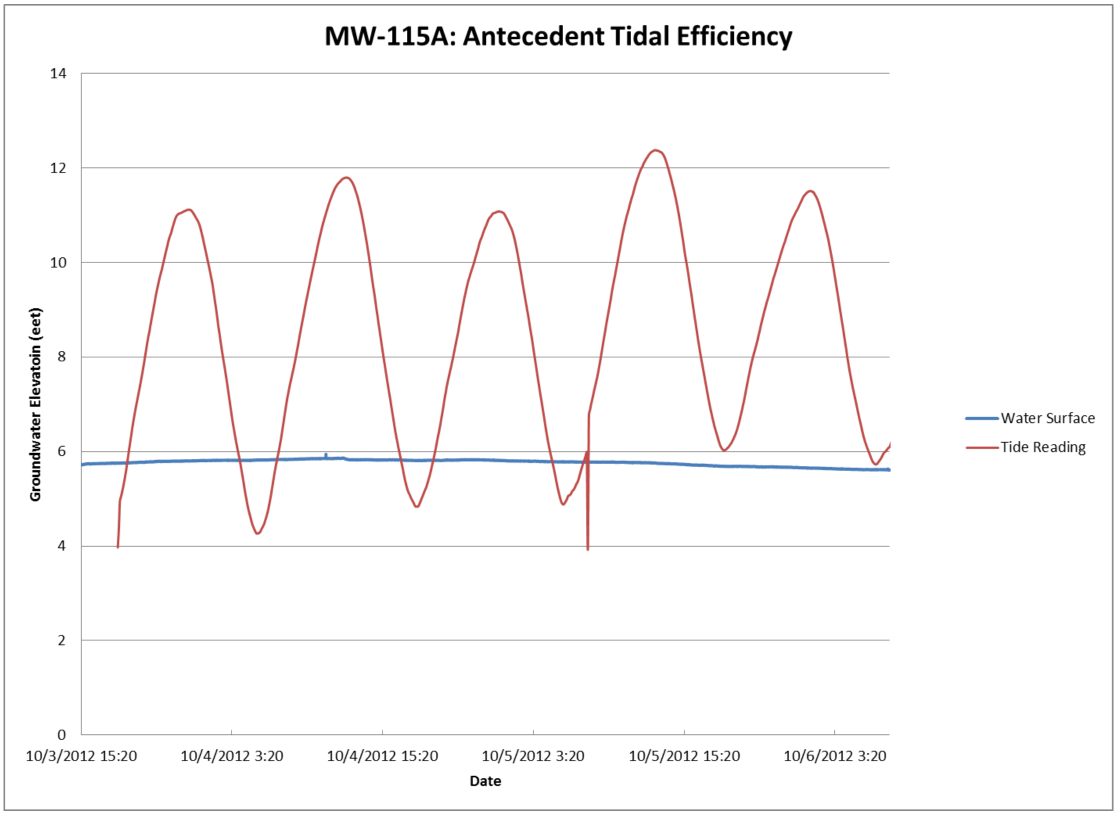


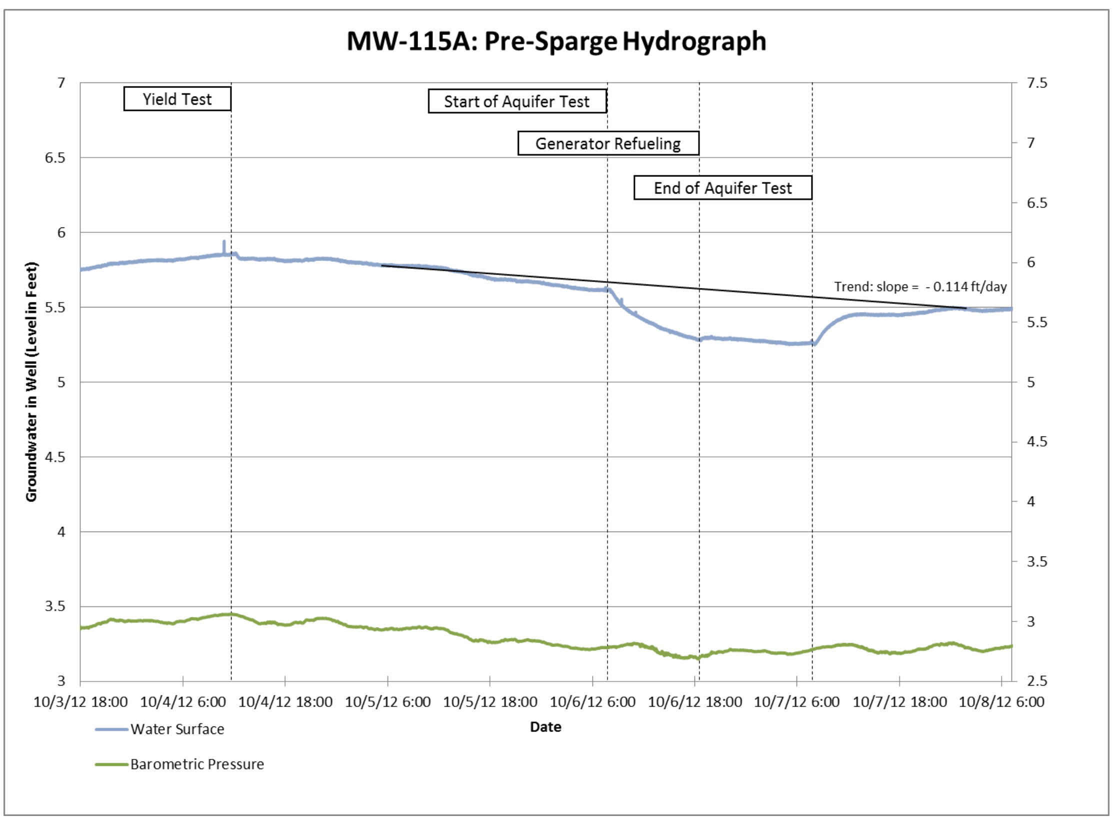
APPENDIX B. HYDROGRAPHS FOR OBSERVATION WELLS DURING AQUIFER TESTING

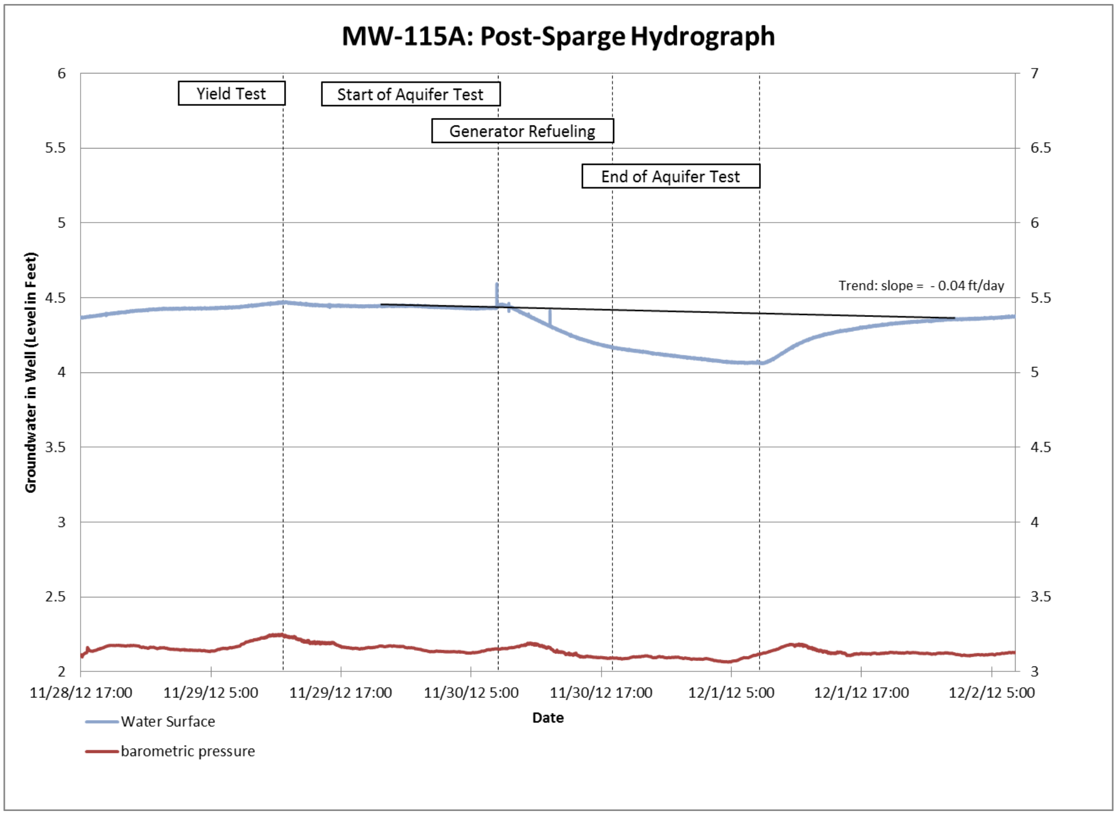


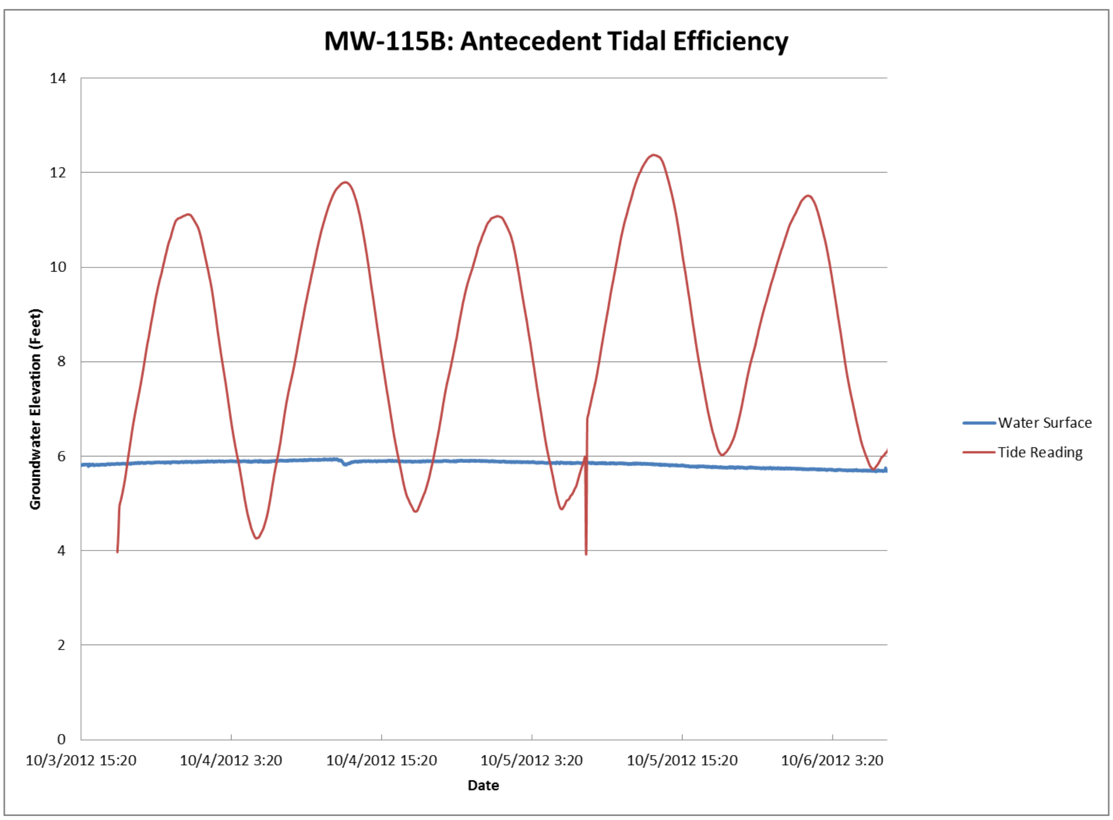

MW-3A: Pre -Sparge Hydrograph
Yield Test
Start of Aquifer Test
Generator Refueling
End of Aquifer Test
Trend: slope = - 0.09 ft/day
Groundwater in Well (Level in Feet)
7.5
7
6.5
6
5.5
5
4.5
4
0
0.5
1
1.5
2
2.5
3
3.5
10/3/2012
10/4/2012
10/4/2012
10/5/2012
10/5/2012
10/6/2012
10/6/2012
10/7/2012
10/7/2012
10/8/2012
Date
Water Surface
Barometric Pressure

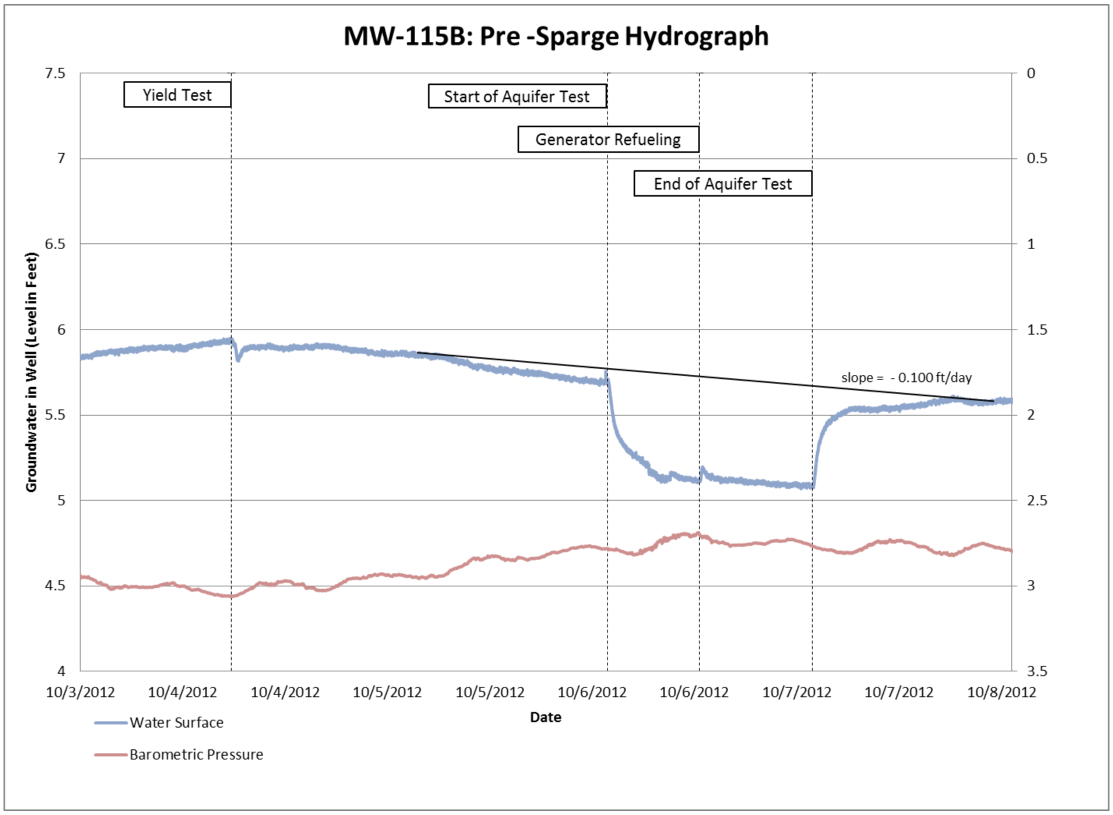

MW-3A: Post -Sparge Hydrograph
Yield Test
Start of Aquifer Test
Generator Refueling
End of Aquifer Test
Trend: slope = - 0.02 ft/day
Groundwater in Well (Level in Feet)
6.5
6
5.5
5
4.5
4
3.5
3
11/28/2012
11/29/2012
11/29/2012
11/30/2012
11/30/2012
12/1/2012
12/1/2012
12/2/2012
Date
Water Surface
barometric pressure

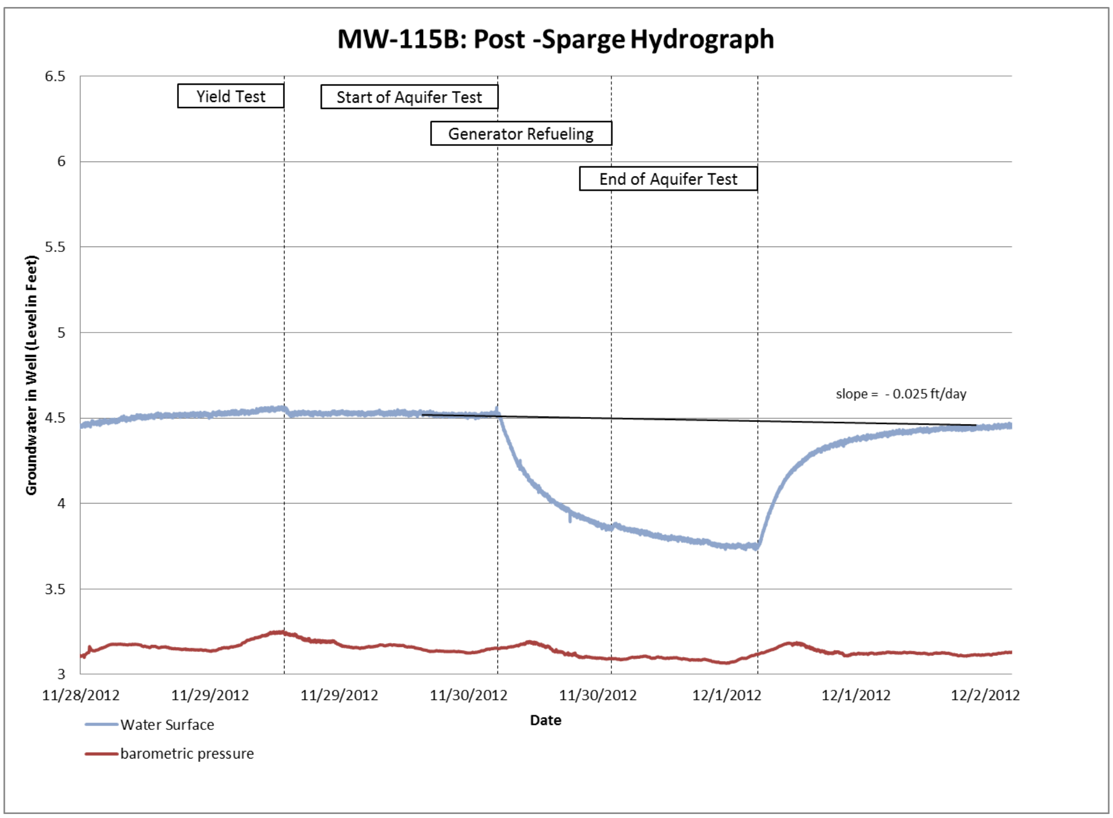

MW-115A: Antecedent Tidal Efficiency
14
12
10
8
6
4
2
0
Groundwater Surface Elevatoin (eet)
10/3/2012 15:20
10/4/2012 3:20
10/4/2012 15:20
10/5/2012 3:20
10/5/2012 15:20
10/6/2012 3:20
Date
Water Surface
Tide Reading

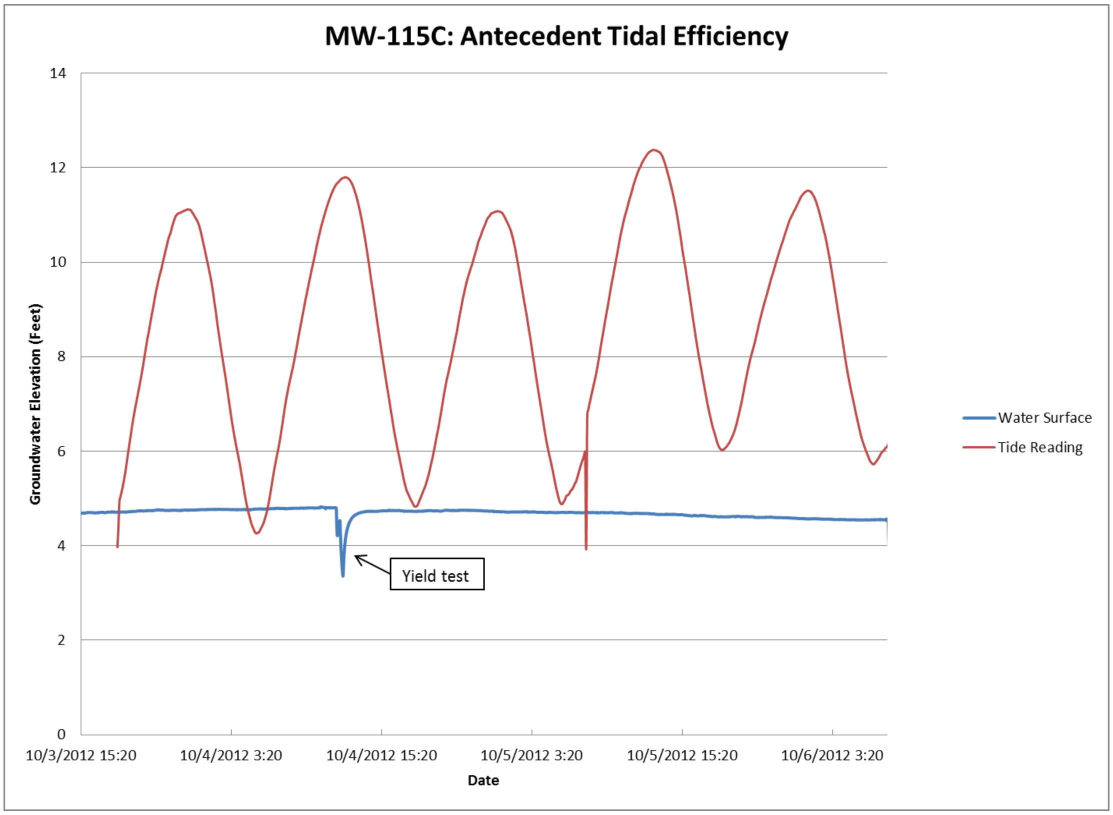

MW-115A: Pre-Sparge Hydrograph
Yield Test
Start of Aquifer Test
Generator Refueling
End of Aquifer Test
Trend: slope = - 0.114 ft/day
7
6.5
6
5.5
5
4.5
4
3.5
3
7.5
7
6.5
6
5.5
5
4.5
4
3.5
3
2.5
Groundwater in Well (Level in Feet)
10/3/12 18:00
10/4/12 6:00
10/4/12 18:00
10/5/12 6:00
10/5/12 18:00
10/6/12 6:00
10/6/12 18:00
10/7/12 6:00
10/7/12 18:00
10/8/12 6:00
Date
Water Surface
Barometric Pressure

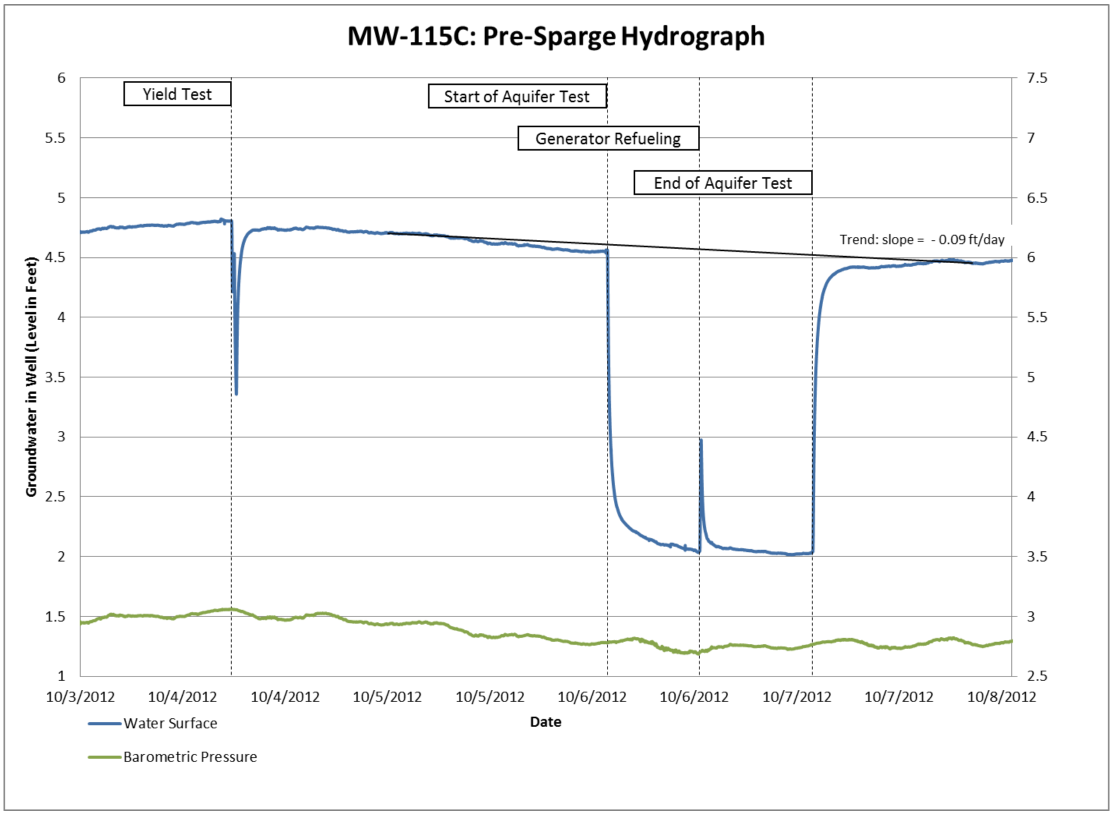

MW-115A: Post-Sparge Hydrograph
Yield Test
Start of Aquifer Test
Generator Refueling
End of Aquifer Test
Trend: slope = - 0.04 ft/day
Groundwater in Well (Level in Feet)
6
5.5
5
4.5
4
3.5
3
2.5
2
7
6.5
6
5.5
5
4.5
4
3.5
3
11/28/12 17:00
11/29/12 5:00
11/29/12 17:00
11/30/12 5:00
11/30/12 17:00
12/1/12 5:00
12/1/12 17:00
12/2/12 5:00
Date
Water Surface
barometric pressure

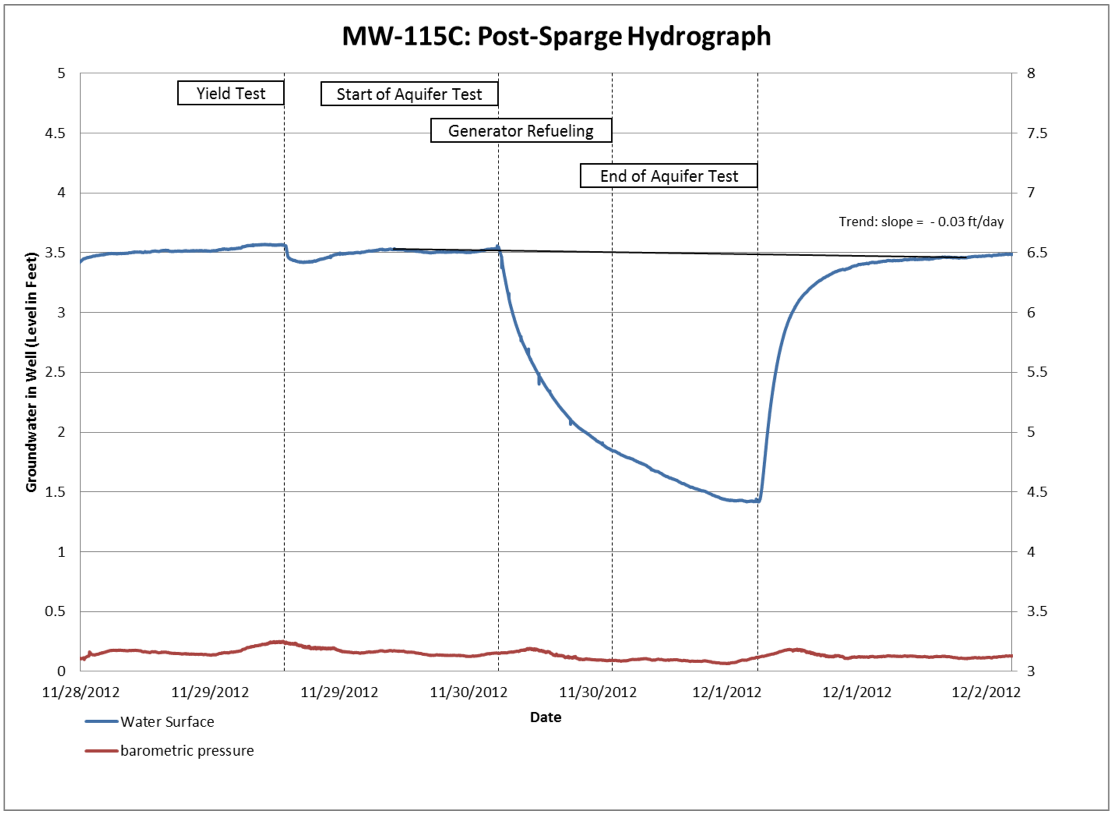

MW-115B: Antecedent Tidal Efficiency
Groundwater Elevation (Feet)
14
12
10
8
6
4
2
0
10/3/2012 15:20
10/4/2012 3:20
10/4/2012 15:20
10/5/2012 3:20
10/5/2012 15:20
10/6/2012 3:20
Date
Water Surface
Tide Reading

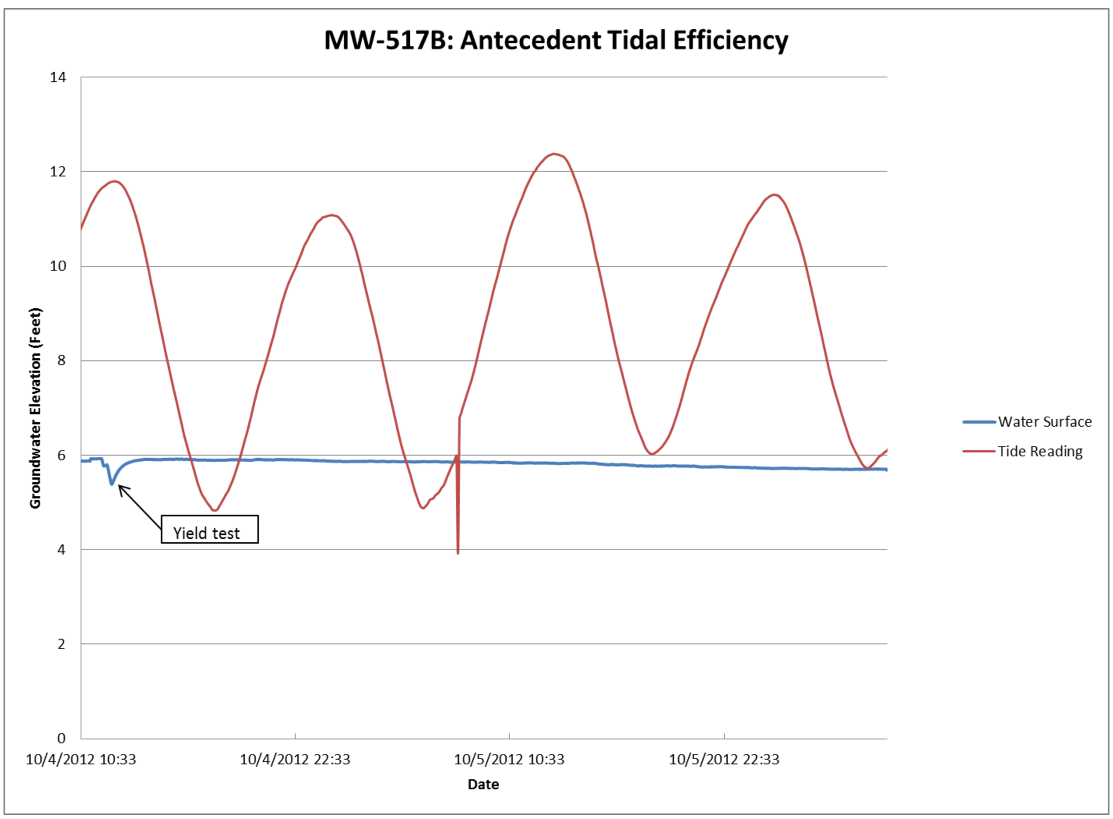

MW-115B: Pre -Sparge Hydrograph
Yield Test
Start of Aquifer Test
Generator Refueling
End of Aquifer Test
slope = - 0.100 ft/day
Groundwater in Well (Level in Feet)
7.5
7
6.5
6
5.5
5
4.5
4
0
0.5
1
1.5
2
2.5
3
3.5
10/3/2012
10/4/2012
10/4/2012
10/5/2012
10/5/2012
10/6/2012
10/6/2012
10/7/2012
10/7/2012
10/8/2012
Date
Water Surface
Barometric Pressure

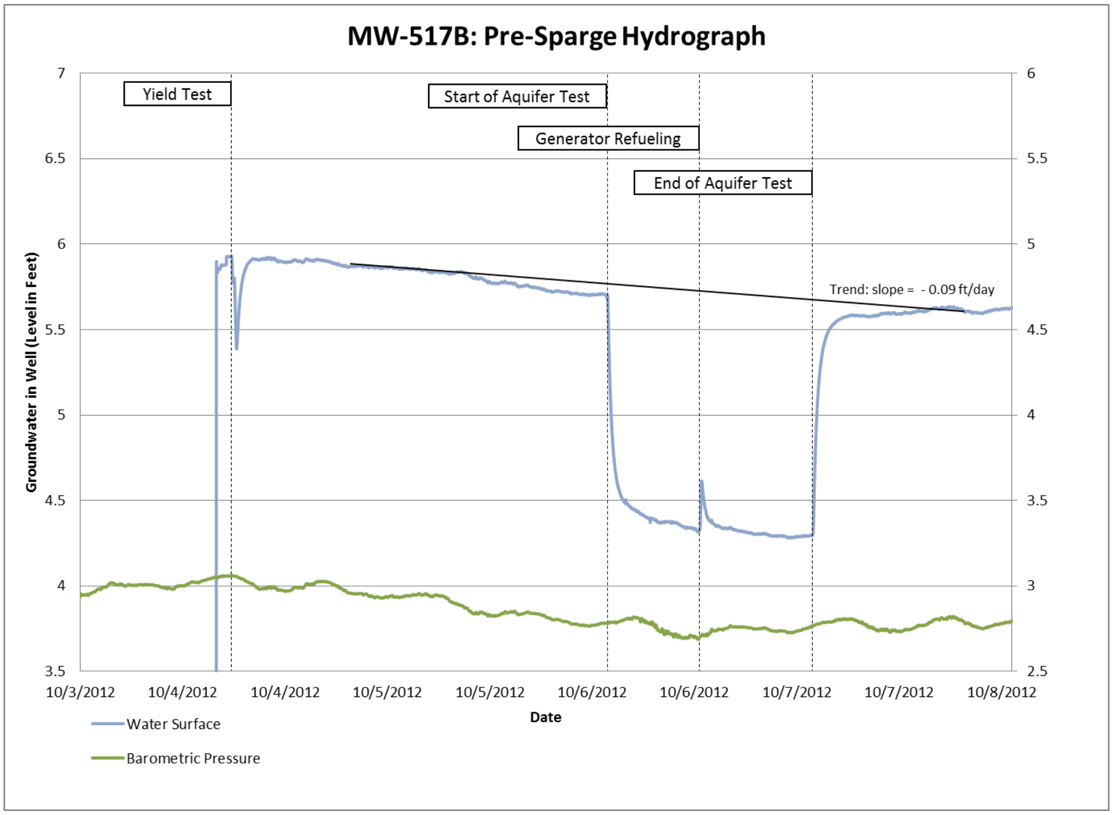

MW-115B: Post -Sparge Hydrograph
Yield Test
Start of Aquifer Test
Generator Refueling
End of Aquifer Test
slope = - 0.025 ft/day
Groundwater in Well (Level in Feet)
6.5
6
5.5
5
4.5
4
3.5
3
11/28/2012
11/29/2012
11/29/2012
11/30/2012
11/30/2012
12/1/2012
12/1/2012
12/2/2012
Date
Water Surface
barometric pressure

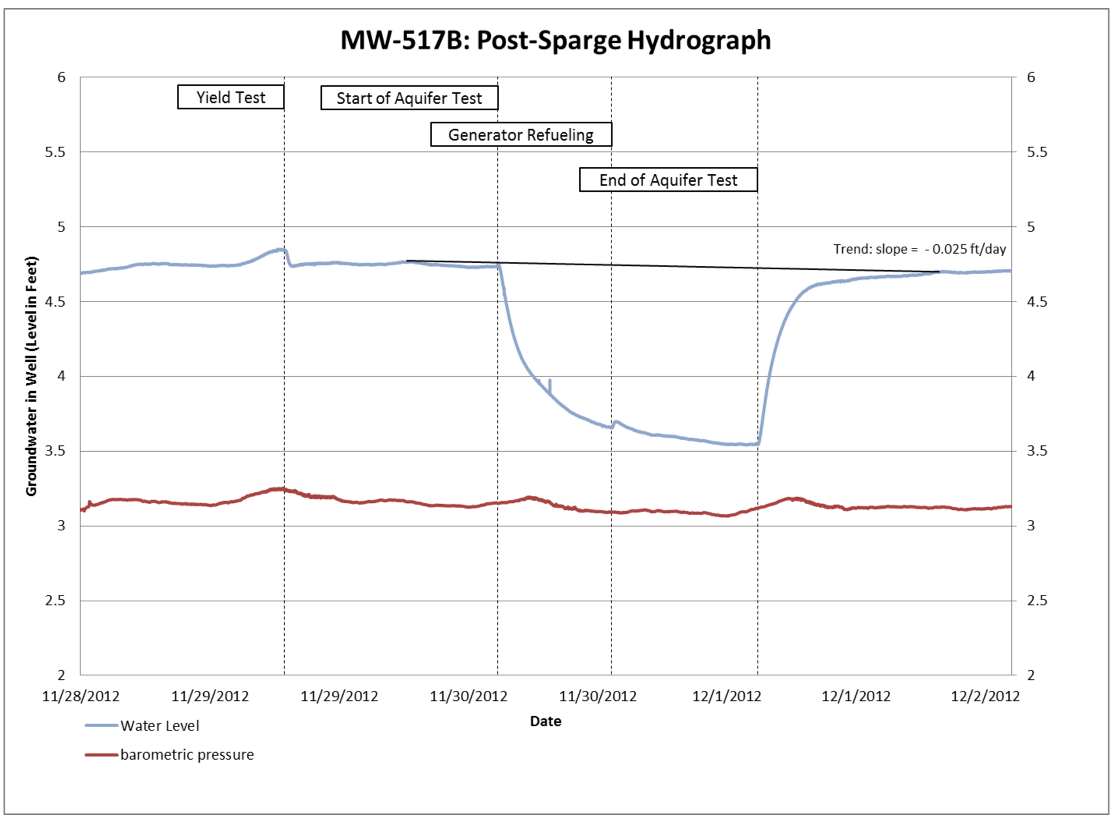

MW-115C: Antecedent Tidal Efficiency
Groundwater Elevation (Feet)
14
12
10
8
6
4
2
0
10/3/2012 15:20
10/4/2012 3:20
10/4/2012 15:20
10/5/2012 3:20
10/5/2012 15:20
10/6/2012 3:20
Date
Yield test
Water Surface
Tide Reading

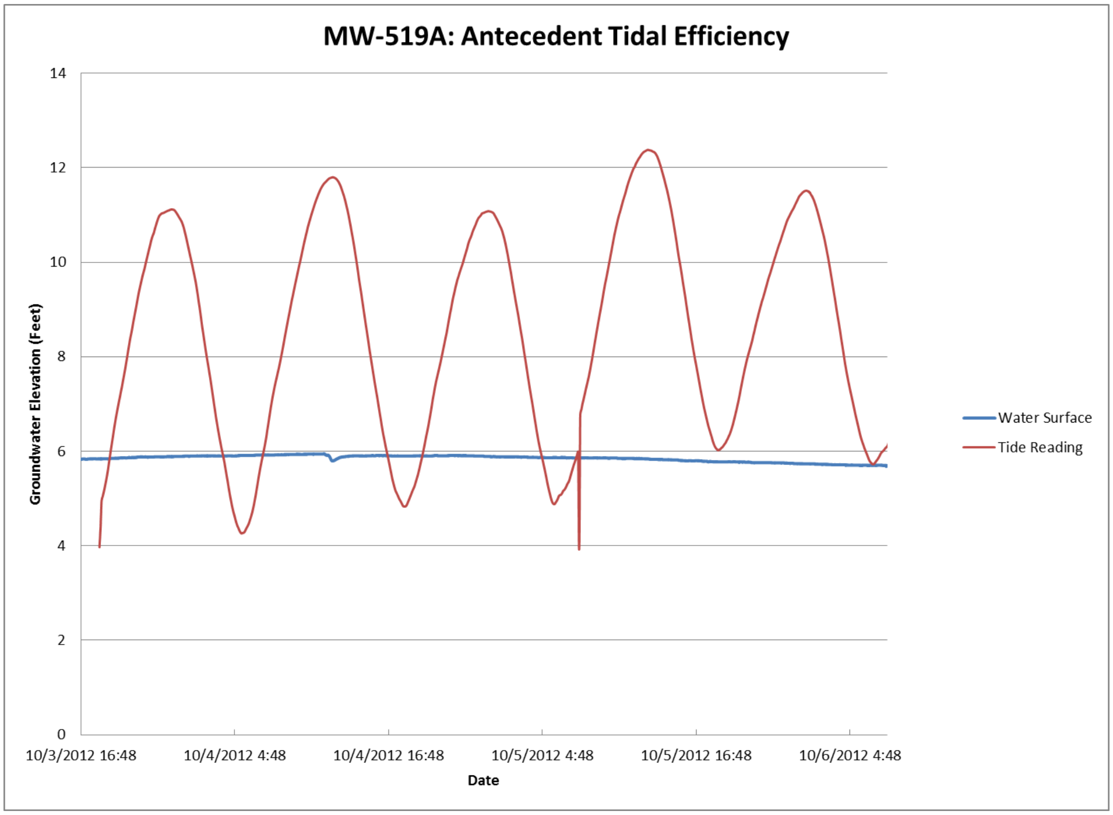

MW-115C: Pre-Sparge Hydrograph
Groundwater in Well (Level in Feet)
6
5.5
5
4.5
4
3.5
3
2.5
2
1.5
1
7.5
7
6.5
6
5.5
5
4.5
4
3.5
3
2.5
Yield Test
Start of Aquifer Test
Generator Refueling
End of Aquifer Test
Trend: slope = - 0.09 ft/day
10/3/2012
10/4/2012
10/4/2012
10/5/2012
10/5/2012
10/6/2012
10/6/2012
10/7/2012
10/7/2012
10/8/2012
Date
Water Surface
Barometric Pressure

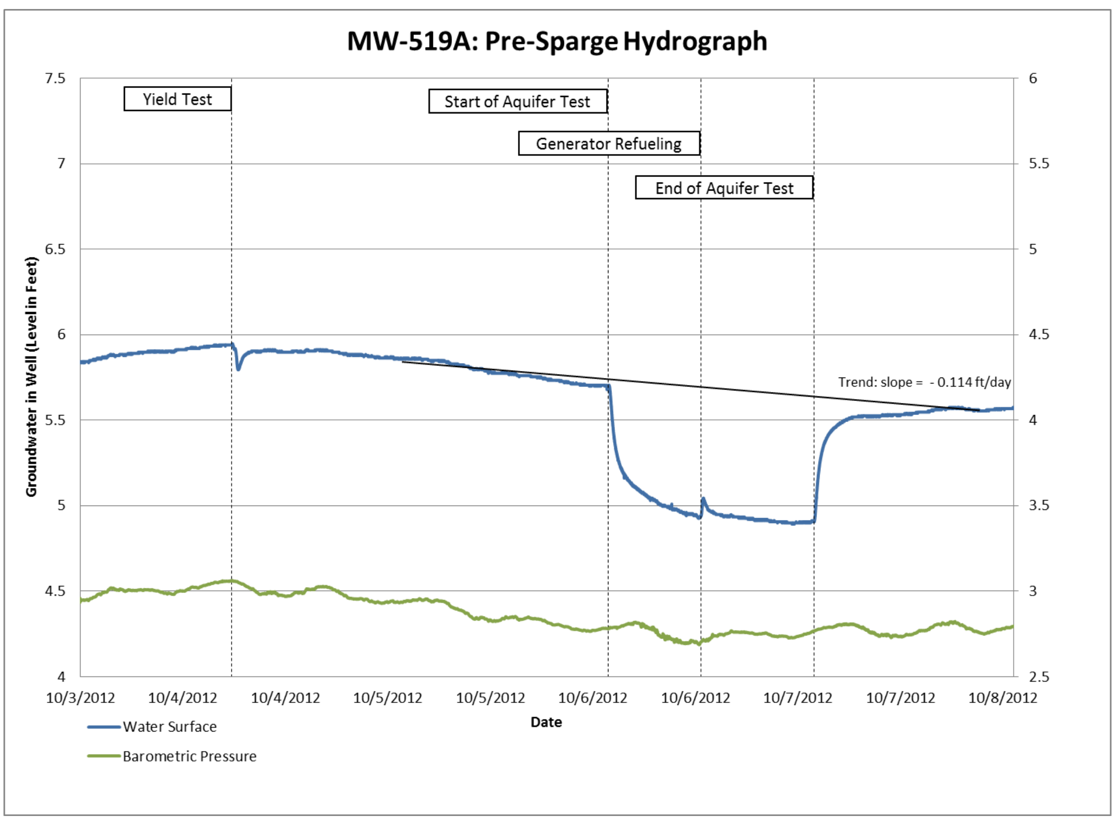

MW-115C: Post-Sparge Hydrograph
Yield Test
Start of Aquifer Test
Generator Refueling
End of Aquifer Test
Trend: slope = - 0.03 ft/day
Groundwater in Well (Level in Feet)
Date
11/28/2012
11/29/2012
11/29/2012
11/30/2012
11/30/2012
12/1/2012
12/1/2012
12/2/2012
Water Surface
barometric pressure

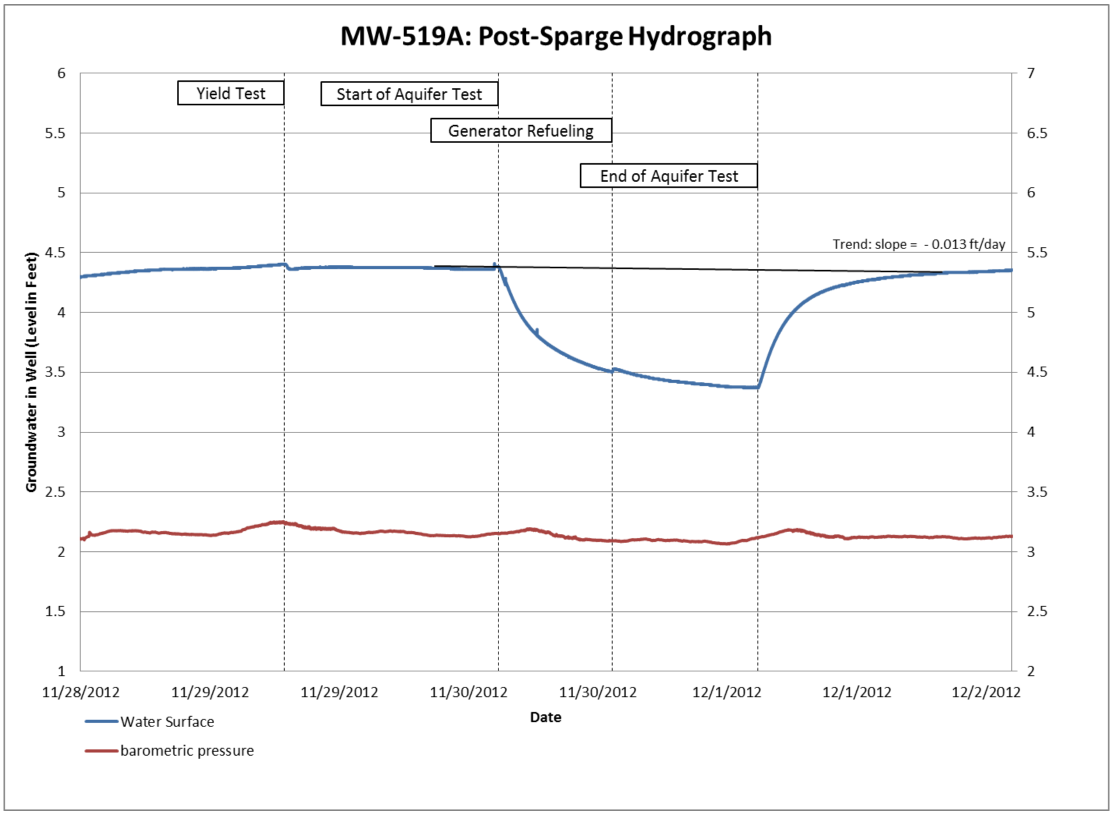

MW-517B: Antecedent Tidal Efficiency
Groundwater Elevation (Feet)
Yield test
Date
10/4/2012 10:33
10/4/2012 22:33
10/5/2012 10:33
10/5/2012 22:33
Water Surface
Tide Reading

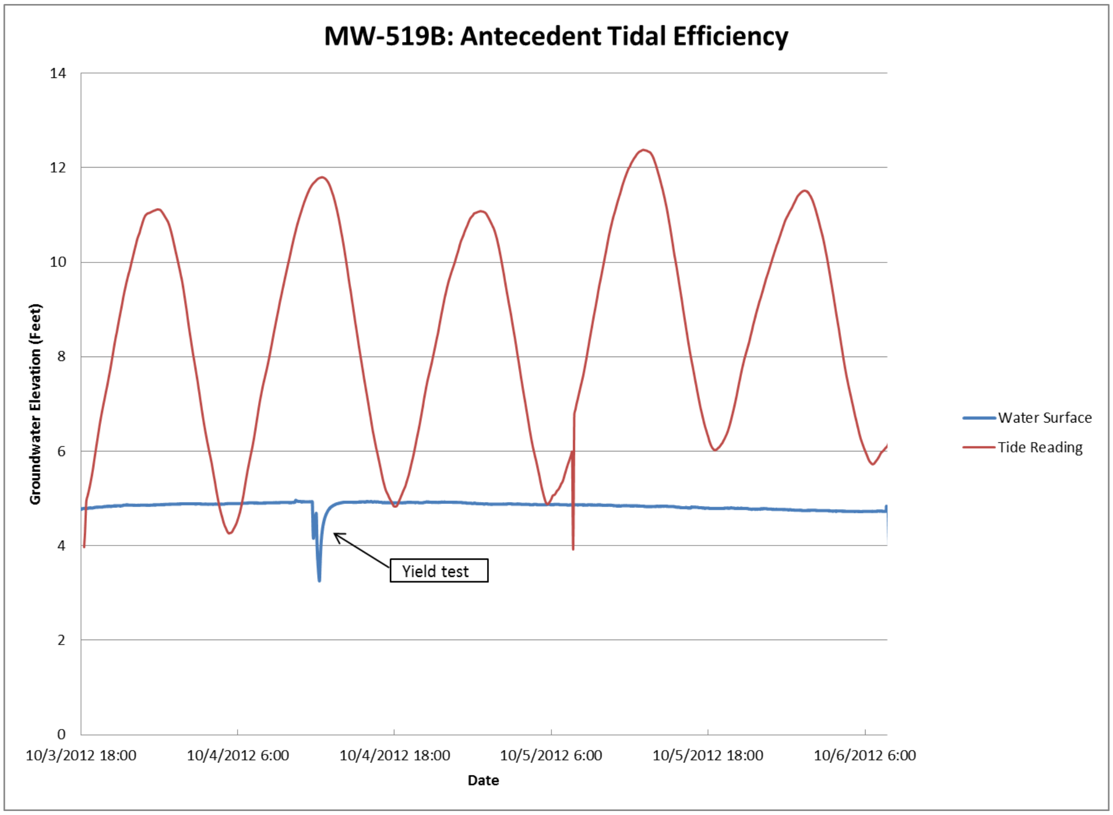

MW-517B: Pre-Sparge Hydrograph
Yield Test
Start of Aquifer Test
Generator Refueling
End of Aquifer Test
Trend: slope = - 0.09 ft/day
Groundwater in Well (Level in Feet)
Date
7
6.5
6
5.5
5
4.5
4
3.5
6
5.5
5
4.5
4
3.5
3
2.5
10/3/2012
10/4/2012
10/4/2012
10/5/2012
10/5/2012
10/6/2012
10/6/2012
10/7/2012
10/7/2012
10/8/2012
Water Surface
Barometric Pressure

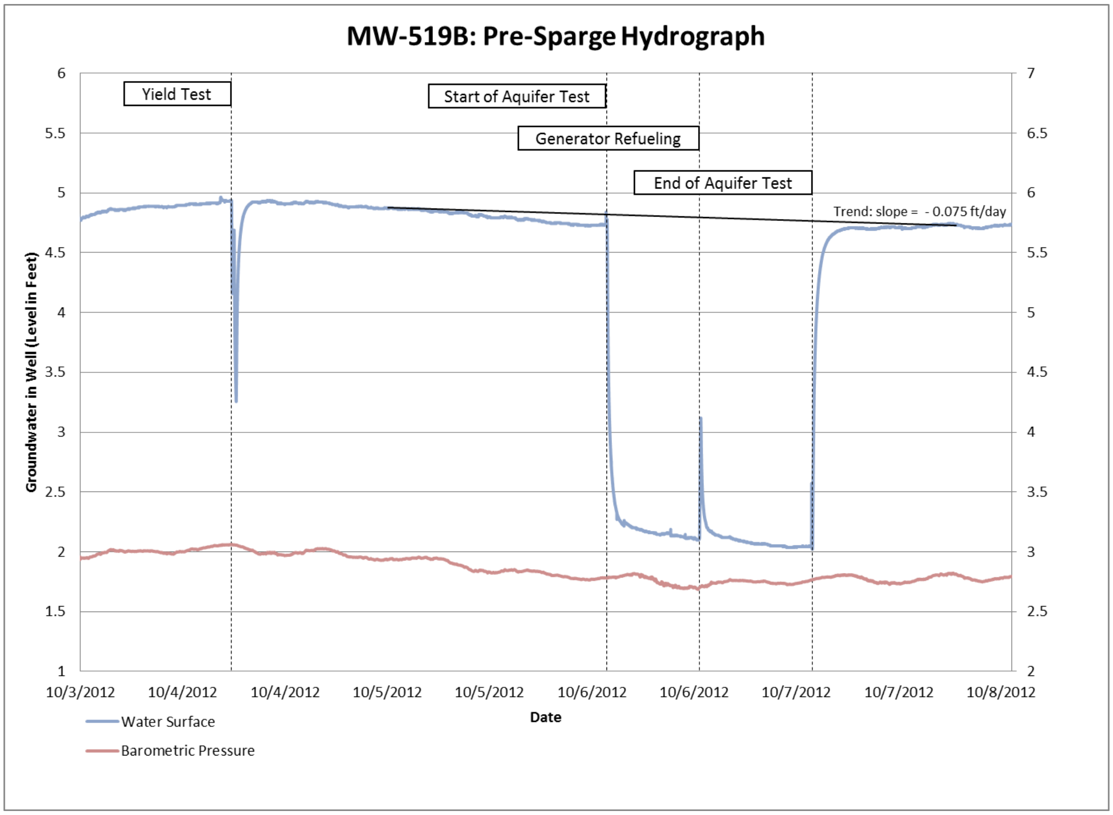

MW-517B: Post-Sparge Hydrograph
Yield Test
Start of Aquifer Test
Generator Refueling
End of Aquifer Test
Trend: slope = - 0.025 ft/day
Groundwater in Well (Level in Feet)
Date
6
5.5
5
4.5
4
3.5
3
2.5
2
11/28/2012
11/29/2012
11/29/2012
11/30/2012
11/30/2012
12/1/2012
12/1/2012
12/2/2012
Water Level
barometric pressure

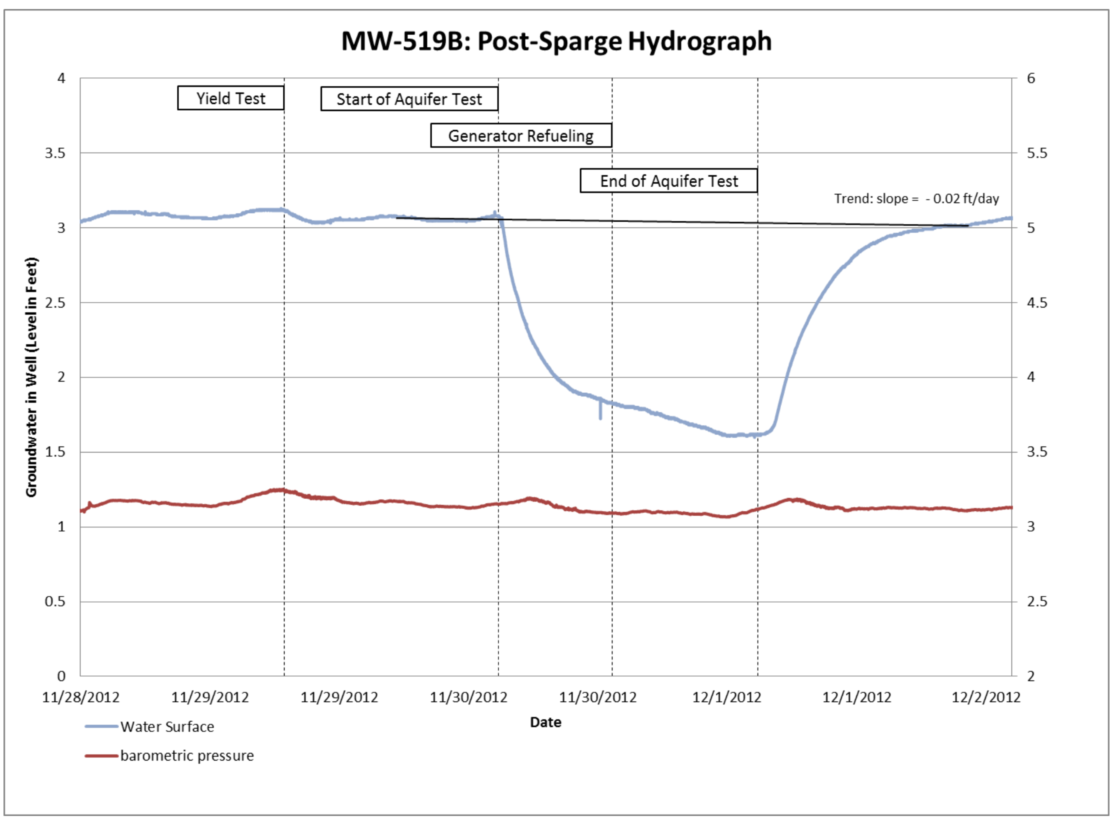

MW-519A: Antecedent Tidal Efficiency
Groundwater Elevation (Feet)
14
12
10
8
6
4
2
0
10/3/2012 16:48
10/4/2012 4:48
10/4/2012 16:48
10/5/2012 4:48
10/5/2012 16:48
10/6/2012 4:48
Date
Water Surface
Tide Reading

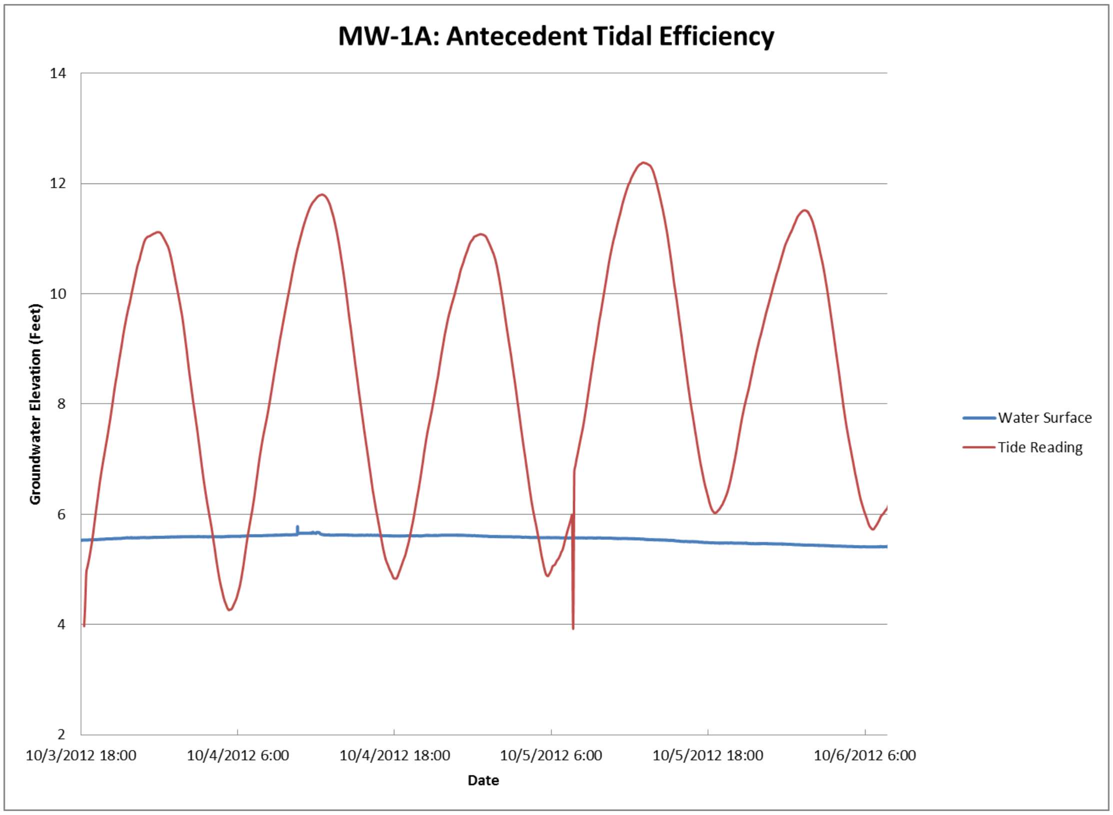

MW-519A: Pre-Sparge Hydrograph
Yield Test
Start of Aquifer Test
Generator Refueling
End of Aquifer Test
Trend: slope = - 0.114 ft/day
Groundwater in Well (Level in Feet)
7.5
7
6.5
6
5.5
5
4.5
4
6
5.5
5
4.5
4
3.5
3
2.5
10/3/2012
10/4/2012
10/4/2012
10/5/2012
10/5/2012
10/6/2012
10/6/2012
10/7/2012
10/7/2012
10/8/2012
Date
Water Surface
Barometric Pressure

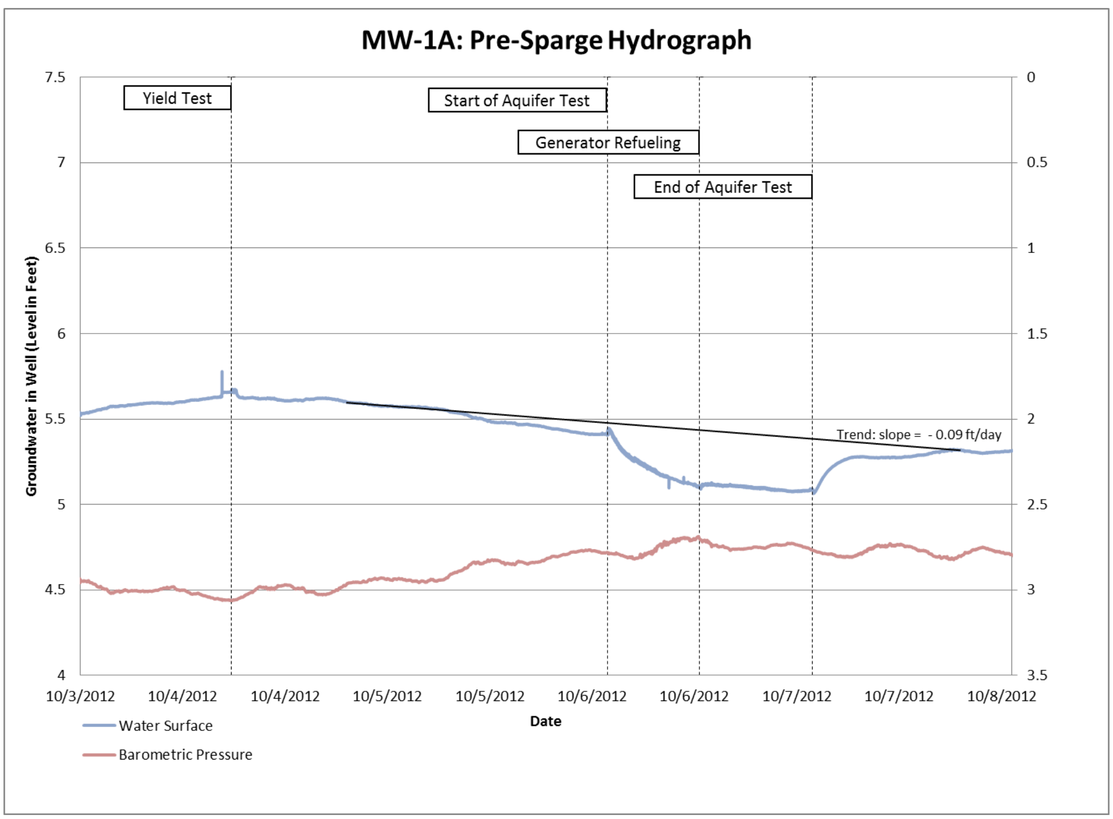

MW-519A: Post-Sparge Hydrograph
Yield Test
Start of Aquifer Test
Generator Refueling
End of Aquifer Test
Trend: slope = - 0.013 ft/day
Groundwater in Well (Level in Feet)
6
5.5
5
4.5
4
3.5
3
2.5
2
1.5
1
7
6.5
6
5.5
5
4.5
4
3.5
3
2.5
2
11/28/2012
11/29/2012
11/29/2012
11/30/2012
11/30/2012
12/1/2012
12/1/2012
12/2/2012
Date
Water Surface
barometric pressure

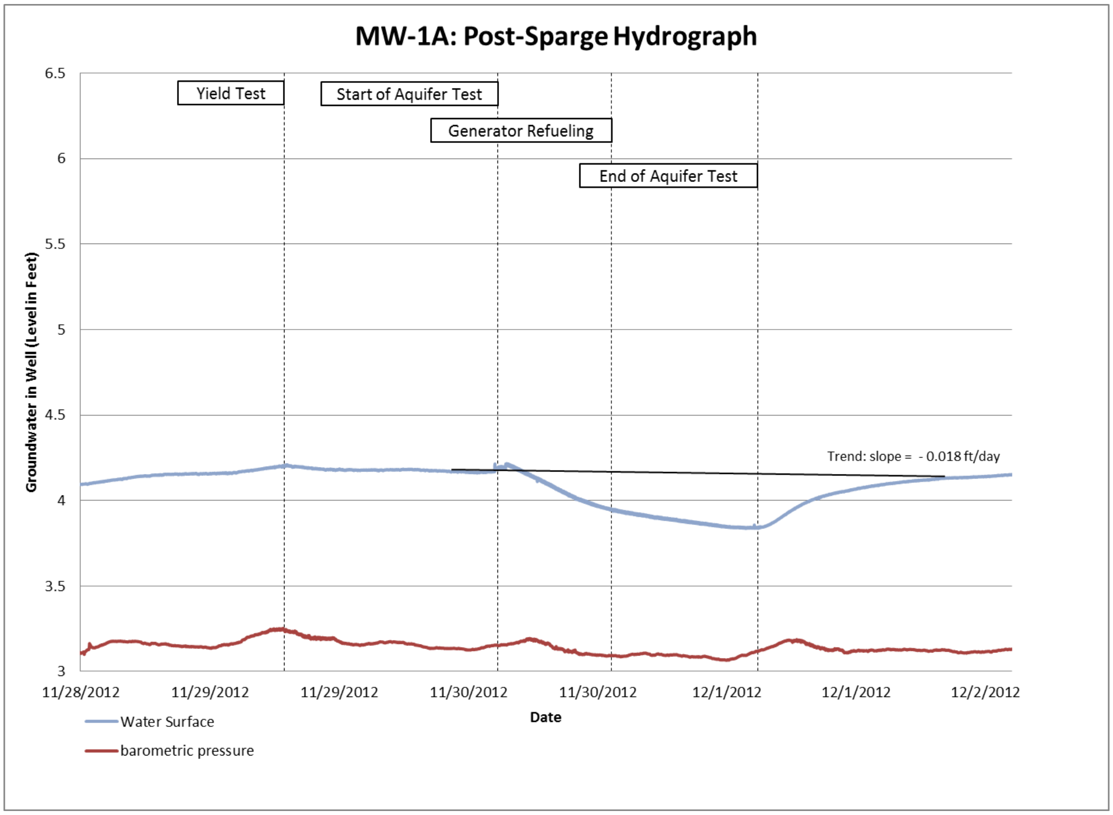

MW-519B: Antecedent Tidal Efficiency
Groundwater Elevation (Feet)
14
12
10
8
6
4
2
0
Yield test
10/3/2012 18:00
10/4/2012 6:00
10/4/2012 18:00
10/5/2012 6:00
10/5/2012 18:00
10/6/2012 6:00
Date
Water Surface
Tide Reading

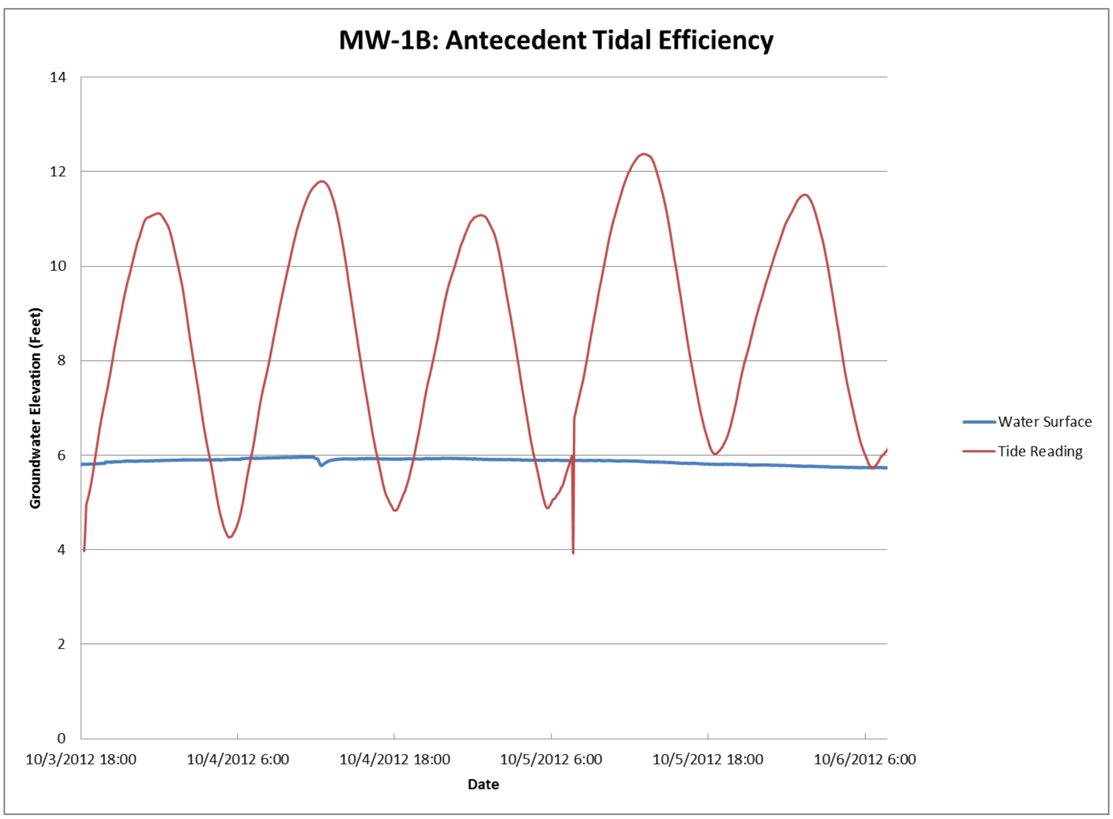

MW-519B: Pre-Sparge Hydrograph
Yield Test
Start of Aquifer Test
Generator Refueling
End of Aquifer Test
Trend: slope = - 0.075 ft/day
Groundwater in Well (Level in Feet)
Date
10/3/2012
10/4/2012
10/4/2012
10/5/2012
10/5/2012
10/6/2012
10/6/2012
10/7/2012
10/7/2012
10/8/2012
Water Surface
Barometric Pressure

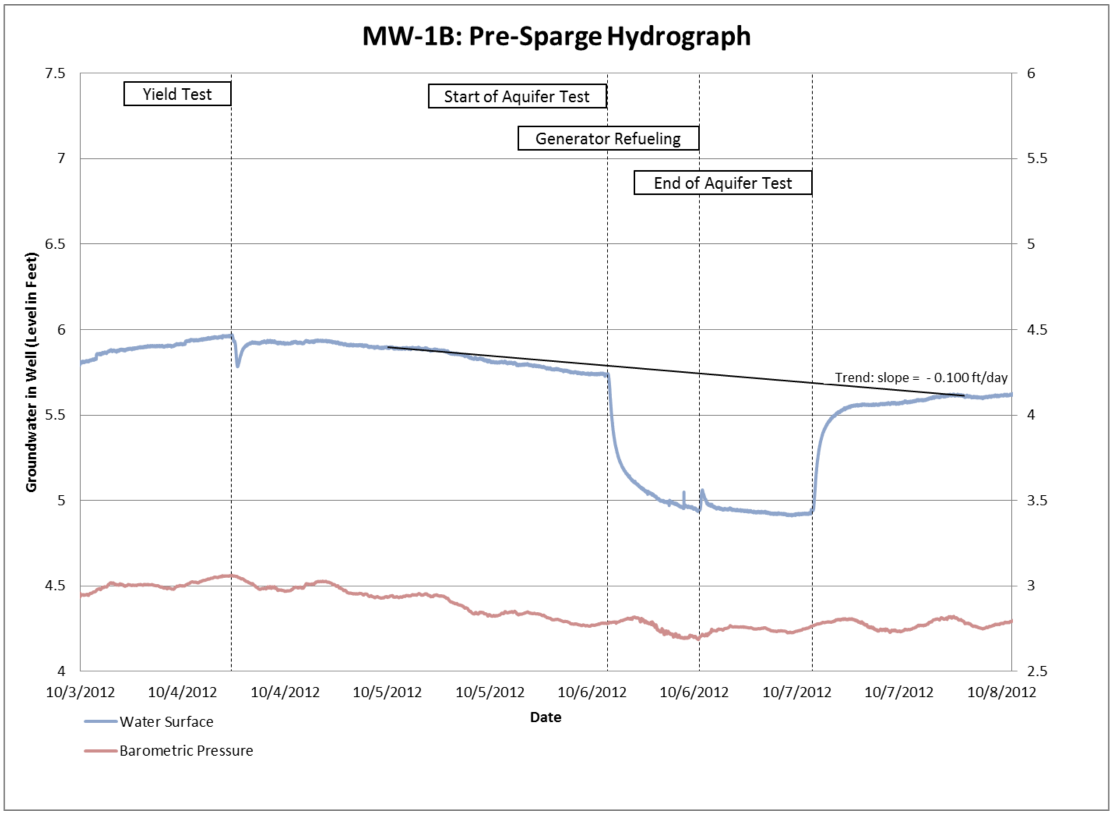

MW-519B: Post-Sparge Hydrograph
Yield Test
Start of Aquifer Test
Generator Refueling
End of Aquifer Test
Trend: slope = - 0.02 ft/day
Groundwater in Well (Level in Feet)
Date
11/28/2012
11/29/2012
11/29/2012
11/30/2012
11/30/2012
12/1/2012
12/1/2012
12/2/2012
Water Surface
barometric pressure


MW-1A: Antecedent Tidal Efficiency
Groundwater Elevation (Feet)
14
12
10
8
6
4
2
10/3/2012 18:00
10/4/2012 6:00
10/4/2012 18:00
10/5/2012 6:00
10/5/2012 18:00
10/6/2012 6:00
Date
Water Surface
Tide Reading

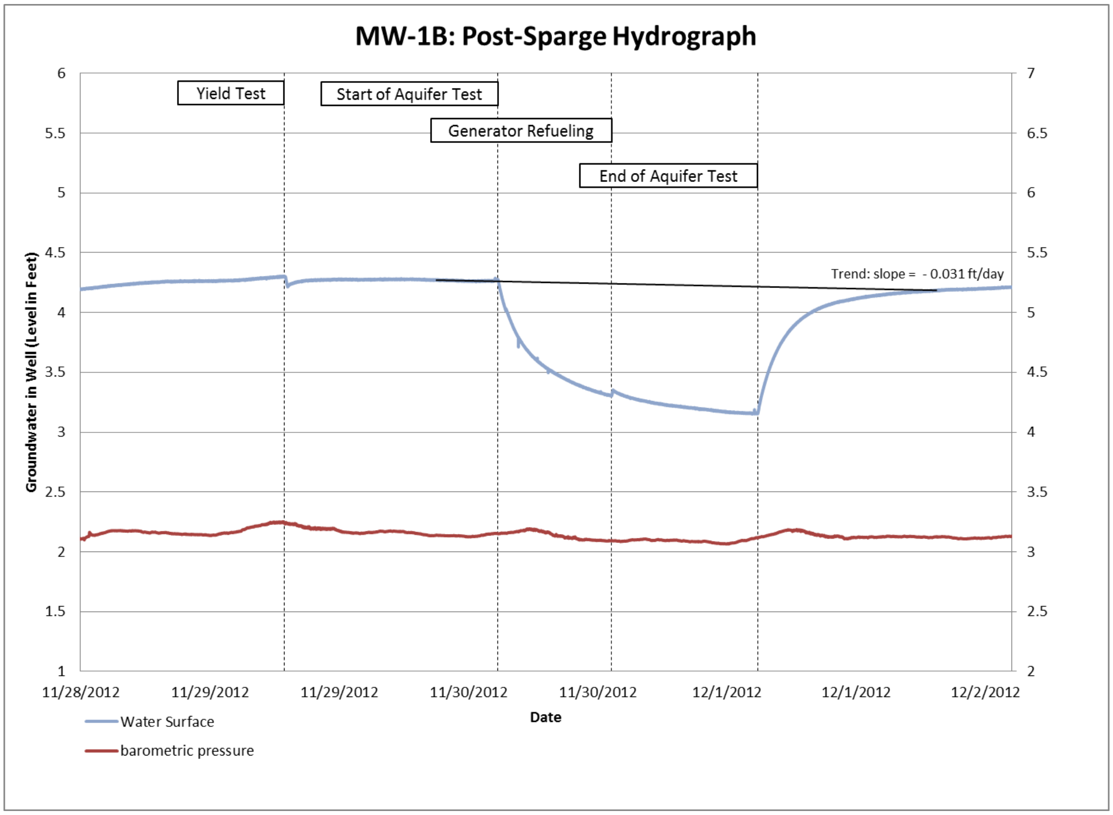

MW-1A: Pre-Sparge Hydrograph
Groundwater in Well (Level in Feet)
Yield Test
Start of Aquifer Test
Generator Refueling
End of Aquifer Test
Trend: slope = - 0.09 ft/day
7.5
7
6.5
6
5.5
5
4.5
4
0
0.5
1
1.5
2
2.5
3
3.5
10/3/2012
10/4/2012
10/4/2012
10/5/2012
10/5/2012
10/6/2012
10/6/2012
10/7/2012
10/7/2012
10/8/2012
Date
Water Surface
Barometric Pressure


MW-1A: Post-Sparge Hydrograph
Yield Test
Start of Aquifer Test
Generator Refueling
End of Aquifer Test
Trend: slope = - 0.018 ft/day
Groundwater in Well (Level in Feet)
6.5
6
5.5
5
4.5
4
3.5
3
11/28/2012
11/29/2012
11/29/2012
11/30/2012
11/30/2012
12/1/2012
12/1/2012
12/2/2012
Date
Water Surface
barometric pressure

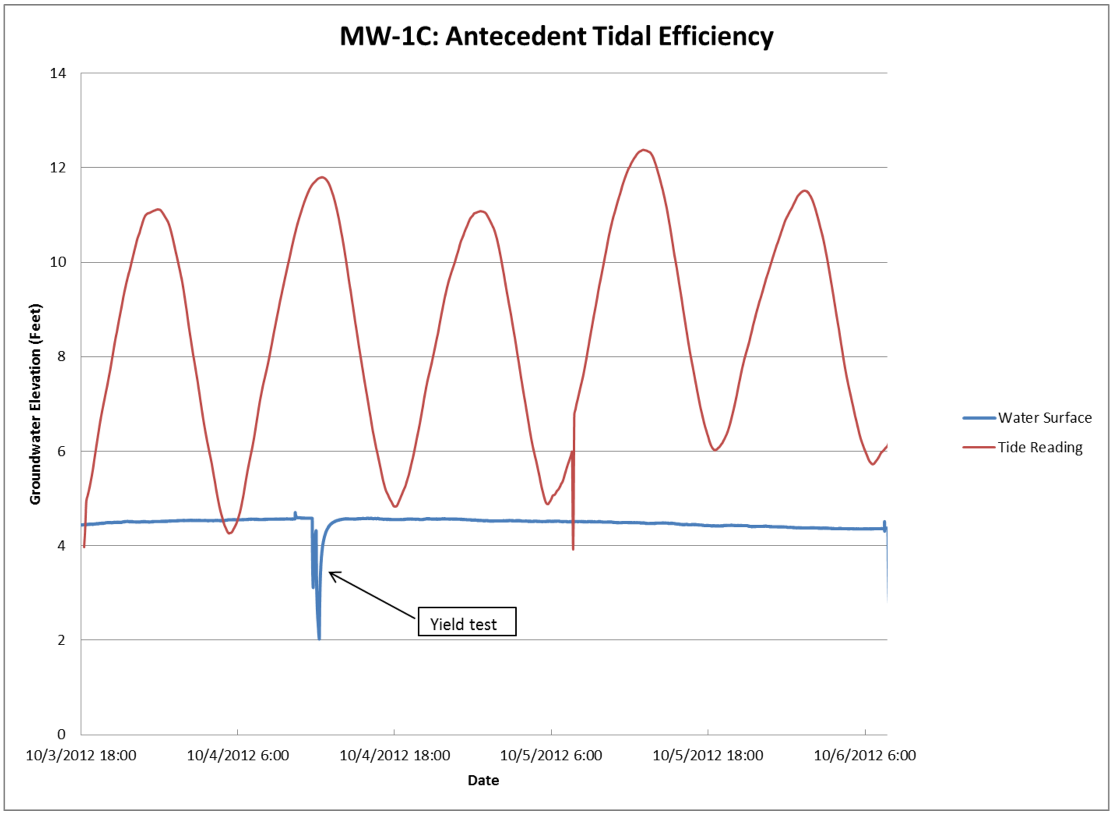

MW-1B: Antecedent Tidal Efficiency
Groundwater Elevation (Feet)
14
12
10
8
6
4
2
0
10/3/2012 18:00
10/4/2012 6:00
10/4/2012 18:00
10/5/2012 6:00
10/5/2012 18:00
10/6/2012 6:00
Date
Water Surface
Tide Reading

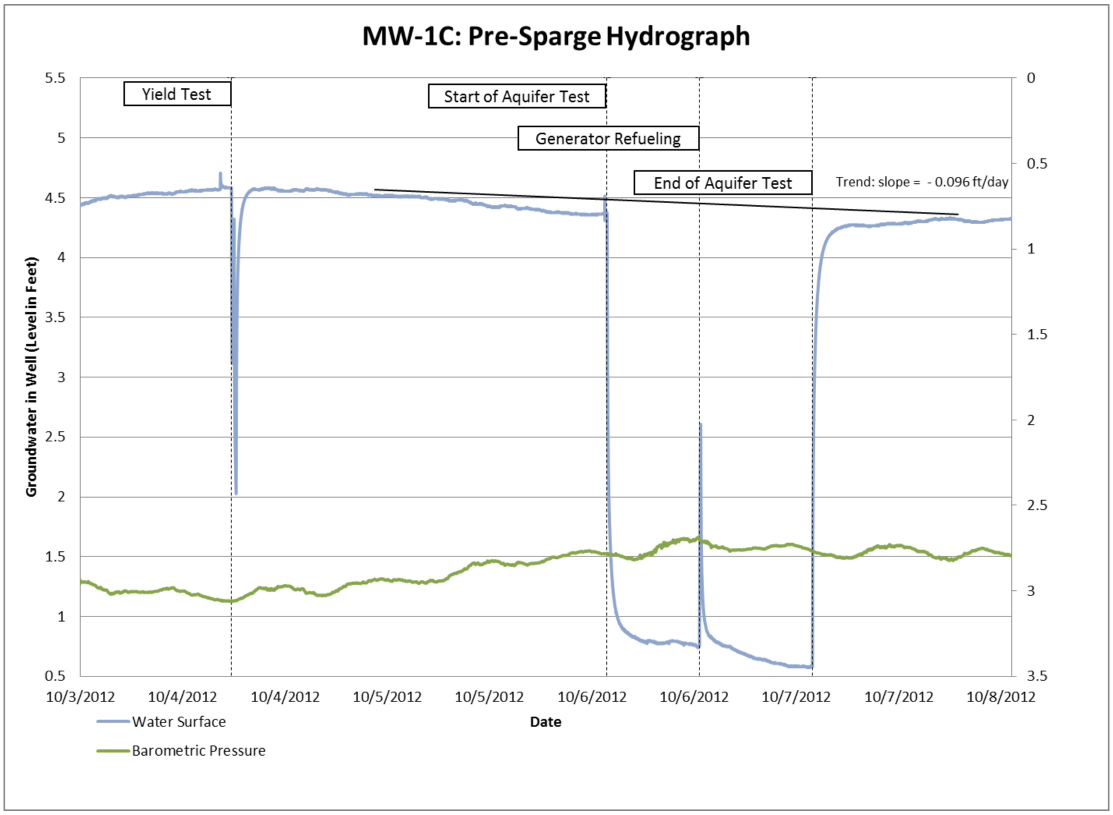


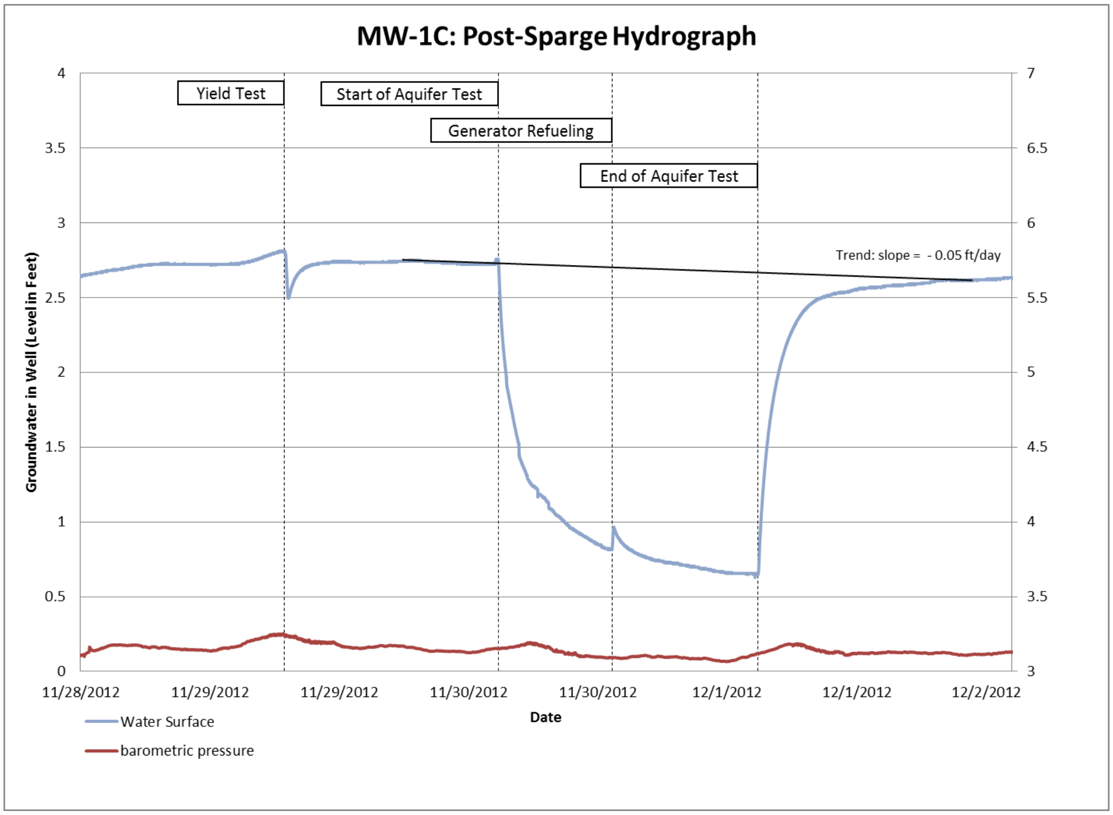
MW-1B: Pre-Sparge Hydrograph
Yield Test
Start of Aquifer Test
Generator Refueling
End of Aquifer Test
Trend: slope = - 0.100 ft/day
Groundwater in Well (Level in Feet)
Date
Water Surface
Barometric Pressure

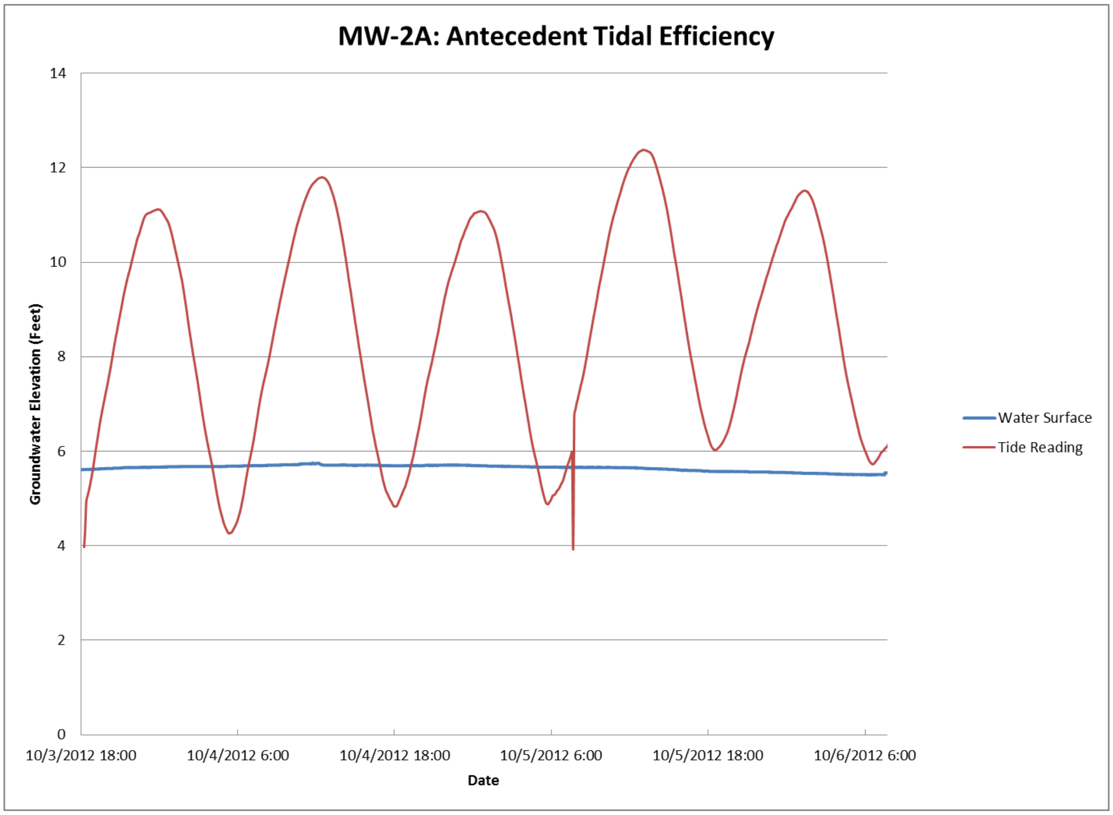


MW-1B: Post-Sparge Hydrograph
Yield Test
Start of Aquifer Test
Generator Refueling
End of Aquifer Test
Trend: slope = - 0.031 ft/day
Groundwater in Well (Level in Feet)
Date
Water Surface
barometric pressure

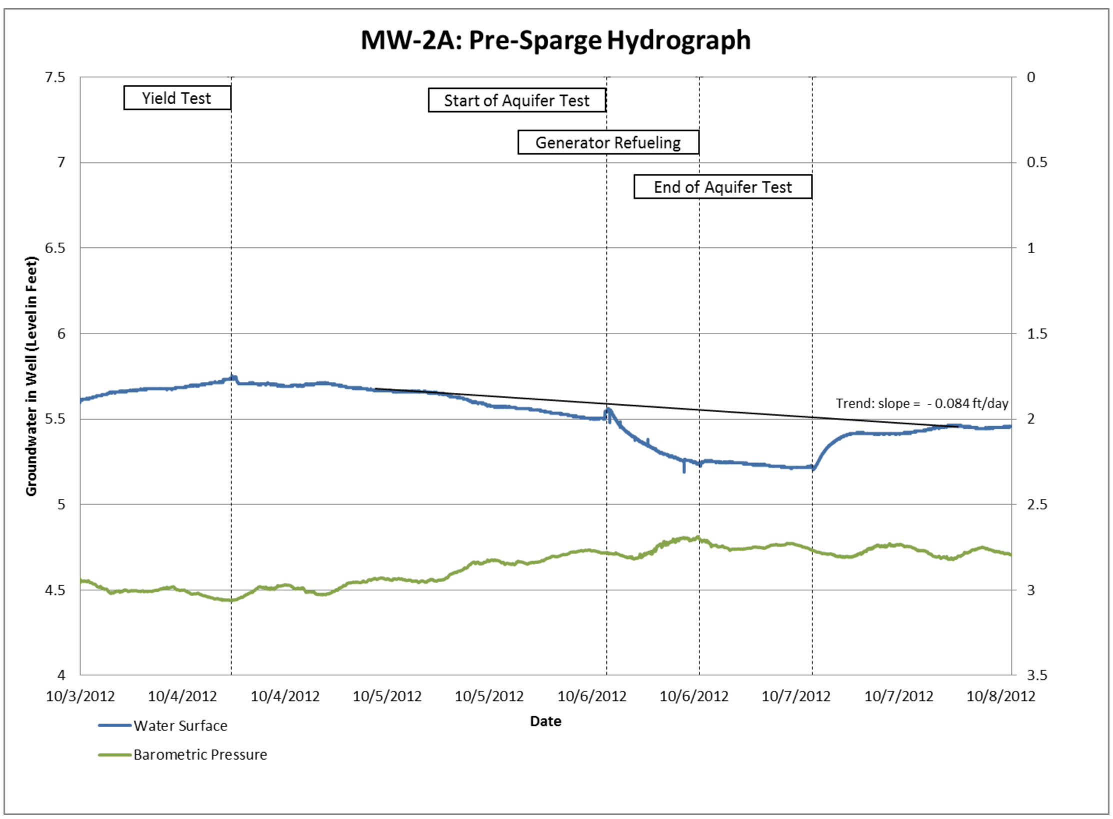

MW-1C: Antecedent Tidal Efficiency
Groundwater Elevation (Feet)
14
12
10
8
6
4
2
0
10/3/2012 18:00
10/4/2012 6:00
10/4/2012 18:00
10/5/2012 6:00
10/5/2012 18:00
10/6/2012 6:00
Date
Water Surface
Tide Reading
Yield test


MW-1C: Pre-Sparge Hydrograph
Groundwater in Well (Level in Feet)
5.5
5
4.5
4
3.5
3
2.5
2
1.5
1
0.5
0
0.5
1
1.5
2
2.5
3
3.5
Yield Test
Start of Aquifer Test
Generator Refueling
End of Aquifer Test
Trend: slope = - 0.096 ft/day
10/3/2012
10/4/2012
10/4/2012
10/5/2012
10/5/2012
10/6/2012
10/6/2012
10/7/2012
10/7/2012
10/8/2012
Date
Water Surface
Barometric Pressure

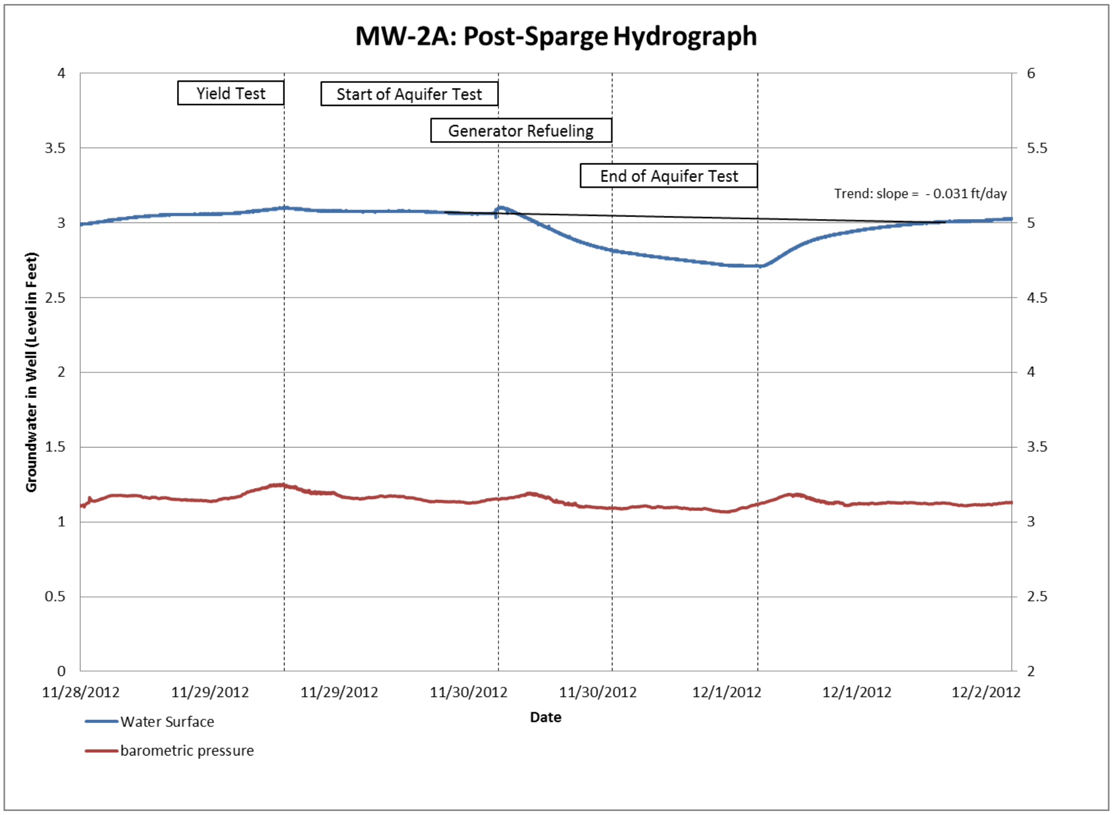

MW-1C: Post-Sparge Hydrograph
Yield Test
Start of Aquifer Test
Generator Refueling
End of Aquifer Test
Trend: slope = - 0.05 ft/day
Groundwater in Well (Level in Feet)
Date
11/28/2012
11/29/2012
11/29/2012
11/30/2012
11/30/2012
12/1/2012
12/1/2012
12/2/2012
Water Surface
barometric pressure

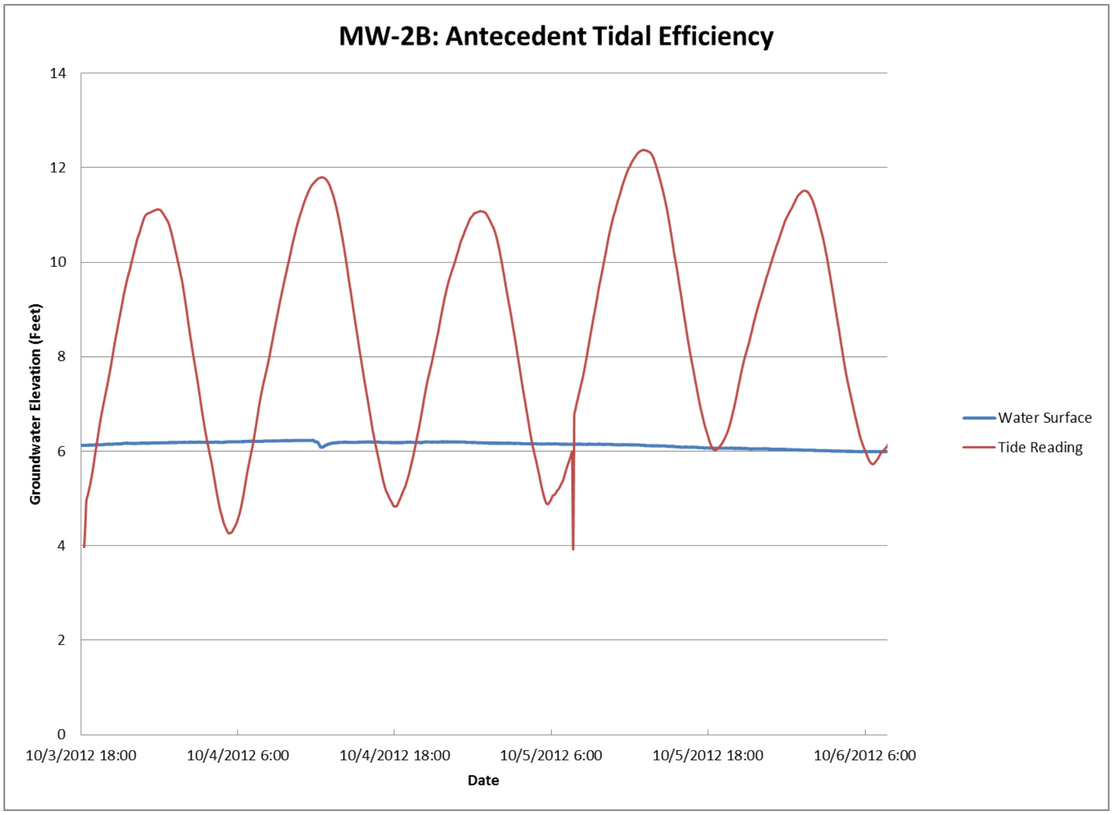


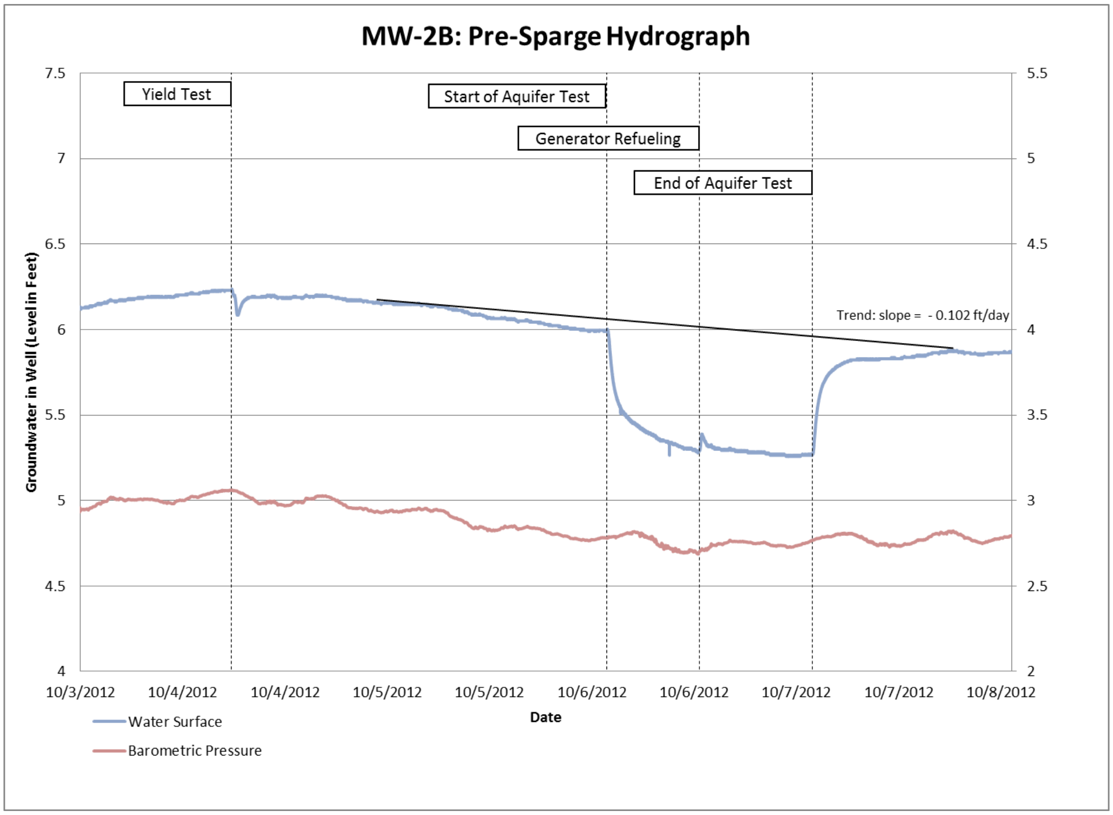
MW-2A: Antecedent Tidal Efficiency
14
12
10
8
6
4
2
0
Groundwater Elevation (Feet)
10/3/2012 18:00
10/4/2012 6:00
10/4/2012 18:00
10/5/2012 6:00
10/5/2012 18:00
10/6/2012 6:00
Date
Water Surface
Tide Reading

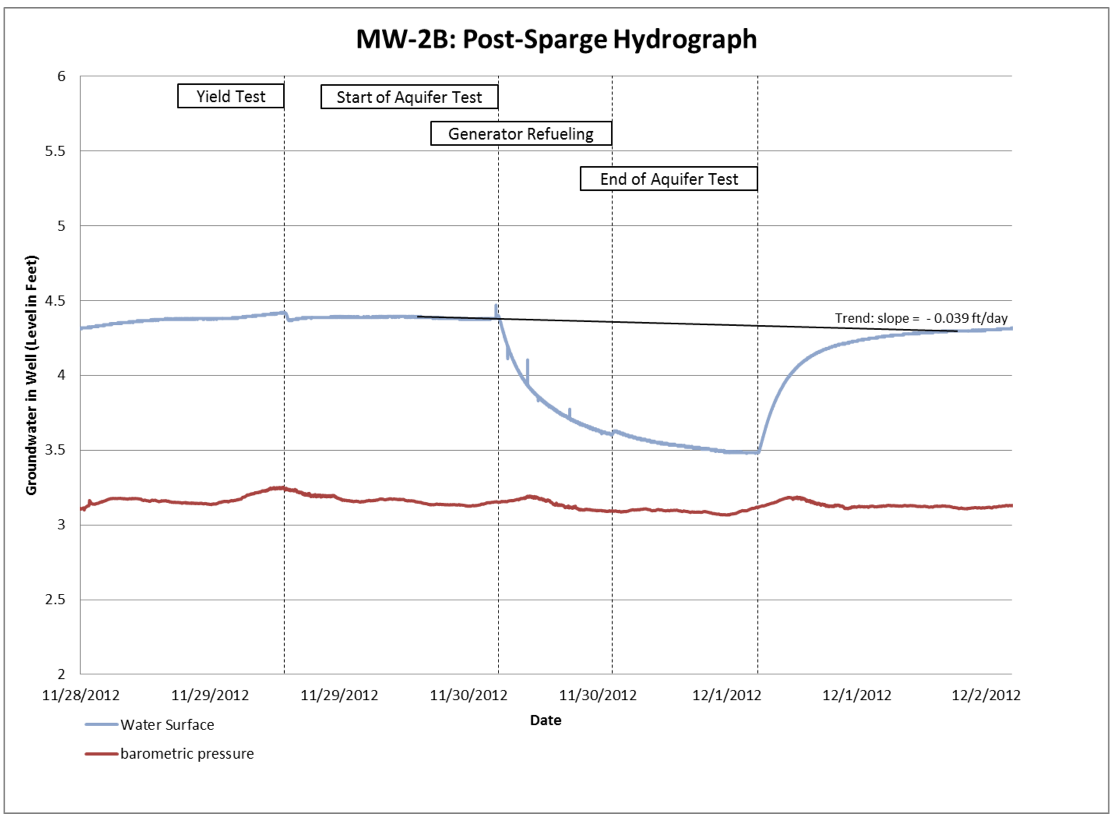


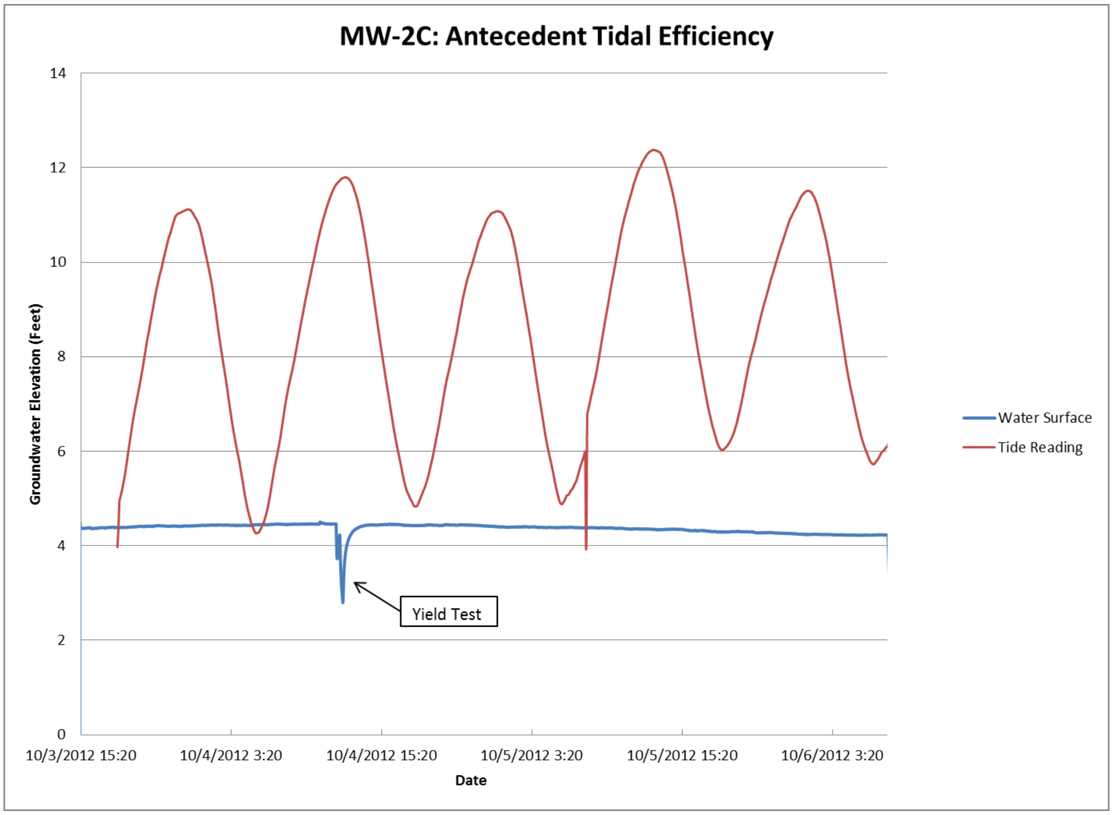
MW-2A: Pre-Sparge Hydrograph
Yield Test
Start of Aquifer Test
Generator Refueling
End of Aquifer Test
Trend: slope = - 0.084 ft/day
7.5
7
6.5
6
5.5
5
4.5
4
0
0.5
1
1.5
2
2.5
3
3.5
Groundwater in Well (Level in Feet)
10/3/2012
10/4/2012
10/4/2012
10/5/2012
10/5/2012
10/6/2012
10/6/2012
10/7/2012
10/7/2012
10/8/2012
Date
Water Surface
Barometric Pressure

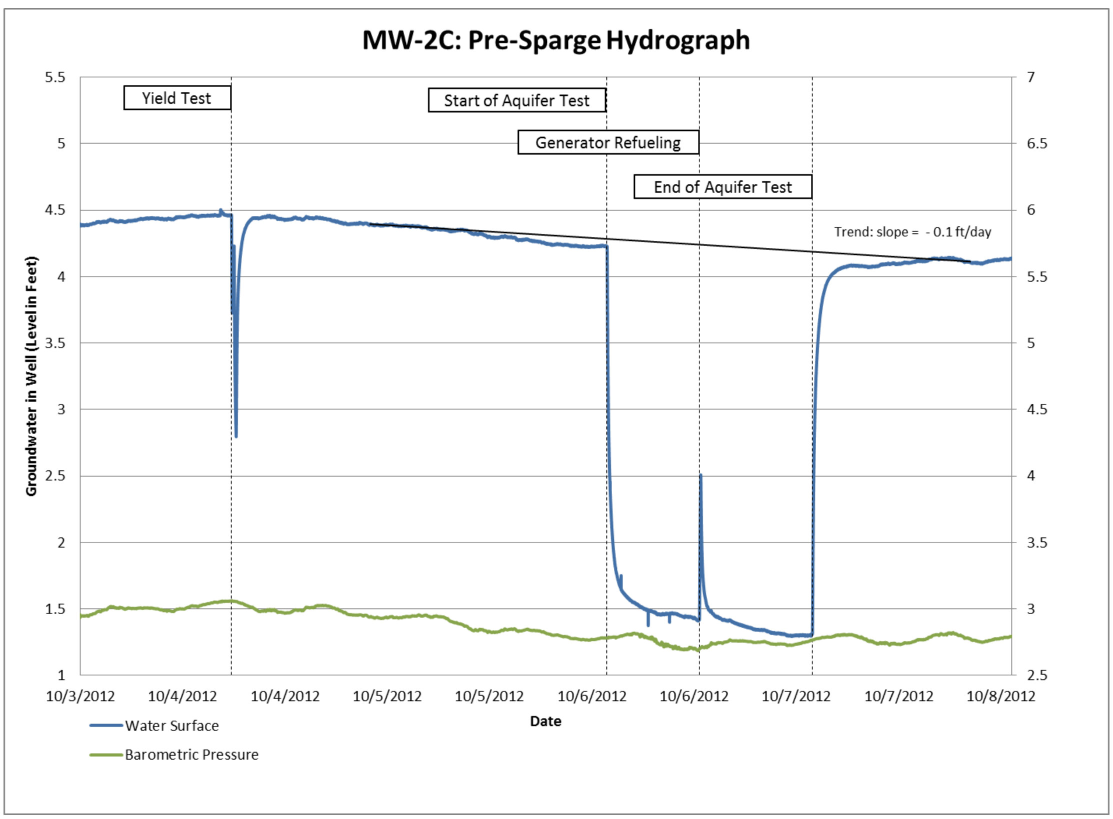

MW-2A: Post-Sparge Hydrograph
Yield Test
Start of Aquifer Test
Generator Refueling
End of Aquifer Test
Trend: slope = - 0.031 ft/day
Groundwater in Well (Level in Feet)
4
3.5
3
2.5
2
1.5
1
0.5
0
6
5.5
5
4.5
4
3.5
3
2.5
2
11/28/2012
11/29/2012
11/29/2012
11/30/2012
11/30/2012
12/1/2012
12/1/2012
12/2/2012
Date
Water Surface
barometric pressure

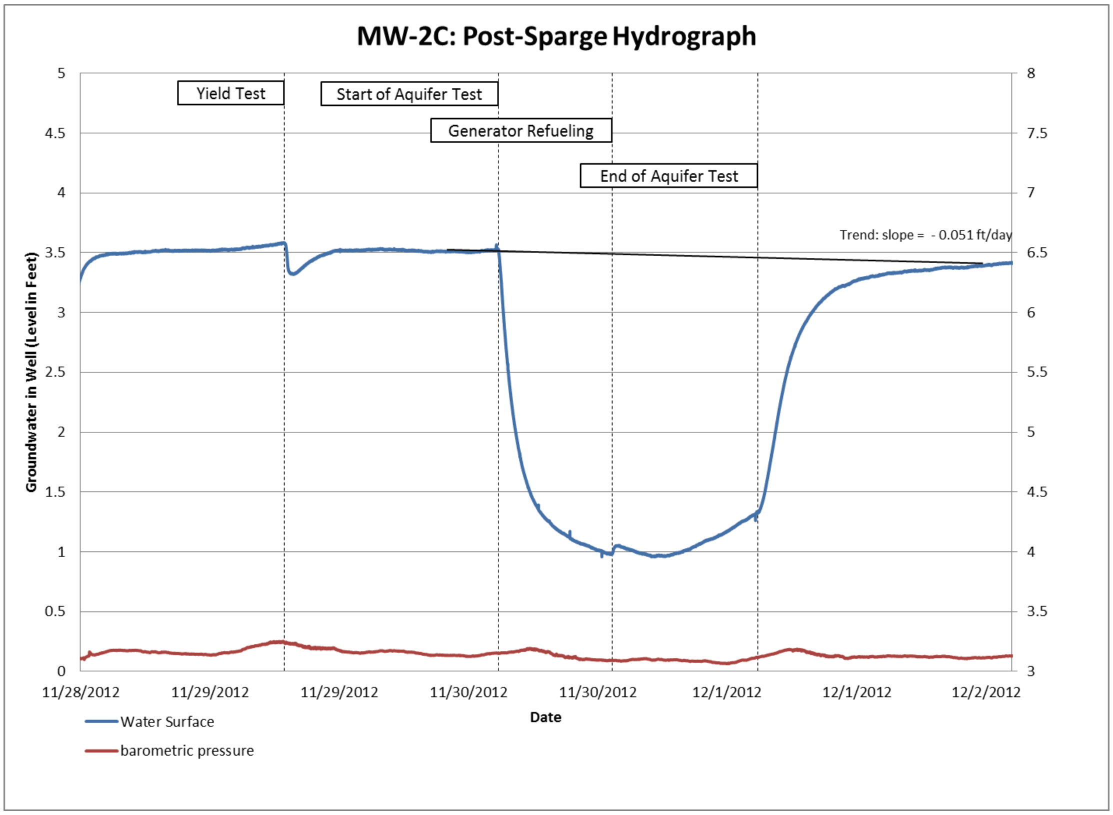

MW-2B: Antecedent Tidal Efficiency
Groundwater Elevation (Feet)
14
12
10
8
6
4
2
0
10/3/2012 18:00
10/4/2012 6:00
10/4/2012 18:00
10/5/2012 6:00
10/5/2012 18:00
10/6/2012 6:00
Date
Water Surface
Tide Reading


MW-2B: Pre-Sparge Hydrograph
Yield Test
Start of Aquifer Test
Generator Refueling
End of Aquifer Test
Trend: slope = - 0.102 ft/day
Groundwater in Well (Level in Feet)
7.5
7
6.5
6
5.5
5
4.5
4
5.5
5
4.5
4
3.5
3
2.5
2
10/3/2012
10/4/2012
10/4/2012
10/5/2012
10/5/2012
10/6/2012
10/6/2012
10/7/2012
10/7/2012
10/8/2012
Date
Water Surface
Barometric Pressure


MW-2B: Post-Sparge Hydrograph
Yield Test
Start of Aquifer Test
Generator Refueling
End of Aquifer Test
Trend: slope = - 0.039 ft/day
Groundwater in Well (Level in Feet)
6
5.5
5
4.5
4
3.5
3
2.5
2
11/28/2012
11/29/2012
11/29/2012
11/30/2012
11/30/2012
12/1/2012
12/1/2012
12/2/2012
Date
Water Surface
barometric pressure


MW-2C: Antecedent Tidal Efficiency
Groundwater Elevation (Feet)
14
12
10
8
6
4
2
0
10/3/2012 15:20
10/4/2012 3:20
10/4/2012 15:20
10/5/2012 3:20
10/5/2012 15:20
10/6/2012 3:20
Date
Yield Test
Water Surface
Tide Reading


MW-2C: Pre-Sparge Hydrograph
Groundwater in Well (Level in Feet)
5.5
5
4.5
4
3.5
3
2.5
2
1.5
1
7
6.5
6
5.5
5
4.5
4
3.5
3
2.5
Yield Test
Start of Aquifer Test
Generator Refueling
End of Aquifer Test
Trend: slope = - 0.1 ft/day
10/3/2012
10/4/2012
10/4/2012
10/5/2012
10/5/2012
10/6/2012
10/6/2012
10/7/2012
10/7/2012
10/8/2012
Date
Water Surface
Barometric Pressure



MW-2C: Post-Sparge Hydrograph
Yield Test
Start of Aquifer Test
Generator Refueling
End of Aquifer Test
Trend: slope = - 0.051 ft/day
Groundwater in Well (Level in Feet)
5
4.5
4
3.5
3
2.5
2
1.5
1
0.5
0
8
7.5
7
6.5
6
5.5
5
4.5
4
3.5
3
11/28/2012
11/29/2012
11/29/2012
11/30/2012
11/30/2012
12/1/2012
12/1/2012
12/2/2012
Date
Water Surface
barometric pressure

APPENDIX C. PURGE LOGS

GROUNDWATER SAMPLING LOG

SITE NAME: LCP Chemical Site	SITE LOCATION: Brunswick, GA	
WELL NO: MW-1A	SAMPLE ID: MW-1A	DATE: 10/2/12

PURGING DATA

WELL DIAMETER (inches): 2	TUBING DIAMETER (inches): 1/4	WELL SCREEN INTERVAL DEPTH(btoc): 18 feet to 23 feet	STATIC DEPTH TO WATER (feet btoc): 7.19	PURGE PUMP TYPE OR BAILER: PP

WELL VOLUME PURGE: **1 WELL VOLUME** = (TOTAL WELL DEPTH – STATIC DEPTH TO WATER) X WELL CAPACITY
(only fill out if applicable)
= (feet – feet) X 0.16 gallons/foot = gallons

EQUIPMENT VOLUME PURGE: **1 EQUIPMENT VOL.** = PUMP VOLUME + (TUBING CAPACITY X TUBING LENGTH) + FLOW CELL VOLUME
(only fill out if applicable)
= +.10 gallons (0.0026 gallons/foot X 23 feet) + .10 gallons = 0.26 gallons

INITIAL PUMP OR TUBING DEPTH IN WELL (feet btoc): 20.5	FINAL PUMP OR TUBING DEPTH IN WELL (feet btoc): 20.5	PURGING INITIATED AT: 1347	PURGING ENDED AT: 1556	TOTAL VOLUME PURGED (gallons): 1.95

TIME	VOLUME PURGED (gallons)	CUMUL. VOLUME PURGED (gallons)	PURGE RATE (gpm)	DEPTH TO WATER (feet btoc)	pH (standard units)	TEMP. (^{o}C)	SP COND. (mS/cm)	DISSOLVED OXYGEN (% saturation)	TURBIDITY (NTUs)	ORP (mV)	SP Gravity (sg)
1548	1.55	1.55	0.05	7.14	8.48	25.52	6.854	1.2	65.7	-257.3	
1550	0.10	1.65	0.05	7.14	8.48	25.31	6.846	1.2	65.8	-274.7	
1552	0.10	1.75	0.05	7.14	8.47	25.08	6.839	1.2	66.4	-273.7	
1554	0.10	1.85	0.05	7.14	8.48	24.92	6.831	1.2	70.1	-276.6	
1556	0.10	1.95	0.05	7.14	8.48	24.88	6.842	1.2	69.6	-277.8	1.001

WELL CAPACITY (Gallons Per Foot): **0.75"** = 0.02; **1"** = 0.04; **1.25"** = 0.06; **2"** = 0.16; **3"** = 0.37; **4"** = 0.65; **5"** = 1.02; **6"** = 1.47; **12"** = 5.88
TUBING INSIDE DIA. CAPACITY (Gal./Ft.): **1/8"** = 0.0006; **3/16"** = 0.0014; **1/4"** = 0.0026; **5/16"** = 0.004; **3/8"** = 0.006; **1/2"** = 0.010; **5/8"** = 0.016
BTOC= Below top of casing- which includes above grade riser

PURGING EQUIPMENT CODES: **B** = Bailer; **BP** = Bladder Pump; **ESP** = Electric Submersible Pump; **PP =** Peristaltic Pump; **O** = Other (Specify)

SAMPLING DATA

SAMPLED BY (PRINT) / AFFILIATION: Maria Johnson/Parsons	SAMPLER(S) SIGNATURE(S): Maria Johnson	SAMPLING INITIATED AT: 1559	SAMPLING ENDED AT: 1616

PUMP OR TUBING DEPTH IN WELL (feet): 20.5	TUBING MATERIAL CODE: Teflon lined PE	FIELD-FILTERED: Yes/**SM 4500 Sulfide** FILTER SIZE: 0.45 μm Filtration Equipment Type: Syringe
FIELD DECONTAMINATION: PUMP Y **No**	TUBING Y **No (replaced)**	DUPLICATE: No

SAMPLE CONTAINER SPECIFICATION				SAMPLE PRESERVATION			INTENDED ANALYSIS AND/OR METHOD	SAMPLING EQUIPMENT CODE	SAMPLE PUMP FLOW RATE (mL per minute)
SAMPLE ID CODE	# CONTAINERS	MATERIAL CODE	VOLUME	PRESERVATIVE USED	TOTAL VOL ADDED IN FIELD (mL)	FINAL pH			
MW-1A	1	PE	250mL	HNO3	--	--	6010B TAL Metals/7470A Hg	APP	125
MW-1A	1	PE	125mL	--	--		3500 FE/ 9040B pH	APP	125
MW-1A	1	PE	250mL	--	--	--	6010B Dissolved Silica	APP	250
MW-1A	1	PE	125mL	--	--	--	9056A_28D Chloride &	APP	125
MW-1A	1	AG	125mL	--	--	--	SM 5310 DOC	APP	125
MW-1A	2	PE	250mL	NaOH Zinc Acetate	--	--	SM4500 Sulfide	APP	**Field-Filtered**
MW-1A	1	PE	500mL	--	--	--	2540C TDS	APP	125
MW-1A	1	PE	250mL	--	--	--	2320B Alkalinity	APP	250
MW-1A	1	AG	125mL	HCl	--	--	SM5310 TOC	APP	125

REMARKS: Per SOP, parameters stable for three readings prior to sampling. Tubing-In-Screened Interval purge method was used. Purge was puased1404 to 1516 due to heavy rain. Turbidity was greater than 10 NTU but within 10%. Purge water dark brown.

MATERIAL CODES: **AG** = Amber Glass; **CG** = Clear Glass; **PE** = Polyethylene; **PP** = Polypropylene; **S** = Silicone; **T** = Teflon; **O** = Other (Specify)

SAMPLING EQUIPMENT CODES: **APP** = After Peristaltic Pump; **B** = Bailer; **BP** = Bladder Pump; **ESP** = Electric Submersible Pump; **RFPP** = Reverse Flow Peristaltic Pump; **SM** = Straw Method (Tubing Gravity Drain); **O** = Other (Specify)

NOTES: Stabilization Criteria for Range of Variation of Last Three Consecutive Readings:-**pH:** ± 0.1 unit **Specific Conductance:** ± 5% **Dissolved Oxygen:** all readings ≤ 10% saturation; optionally, ± 0.2 mg/L **Turbidity:** all readings ≤ 10 NTU; or ± 10%

GROUNDWATER SAMPLING LOG

SITE NAME: LCP Chemical Site		SITE LOCATION: Brunswick, GA
WELL NO: MW-1B	SAMPLE ID: MW-1B	DATE: 10/2/12

PURGING DATA

WELL DIAMETER (inches): 2	TUBING DIAMETER (inches): 1/4	WELL SCREEN INTERVAL (btoc) DEPTH: 33 feet to 38 feet	STATIC DEPTH (btoc) TO WATER (feet): 6.75	PURGE PUMP TYPE OR BAILER: PP

WELL VOLUME PURGE: 1 WELL VOLUME = (TOTAL WELL DEPTH – STATIC DEPTH TO WATER) X WELL CAPACITY
(only fill out if applicable)
= (feet – feet) X 0.16 gallons/foot = gallons

EQUIPMENT VOLUME PURGE: 1 EQUIPMENT VOL. = PUMP VOLUME + (TUBING CAPACITY X TUBING LENGTH) + FLOW CELL VOLUME
(only fill out if applicable)
= +.10 gallons (0.0026 gallons/foot X 38 feet) + .10 gallons = 0.3 gallons

INITIAL PUMP OR TUBING DEPTH IN WELL (feet btoc): 35	FINAL PUMP OR TUBING DEPTH IN WELL (feet btoc): 35	PURGING INITIATED AT: 1046	PURGING ENDED AT: 1138	TOTAL VOLUME PURGED (gallons): 1.6

TIME	VOLUME PURGED (gallons)	CUMUL. VOLUME PURGED (gallons)	PURGE RATE (gpm)	DEPTH TO WATER (feet btoc)	pH (standard units)	TEMP. (°C)	SP COND. (mS/cm)	DISSOLVED OXYGEN (% saturation)	TURBIDITY (NTUs)	ORP (mV)	SP Gravity (sg)
1111	0.75	0.75	0.03	7.00	8.91	25.06	6.366	1.8	55.9	-278.0	
1114	0.10	0.85	0.03	7.00	8.94	25.02	6.382	1.7	52.7	-289.5	
1118	0.15	1.00	0.04	7.11	8.96	25.18	6.397	1.7	52.6	-284.4	
1122	0.15	1.15	0.04	7.11	8.98	25.45	6.408	1.6	52.4	-293.0	
1132	0.35	1.50	0.04	7.11	9.05	25.47	6.400	1.5	56.4	-347.1	
1136	0.10	1.60	0.03	7.11	9.04	25.43	6.398	1.3	56.4	-359.8	0.999

WELL CAPACITY (Gallons Per Foot): **0.75"** = 0.02; **1"** = 0.04; **1.25"** = 0.06; **2"** = 0.16; **3"** = 0.37; **4"** = 0.65; **5"** = 1.02; **6"** = 1.47; **12"** = 5.88
TUBING INSIDE DIA. CAPACITY (Gal./Ft.): **1/8"** = 0.0006; **3/16"** = 0.0014; **1/4"** = 0.0026; **5/16"** = 0.004; **3/8"** = 0.006; **1/2"** = 0.010; **5/8"** = 0.016
BTOC = Below top of casing –which includes above grade riser

PURGING EQUIPMENT CODES: **B** = Bailer; **BP** = Bladder Pump; **ESP** = Electric Submersible Pump; **PP =** Peristaltic Pump; **O** = Other (Specify)

SAMPLING DATA

SAMPLED BY (PRINT) / AFFILIATION: Christine Jaynes/Parsons	SAMPLER(S) SIGNATURE(S): CJaynes	SAMPLING INITIATED AT: 1151	SAMPLING ENDED AT: 1218

PUMP OR TUBING DEPTH IN WELL (feet): 35	TUBING MATERIAL CODE: Teflon lined PE	FIELD-FILTERED: Yes/**SM 4500 Sulfide** FILTER SIZE: 0.45 μm Filtration Equipment Type: Syringe
FIELD DECONTAMINATION: PUMP Y **No** TUBING Y **No (replaced)**		DUPLICATE: No

SAMPLE CONTAINER SPECIFICATION				SAMPLE PRESERVATION			INTENDED ANALYSIS AND/OR METHOD	SAMPLING EQUIPMENT CODE	SAMPLE PUMP FLOW RATE (mL per minute)
SAMPLE ID CODE	# CONTAINERS	MATERIAL CODE	VOLUME	PRESERVATIVE USED	TOTAL VOL ADDED IN FIELD (mL)	FINAL pH			
MW-1B	1	PE	250mL	HNO3	--	--	6010B TAL Metals/7470A Hg	APP	125
MW-1B	1	PE	125mL	--	--		3500 FE/ 9040B pH	APP	63
MW-1B	1	PE	250mL	--	--	--	6010B Dissolved Silica	APP	125
MW-1B	1	PE	125mL	--	--	--	9056A_28D Chloride & Sulfate	APP	63
MW-1B	1	AG	125mL	--	--	--	SM 5310 DOC	APP	125
MW-1B	2	PE	250mL	NaOH Zinc Acetate	--	--	SM4500 Sulfide	APP	**Field-Filtered**
MW-1B	1	PE	500mL	--	--	--	2540C TDS	APP	83
MW-1B	1	PE	250mL	--	--	--	2320B Alkalinity	APP	83
MW-1B	1	AG	125mL	HCl	--	--	SM5310 TOC	APP	125

REMARKS: Per SOP, parameters stable for three readings prior to sampling. Tubing-In Screened-Interval purge method used. Turbidity greater than 10 NTU but within 10%. Purge water clear brown.

MATERIAL CODES: **AG** = Amber Glass; **CG** = Clear Glass; **PE** = Polyethylene; **PP** = Polypropylene; **S** = Silicone; **T** = Teflon; **O** = Other (Specify)

SAMPLING EQUIPMENT CODES: **APP** = After Peristaltic Pump; **B** = Bailer; **BP** = Bladder Pump; **ESP** = Electric Submersible Pump; **RFPP** = Reverse Flow Peristaltic Pump; **SM** = Straw Method (Tubing Gravity Drain); **O** = Other (Specify)

NOTES: Stabilization Criteria for Range of Variation of Last Three Consecutive Readings:-**pH:** ± 0.1 unit **Specific Conductance:** ± 5% **Dissolved Oxygen:** all readings ≤ 10% saturation; optionally, ± 0.2 mg/L **Turbidity:** all readings ≤ 10 NTU; or ± 10%

GROUNDWATER SAMPLING LOG

SITE NAME: LCP Chemical	SITE LOCATION: Brunswick, GA	
WELL NO: MW-1C	SAMPLE ID: MW-1C	DATE: 10/2/12

PURGING DATA

WELL DIAMETER (inches): 2	TUBING DIAMETER (inches): 1/4	WELL SCREEN INTERVAL DEPTH btoc: 45 feet to 50 feet	STATIC DEPTH TO WATER (feet btoc): 8.37	PURGE PUMP TYPE OR BAILER: PP

WELL VOLUME PURGE: 1 WELL VOLUME = (TOTAL WELL DEPTH – STATIC DEPTH TO WATER) X WELL CAPACITY
(only fill out if applicable)
= (feet – feet) X 0.16 gallons/foot = gallons

EQUIPMENT VOLUME PURGE: 1 EQUIPMENT VOL. = PUMP VOLUME + (TUBING CAPACITY X TUBING LENGTH) + FLOW CELL VOLUME
(only fill out if applicable)
= +.10 gallons (0.0026 gallons/foot X 50 feet) + .10 gallons = 0.33 gallons

INITIAL PUMP OR TUBING DEPTH IN WELL (feet btoc): 47.5	FINAL PUMP OR TUBING DEPTH IN WELL (feet btoc): 47.5	PURGING INITIATED AT: 1046	PURGING ENDED AT: 1111	TOTAL VOLUME PURGED (gallons): 1.2

TIME	VOLUME PURGED (gallons)	CUMUL. VOLUME PURGED (gallons)	PURGE RATE (gpm)	DEPTH TO WATER (feet btoc)	pH (standard units)	TEMP. (^{O}C)	SP COND. (mS/cm)	DISSOLVED OXYGEN (% saturation)	TURBIDITY (NTUs)	ORP (mV)	SP Gravity (sg)
1107	1.0	1.0	0.05	8.5	12.20	24.09	58.48	1.5	5.70	-347.7	
1109	0.1	1.1	0.05	8.5	12.22	24.12	58.50	1.5	4.88	-351.6	
1111	0.1	1.2	0.05	8.5	12.24	24.14	58.52	1.6	7.12	-354.4	1.023

WELL CAPACITY (Gallons Per Foot): **0.75"** = 0.02; **1"** = 0.04; **1.25"** = 0.06; **2"** = 0.16; **3"** = 0.37; **4"** = 0.65; **5"** = 1.02; **6"** = 1.47; **12"** = 5.88
TUBING INSIDE DIA. CAPACITY (Gal./Ft.): **1/8"** = 0.0006; **3/16"** = 0.0014; **1/4"** = 0.0026; **5/16"** = 0.004; **3/8"** = 0.006; **1/2"** = 0.010; **5/8"** = 0.016
BTOC= Below top of casing- which includes above grade riser

PURGING EQUIPMENT CODES: **B** = Bailer; **BP** = Bladder Pump; **ESP** = Electric Submersible Pump; **PP =** Peristaltic Pump; **O** = Other (Specify)

SAMPLING DATA

SAMPLED BY (PRINT) / AFFILIATION: Maria Johnson/Parsons	SAMPLER(S) SIGNATURE(S): Maria Johnson	SAMPLING INITIATED AT: 1117	SAMPLING ENDED AT: 1142
PUMP OR TUBING DEPTH IN WELL (feet): 47.5	TUBING MATERIAL CODE: Teflon-lined PE	FIELD-FILTERED: Yes/**SM 4500 Sulfide** FILTER SIZE: 0.45 μm Filtration Equipment Type: Syringe	
FIELD DECONTAMINATION: PUMP Y **No**	TUBING Y **No (replaced)**	DUPLICATE: No	

SAMPLE CONTAINER SPECIFICATION				SAMPLE PRESERVATION			INTENDED ANALYSIS AND/OR METHOD	SAMPLING EQUIPMENT CODE	SAMPLE PUMP FLOW RATE (mL per minute)
SAMPLE ID CODE	# CONTAINERS	MATERIAL CODE	VOLUME	PRESERVATIVE USED	TOTAL VOL ADDED IN FIELD (mL)	FINAL pH			
MW-1C	1	PE	250mL	HNO3	--	--	6010B TAL Metals/7470A Hg	APP	125
MW-1C	1	PE	125mL	--	--		3500 FE/ 9040B pH	APP	125
MW-1C	1	PE	250mL	--	--	--	6010B Dissolved Silica	APP	125
MW-1C	1	PE	125mL	--	--	--	9056A_28D Chloride &	APP	125
MW-1C	1	AG	125mL	--	--	--	SM 5310 DOC	APP	125
MW-1C	2	PE	250mL	NaOH Zinc Acetate	--	--	SM4500 Sulfide	APP	**Field-Filtered**
MW-1C	1	PE	500mL	--	--	--	2540C TDS	APP	167
MW-1C	1	PE	250mL	--	--	--	2320B Alkalinity	APP	125
MW-1C	1	AG	125mL	HCl	--	--	SM5310 TOC	APP	125

REMARKS: Per SOP, parameters stable for three readings prior to sampling. Tubing-in-Screen- Interval Purge method used. Purge water dark brown.

MATERIAL CODES: **AG** = Amber Glass; **CG** = Clear Glass; **PE** = Polyethylene; **PP** = Polypropylene; **S** = Silicone; **T** = Teflon; **O** = Other (Specify)

SAMPLING EQUIPMENT CODES: **APP** = After Peristaltic Pump; **B** = Bailer; **BP** = Bladder Pump; **ESP** = Electric Submersible Pump; **RFPP** = Reverse Flow Peristaltic Pump; **SM** = Straw Method (Tubing Gravity Drain); **O** = Other (Specify)

NOTES: Stabilization Criteria for Range of Variation of Last Three Consecutive Readings:-**pH:** ± 0.1 unit **Specific Conductance:** ± 5% **Dissolved Oxygen:** all readings ≤ 10% saturation; optionally, ± 0.2 mg/L **Turbidity:** all readings ≤ 10 NTU; or ± 10%

GROUNDWATER SAMPLING LOG

SITE NAME: LCP Chemical Site	SITE LOCATION: Brunswick, GA

WELL NO: MW-2A	SAMPLE ID: MW-2A	DATE: 10/3/12

PURGING DATA

WELL DIAMETER (inches): 2	TUBING DIAMETER (inches): 1/4	WELL SCREEN INTERVAL (btoc) DEPTH: 18.5 feet to 23.5 feet	STATIC DEPTH (btoc) TO WATER (feet): 7.15	PURGE PUMP TYPE OR BAILER: PP

WELL VOLUME PURGE: 1 WELL VOLUME = (TOTAL WELL DEPTH – STATIC DEPTH TO WATER) X WELL CAPACITY
(only fill out if applicable)
= (feet – feet) X 0.16 gallons/foot = gallons

EQUIPMENT VOLUME PURGE: 1 EQUIPMENT VOL. = PUMP VOLUME + (TUBING CAPACITY X TUBING LENGTH) + FLOW CELL VOLUME
(only fill out if applicable)
= +.10 gallons (0.0026 gallons/foot X 23.5 feet) + .10 gallons = 0.26 gallons

INITIAL PUMP OR TUBING DEPTH IN WELL (feet btoc): 21.5	FINAL PUMP OR TUBING DEPTH IN WELL (feet btoc): 21.5	PURGING INITIATED AT: 1439	PURGING ENDED AT: 1501	TOTAL VOLUME PURGED (gallons): 1.2

TIME	VOLUME PURGED (gallons)	CUMUL. VOLUME PURGED (gallons)	PURGE RATE (gpm)	DEPTH TO WATER (feet btoc)	pH (standard units)	TEMP. (^{O}C)	SP COND. (mS/cm)	DISSOLVED OXYGEN (% saturation)	TURBIDITY (NTUs)	ORP (mV)	SP Gravity (sg)
1456	1.0	1.0	0.06	7.1	8.77	24.77	6.802	1.6	96.8	-188.7	
1458	0.1	1.1	0.05	7.1	8.76	24.74	6.809	1.5	97.7	-191.6	
1500	0.1	1.2	0.05	7.1	8.74	24.69	6.810	1.5	99.7	-193.7	1.001

WELL CAPACITY (Gallons Per Foot): **0.75"** = 0.02; **1"** = 0.04; **1.25"** = 0.06; **2"** = 0.16; **3"** = 0.37; **4"** = 0.65; **5"** = 1.02; **6"** = 1.47; **12"** = 5.88
TUBING INSIDE DIA. CAPACITY (Gal./Ft.): **1/8"** = 0.0006; **3/16"** = 0.0014; **1/4"** = 0.0026; **5/16"** = 0.004; **3/8"** = 0.006; **1/2"** = 0.010; **5/8"** = 0.016
BTOC = Below top of casing –which includes above grade riser

PURGING EQUIPMENT CODES: **B** = Bailer; **BP** = Bladder Pump; **ESP** = Electric Submersible Pump; **PP =** Peristaltic Pump; **O** = Other (Specify)

SAMPLING DATA

SAMPLED BY (PRINT) / AFFILIATION: Maria Johnson/Parsons	SAMPLER(S) SIGNATURE(S): Maria Johnson	SAMPLING INITIATED AT: 1506	SAMPLING ENDED AT: 1524

PUMP OR TUBING DEPTH IN WELL (feet): 21.5	TUBING MATERIAL CODE: Teflon-lined PE	FIELD-FILTERED: Yes/**SM 4500 Sulfide** FILTER SIZE: 0.45 μm Filtration Equipment Type: Syringe

FIELD DECONTAMINATION: PUMP Y **No** TUBING Y **No (replaced)**	DUPLICATE: No

SAMPLE CONTAINER SPECIFICATION				SAMPLE PRESERVATION			INTENDED ANALYSIS AND/OR METHOD	SAMPLING EQUIPMENT CODE	SAMPLE PUMP FLOW RATE (mL per minute)
SAMPLE ID CODE	# CONTAINERS	MATERIAL CODE	VOLUME	PRESERVATIVE USED	TOTAL VOL ADDED IN FIELD (mL)	FINAL pH			
MW-2A	1	PE	250mL	HNO3	--	--	6010B TAL Metals/7470A Hg	APP	250
MW-2A	1	PE	125mL	--	--		3500 FE/ 9040B pH	APP	125
MW-2A	1	PE	250mL	--	--	--	6010B Dissolved Silica	APP	250
MW-2A	1	PE	125mL	--	--	--	9056A_28D Chloride & Sulfate	APP	125
MW-2A	1	AG	125mL	--	--	--	SM 5310 DOC	APP	125
MW-2A	2	PE	250mL	NaOH Zinc Acetate	--	--	SM4500 Sulfide	APP	**Field-Filtered**
MW-2A	1	PE	500mL	--	--	--	2540C TDS	APP	250
MW-2A	1	PE	250mL	--	--	--	2320B Alkalinity	APP	250
MW-2A	1	AG	125mL	HCl	--	--	SM5310 TOC	APP	125

REMARKS: Per SOP, parameters stable for three readings prior to collecting sample. Tubing-in-Screened- Interval purge method was used. Turbidity was above 10 NTU, however, +/- 10%. Purge water dark brown

MATERIAL CODES: **AG** = Amber Glass; **CG** = Clear Glass; **PE** = Polyethylene; **PP** = Polypropylene; **S** = Silicone; **T** = Teflon; **O** = Other (Specify)

SAMPLING EQUIPMENT CODES: **APP** = After Peristaltic Pump; **B** = Bailer; **BP** = Bladder Pump; **ESP** = Electric Submersible Pump; **RFPP** = Reverse Flow Peristaltic Pump; **SM** = Straw Method (Tubing Gravity Drain); **O** = Other (Specify)

NOTES: Stabilization Criteria for Range of Variation of Last Three Consecutive Readings:-**pH:** $\pm$ 0.1 unit **Specific Conductance:** $\pm$ 5% **Dissolved Oxygen:** all readings $\leq$ 10% saturation; optionally, $\pm$ 0.2 mg/L **Turbidity:** all readings $\leq$ 10 NTU; or $\pm$ 10%

GROUNDWATER SAMPLING LOG

SITE NAME: LCP Chemical Site	SITE LOCATION: Brunswick, GA

WELL NO: MW-2B	SAMPLE ID: MW-2B	DATE: 10/3/12

PURGING DATA

WELL DIAMETER (inches): 2	TUBING DIAMETER (inches): 1/4	WELL SCREEN INTERVAL (btoc) DEPTH: 34 feet to 38 feet	STATIC DEPTH (btoc) TO WATER (feet): 6.82	PURGE PUMP TYPE OR BAILER: PP

WELL VOLUME PURGE: 1 WELL VOLUME = (TOTAL WELL DEPTH – STATIC DEPTH TO WATER) X WELL CAPACITY
(only fill out if applicable)
= (feet – feet) X 0.16 gallons/foot = gallons

EQUIPMENT VOLUME PURGE: 1 EQUIPMENT VOL. = PUMP VOLUME + (TUBING CAPACITY X TUBING LENGTH) + FLOW CELL VOLUME
(only fill out if applicable)
= +.10 gallons (0.0026 gallons/foot X 38 feet) + .10 gallons = 0.3 gallons

INITIAL PUMP OR TUBING DEPTH IN WELL (feet btoc): 36	FINAL PUMP OR TUBING DEPTH IN WELL (feet btoc): 36	PURGING INITIATED AT: 1348	PURGING ENDED AT: 1430	TOTAL VOLUME PURGED (gallons): 3.1

TIME	VOLUME PURGED (gallons)	CUMUL. VOLUME PURGED (gallons)	PURGE RATE (gpm)	DEPTH TO WATER (feet btoc)	pH (standard units)	TEMP. (^{O}C)	SP COND. (mS/cm)	DISSOLVED OXYGEN (% saturation)	TURBIDITY (NTUs)	ORP (mV)	SP Gravity (sg)
1412	1.90	1.90	0.08	6.89	9.37	23.86	5.762	2.3	19.1	-276.6	
1417	0.60	2.50	0.12	6.89	9.37	23.69	5.787	2.3	14.6	-294.4	
1422	0.25	2.75	0.05	6.89	9.36	23.65	5.740	2.2	15.6	-308.9	
1426	0.35	3.10	0.09	6.89	9.36	23.77	5.736	2.1	15.9	-315.6	1.000

WELL CAPACITY (Gallons Per Foot): **0.75"** = 0.02; **1"** = 0.04; **1.25"** = 0.06; **2"** = 0.16; **3"** = 0.37; **4"** = 0.65; **5"** = 1.02; **6"** = 1.47; **12"** = 5.88
TUBING INSIDE DIA. CAPACITY (Gal./Ft.): **1/8"** = 0.0006; **3/16"** = 0.0014; **1/4"** = 0.0026; **5/16"** = 0.004; **3/8"** = 0.006; **1/2"** = 0.010; **5/8"** = 0.016
BTOC = Below top of casing –which includes above grade riser

PURGING EQUIPMENT CODES: **B** = Bailer; **BP** = Bladder Pump; **ESP** = Electric Submersible Pump; **PP =** Peristaltic Pump; **O** = Other (Specify)

SAMPLING DATA

SAMPLED BY (PRINT) / AFFILIATION: Christine Jaynes/Parsons	SAMPLER(S) SIGNATURE(S): CJaynes	SAMPLING INITIATED AT: 1441	SAMPLING ENDED AT: 1459

PUMP OR TUBING DEPTH IN WELL (feet): 36	TUBING MATERIAL CODE: Teflon-lined PE	FIELD-FILTERED: Yes/**SM 4500 Sulfide** FILTER SIZE: 0.45 μm Filtration Equipment Type: Syringed

FIELD DECONTAMINATION: PUMP Y **No** TUBING Y **No (replaced)**	DUPLICATE: No

SAMPLE CONTAINER SPECIFICATION				SAMPLE PRESERVATION			INTENDED ANALYSIS AND/OR METHOD	SAMPLING EQUIPMENT CODE	SAMPLE PUMP FLOW RATE (mL per minute)
SAMPLE ID CODE	# CONTAINERS	MATERIAL CODE	VOLUME	PRESERVATIVE USED	TOTAL VOL ADDED IN FIELD (mL)	FINAL pH			
MW-2B	1	PE	250mL	HNO3	--	--	6010B TAL Metals/7470A Hg	APP	250
MW-2B	1	PE	125mL	--	--		3500 FE/ 9040B pH	APP	125
MW-2B	1	PE	250mL	--	--	--	6010B Dissolved Silica	APP	250
MW-2B	1	PE	125mL	--	--	--	9056A_28D Chloride & Sulfate	APP	125
MW-2B	1	AG	125mL	--	--	--	SM 5310 DOC	APP	125
MW-2B	2	PE	250mL	NaOH Zinc Acetate	--	--	SM4500 Sulfide	APP	**Field-Filtered**
MW-2B	1	PE	500mL	--	--	--	2540C TDS	APP	250
MW-2B	1	PE	250mL	--	--	--	2320B Alkalinity	APP	250
MW-2B	1	AG	125mL	HCl	--	--	SM5310 TOC	APP	125

REMARKS: Per SOP, parameters stable for three readings to collecting the sample. Tubing-in-Screened- Interval purge method used. Purge water brown. Turbidity is above 10 NTU, however, +/- 10%.

MATERIAL CODES: **AG** = Amber Glass; **CG** = Clear Glass; **PE** = Polyethylene; **PP** = Polypropylene; **S** = Silicone; **T** = Teflon; **O** = Other (Specify)

SAMPLING EQUIPMENT CODES: **APP** = After Peristaltic Pump; **B** = Bailer; **BP** = Bladder Pump; **ESP** = Electric Submersible Pump; **RFPP** = Reverse Flow Peristaltic Pump; **SM** = Straw Method (Tubing Gravity Drain); **O** = Other (Specify)

NOTES: Stabilization Criteria for Range of Variation of Last Three Consecutive Readings:-**pH:** $\pm$ 0.1 unit **Specific Conductance:** $\pm$ 5% **Dissolved Oxygen:** all readings $\leq$ 10% saturation; optionally, $\pm$ 0.2 mg/L **Turbidity:** all readings $\leq$ 10 NTU; or $\pm$ 10%

GROUNDWATER SAMPLING LOG

SITE NAME: LCP Chemical Site	SITE LOCATION: Brunswick, GA	
WELL NO: MW-2C	SAMPLE ID: MW-2C	DATE: 10/3/12

PURGING DATA

WELL DIAMETER (inches): 2	TUBING DIAMETER (inches): 1/4	WELL SCREEN INTERVAL (btoc) DEPTH: 48 feet to 53 feet	STATIC DEPTH (btoc) TO WATER (feet): 8.15	PURGE PUMP TYPE OR BAILER: PP

WELL VOLUME PURGE: 1 WELL VOLUME = (TOTAL WELL DEPTH – STATIC DEPTH TO WATER) X WELL CAPACITY
(only fill out if applicable)
= (feet – feet) X 0.16 gallons/foot = gallons

EQUIPMENT VOLUME PURGE: 1 EQUIPMENT VOL. = PUMP VOLUME + (TUBING CAPACITY X TUBING LENGTH) + FLOW CELL VOLUME
(only fill out if applicable)
= +.10 gallons (0.0026 gallons/foot X 50 feet) + .10 gallons = 0.33 gallons

INITIAL PUMP OR TUBING DEPTH IN WELL (feet btoc): 47.5	FINAL PUMP OR TUBING DEPTH IN WELL (feet btoc): 47.5	PURGING INITIATED AT: 1345	PURGING ENDED AT: 1408	TOTAL VOLUME PURGED (gallons): 1.15

TIME	VOLUME PURGED (gallons)	CUMUL. VOLUME PURGED (gallons)	PURGE RATE (gpm)	DEPTH TO WATER (feet btoc)	pH (standard units)	TEMP. (^{O}C)	SP COND. (mS/cm)	DISSOLVED OXYGEN (% saturation)	TURBIDITY (NTUs)	ORP (mV)	SP Gravity (sg)
1403	1.00	1.00	0.06	8.7	11.10	23.90	52.39	1.3	9.15	-363.7	
1405	0.05	1.05	0.03	8.7	11.10	23.92	52.47	1.3	4.60	-367.4	
1407	0.10	1.15	0.05	8.7	11.10	23.93	52.52	1.3	3.35	-371.5	1.022

WELL CAPACITY (Gallons Per Foot): **0.75"** = 0.02; **1"** = 0.04; **1.25"** = 0.06; **2"** = 0.16; **3"** = 0.37; **4"** = 0.65; **5"** = 1.02; **6"** = 1.47; **12"** = 5.88
TUBING INSIDE DIA. CAPACITY (Gal./Ft.): **1/8"** = 0.0006; **3/16"** = 0.0014; **1/4"** = 0.0026; **5/16"** = 0.004; **3/8"** = 0.006; **1/2"** = 0.010; **5/8"** = 0.016
BTOC = Below top of casing –which includes above grade riser

PURGING EQUIPMENT CODES: **B** = Bailer; **BP** = Bladder Pump; **ESP** = Electric Submersible Pump; **PP =** Peristaltic Pump; **O** = Other (Specify)

SAMPLING DATA

SAMPLED BY (PRINT) / AFFILIATION: Maria Johnson/Parsons	SAMPLER(S) SIGNATURE(S): Maria Johnson	SAMPLING INITIATED AT: 1413	SAMPLING ENDED AT: 1432

PUMP OR TUBING DEPTH IN WELL (feet): 47.5	TUBING MATERIAL CODE: Teflon-lined PE	FIELD-FILTERED: Yes/**SM 4500 Sulfide** FILTER SIZE: 0.45 µm Filtration Equipment Type: Syringe

FIELD DECONTAMINATION: PUMP Y **No** TUBING Y **No (replaced)**	DUPLICATE: No

SAMPLE CONTAINER SPECIFICATION				SAMPLE PRESERVATION			INTENDED ANALYSIS AND/OR METHOD	SAMPLING EQUIPMENT CODE	SAMPLE PUMP FLOW RATE (mL per minute)
SAMPLE ID CODE	# CONTAINERS	MATERIAL CODE	VOLUME	PRESERVATIVE USED	TOTAL VOL ADDED IN FIELD (mL)	FINAL pH			
MW-2C	1	PE	250mL	HNO3	--	--	6010B TAL Metals/7470A Hg	APP	250
MW-2C	1	PE	125mL	--	--		3500 FE/ 9040B pH	APP	125
MW-2C	1	PE	250mL	--	--	--	6010B Dissolved Silica	APP	250
MW-2C	1	PE	125mL	--	--	--	9056A_28D Chloride & Sulfate	APP	125
MW-2C	1	AG	125mL	--	--	--	SM 5310 DOC	APP	125
MW-2C	2	PE	250mL	NaOH Zinc Acetate	--	--	SM4500 Sulfide	APP	**Field-Filtered**
MW-2C	1	PE	500mL	--	--	--	2540C TDS	APP	250
MW-2C	1	PE	250mL	--	--	--	2320B Alkalinity	APP	250
MW-2C	1	AG	125mL	HCl	--	--	SM5310 TOC	APP	125

REMARKS: Per SOP, parameters stable for three readings prior to sample collection. Tubing-in-Screened-Interval purge method used. Purge water was very dark brown.

MATERIAL CODES: **AG** = Amber Glass; **CG** = Clear Glass; **PE** = Polyethylene; **PP** = Polypropylene; **S** = Silicone; **T** = Teflon; **O** = Other (Specify)

SAMPLING EQUIPMENT CODES: **APP** = After Peristaltic Pump; **B** = Bailer; **BP** = Bladder Pump; **ESP** = Electric Submersible Pump; **RFPP** = Reverse Flow Peristaltic Pump; **SM** = Straw Method (Tubing Gravity Drain); **O** = Other (Specify)

NOTES: Stabilization Criteria for Range of Variation of Last Three Consecutive Readings: **pH:** ± 0.1 unit **Specific Conductance:** ± 5% **Dissolved Oxygen:** all readings ≤ 10% saturation; optionally, ± 0.2 mg/L **Turbidity:** all readings ≤ 10 NTU; or ± 10%

GROUNDWATER SAMPLING LOG

SITE NAME: LCP Chemical Site	SITE LOCATION: Brunswick, GA	
WELL NO: MW-3A	SAMPLE ID: MW-3A	DATE: 10/3/10

PURGING DATA

WELL DIAMETER (inches): 2	TUBING DIAMETER (inches): 1/4	WELL SCREEN INTERVAL DEPTH: 18 feet to 23 feet btoc	STATIC DEPTH TO WATER (feet btoc): 7.45	PURGE PUMP TYPE OR BAILER: PP

WELL VOLUME PURGE: 1 WELL VOLUME = (TOTAL WELL DEPTH – STATIC DEPTH TO WATER) X WELL CAPACITY
(only fill out if applicable)
= (feet – feet) X 0.16 gallons/foot = gallons

EQUIPMENT VOLUME PURGE: 1 EQUIPMENT VOL. = PUMP VOLUME + (TUBING CAPACITY X TUBING LENGTH) + FLOW CELL VOLUME
(only fill out if applicable)
= +.10 gallons (0.0026 gallons/foot X 25 feet) + .10 gallons = 0.27 gallons

INITIAL PUMP OR TUBING DEPTH IN WELL (feet btoc): 21	FINAL PUMP OR TUBING DEPTH IN WELL (feet btoc): 21	PURGING INITIATED AT: 0740	PURGING ENDED AT: 0822	TOTAL VOLUME PURGED (gallons): 2.0

TIME	VOLUME PURGED (gallons)	CUMUL. VOLUME PURGED (gallons)	PURGE RATE (gpm)	DEPTH TO WATER (feet btoc)	pH (standard units)	TEMP. (^{o}C)	SP COND. (mS/cm)	DISSOLVED OXYGEN (% saturation)	TURBIDITY (NTUs)	ORP (mV)	SP Gravity (sg)
0816	1.75	1.75	0.05	7.55	8.01	24.71	46.86	3.0	37.4	-298.6	
0818	0.15	1.90	0.08	7.55	8.02	24.75	46.61	2.8	37.7	-308.6	
0820	0.10	2.00	0.05	7.55	8.02	24.77	45.97	2.6	37.9	-288.9	1.023

WELL CAPACITY (Gallons Per Foot): **0.75"** = 0.02; **1"** = 0.04; **1.25"** = 0.06; **2"** = 0.16; **3"** = 0.37; **4"** = 0.65; **5"** = 1.02; **6"** = 1.47; **12"** = 5.88
TUBING INSIDE DIA. CAPACITY (Gal./Ft.): **1/8"** = 0.0006; **3/16"** = 0.0014; **1/4"** = 0.0026; **5/16"** = 0.004; **3/8"** = 0.006; **1/2"** = 0.010; **5/8"** = 0.016
BTOC= Below top of casing- which include above grade riser.

PURGING EQUIPMENT CODES: **B** = Bailer; **BP** = Bladder Pump; **ESP** = Electric Submersible Pump; **PP =** Peristaltic Pump; **O** = Other (Specify)

SAMPLING DATA

SAMPLED BY (PRINT) / AFFILIATION: Maria Johnson/Parsons	SAMPLER(S) SIGNATURE(S): Maria Johnson	SAMPLING INITIATED AT: 0827	SAMPLING ENDED AT: 0847
PUMP OR TUBING DEPTH IN WELL (feet): 21	TUBING MATERIAL CODE: Teflon-lined PE	FIELD-FILTERED: Yes/**SM 4500 Sulfide** FILTER SIZE: 0.45 µm Filtration Equipment Type: Syringe	
FIELD DECONTAMINATION: PUMP Y **No**	TUBING Y **No (replaced)**	DUPLICATE: No	

SAMPLE CONTAINER SPECIFICATION				SAMPLE PRESERVATION			INTENDED ANALYSIS AND/OR METHOD	SAMPLING EQUIPMENT CODE	SAMPLE PUMP FLOW RATE (mL per minute)
SAMPLE ID CODE	# CONTAINERS	MATERIAL CODE	VOLUME	PRESERVATIVE USED	TOTAL VOL ADDED IN FIELD (mL)	FINAL pH			
MW-3A	1	PE	250mL	HNO3	--	--	6010B TAL Metals/7470A Hg	APP	250
MW-3A	1	PE	125mL	--	--		3500 FE/ 9040B pH	APP	125
MW-3A	1	PE	250mL	--	--	--	6010B Dissolved Silica	APP	250
MW-3A	1	PE	125mL	--	--	--	9056A_28D Chloride &	APP	125
MW-3A	1	AG	125mL	--	--	--	SM 5310 DOC	APP	125
MW-3A	2	PE	250mL	NaOH Zinc Acetate	--	--	SM4500 Sulfide	APP	**Field-Filtered**
MW-3A	1	PE	500mL	--	--	--	2540C TDS	APP	250
MW-3A	1	PE	250mL	--	--	--	2320B Alkalinity	APP	250
MW-3A	1	AG	125mL	HCl	--	--	SM5310 TOC	APP	125

REMARKS: Per SOP, parameters stable for three readings prior to sample collection. Tubing-in-Screened-Interval purge method used. Specific Conductance is within 5%; turbidity is greater than 10 NTU but within 10%. Purge water very brown.

MATERIAL CODES: **AG** = Amber Glass; **CG** = Clear Glass; **PE** = Polyethylene; **PP** = Polypropylene; **S** = Silicone; **T** = Teflon; **O** = Other (Specify)

SAMPLING EQUIPMENT CODES: **APP** = After Peristaltic Pump; **B** = Bailer; **BP** = Bladder Pump; **ESP** = Electric Submersible Pump; **RFPP** = Reverse Flow Peristaltic Pump; **SM** = Straw Method (Tubing Gravity Drain); **O** = Other (Specify)

NOTES: Stabilization Criteria for Range of Variation of Last Three Consecutive Readings:-**pH:** ± 0.1 unit **Specific Conductance:** ± 5% **Dissolved Oxygen:** all readings ≤ 10% saturation; optionally, ± 0.2 mg/L **Turbidity:** all readings ≤ 10 NTU; or ± 10%

GROUNDWATER SAMPLING LOG

SITE NAME: LCP Chemical Site		SITE LOCATION: Brunswick, GA
WELL NO: MW-115A	SAMPLE ID: MW-115A	DATE: 10/3/12

PURGING DATA

WELL DIAMETER (inches): 2	TUBING DIAMETER (inches): 1/4	WELL SCREEN INTERVAL (btoc) DEPTH:12.5 feet to 17.5 feet	STATIC DEPTH (btoc) TO WATER (feet): 6.0	PURGE PUMP TYPE OR BAILER: PP

WELL VOLUME PURGE: 1 WELL VOLUME = (TOTAL WELL DEPTH – STATIC DEPTH TO WATER) X WELL CAPACITY
(only fill out if applicable)
= (feet – feet) X 0.16 gallons/foot = gallons

EQUIPMENT VOLUME PURGE: 1 EQUIPMENT VOL. = PUMP VOLUME + (TUBING CAPACITY X TUBING LENGTH) + FLOW CELL VOLUME
(only fill out if applicable)
= +.10 gallons (0.0026 gallons/foot X 20 feet) + .10 gallons = 0.25 gallons

INITIAL PUMP OR TUBING DEPTH IN WELL (feet btoc): 15.5	FINAL PUMP OR TUBING DEPTH IN WELL (feet btoc): 15.5	PURGING INITIATED AT: 1033	PURGING ENDED AT: 1114	TOTAL VOLUME PURGED (gallons): 1.25

TIME	VOLUME PURGED (gallons)	CUMUL. VOLUME PURGED (gallons)	PURGE RATE (gpm)	DEPTH TO WATER (feet btoc)	pH (standard units)	TEMP. (°C)	SP COND. (mS/cm)	DISSOLVED OXYGEN (% saturation)	TURBIDITY (NTUs)	ORP (mV)	SP Gravity (sg)
1107	1.00	1.00	0.03	6.11	7.44	23.37	5.261	2.5	9.03	-214.2	
1111	0.20	1.20	0.05	6.11	7.44	23.36	5.238	2.3	8.47	-216.2	
1113	0.05	1.25	0.03	6.11	7.45	23.35	5.232	2.3	9.88	-219.5	1.000

WELL CAPACITY (Gallons Per Foot): **0.75"** = 0.02; **1"** = 0.04; **1.25"** = 0.06; **2"** = 0.16; **3"** = 0.37; **4"** = 0.65; **5"** = 1.02; **6"** = 1.47; **12"** = 5.88
TUBING INSIDE DIA. CAPACITY (Gal./Ft.): **1/8"** = 0.0006; **3/16"** = 0.0014; **1/4"** = 0.0026; **5/16"** = 0.004; **3/8"** = 0.006; **1/2"** = 0.010; **5/8"** = 0.016
BTOC = Below top of casing –which includes above grade riser

PURGING EQUIPMENT CODES: **B** = Bailer; **BP** = Bladder Pump; **ESP** = Electric Submersible Pump; **PP =** Peristaltic Pump; **O** = Other (Specify)

SAMPLING DATA

SAMPLED BY (PRINT) / AFFILIATION: Maria Johnson/Parsons	SAMPLER(S) SIGNATURE(S): Maria Johnson	SAMPLING INITIATED AT: 1126	SAMPLING ENDED AT: 1206

PUMP OR TUBING DEPTH IN WELL (feet): 15.5	TUBING MATERIAL CODE: Teflon-lined PE	FIELD-FILTERED: Yes/**SM 4500 Sulfide** FILTER SIZE: 0.45 μm Filtration Equipment Type: Syringe
FIELD DECONTAMINATION: PUMP Y **No** TUBING Y **No (replaced)**		DUPLICATE: Yes

SAMPLE CONTAINER SPECIFICATION				SAMPLE PRESERVATION			INTENDED ANALYSIS AND/OR METHOD	SAMPLING EQUIPMENT CODE	SAMPLE PUMP FLOW RATE (mL per minute)
SAMPLE ID CODE	# CONTAINERS	MATERIAL CODE	VOLUME	PRESERVATIVE USED	TOTAL VOL ADDED IN FIELD (mL)	FINAL pH			
MW-115A	2	PE	250mL	HNO3	--	--	6010B TAL Metals/7470A Hg	APP	125
MW-115A	2	PE	125mL	--	--		3500 FE/ 9040B pH	APP	125
MW-115A	2	PE	250mL	--	--	--	6010B Dissolved Silica	APP	167
MW-115A	2	PE	125mL	--	--	--	9056A_28D Chloride & Sulfate	APP	125
MW-115A	2	AG	125mL	--	--	--	SM 5310 DOC	APP	125
MW-115A	4	PE	250mL	NaOH Zinc Acetate	--	--	SM4500 Sulfide	APP	**Field-Filtered**
MW-115A	2	PE	500mL	--	--	--	2540C TDS	APP	167
MW-115A	2	PE	250mL	--	--	--	2320B Alkalinity	APP	125
MW-115A	2	AG	125mL	HCl	--	--	SM5310 TOC	APP	125

REMARKS: Per SOP, parameters stable for three readings prior to sample collection. Tubing-in-Screened- Interval purge method used. Purge water brown

MATERIAL CODES: **AG** = Amber Glass; **CG** = Clear Glass; **PE** = Polyethylene; **PP** = Polypropylene; **S** = Silicone; **T** = Teflon; **O** = Other (Specify)

SAMPLING EQUIPMENT CODES: **APP** = After Peristaltic Pump; **B** = Bailer; **BP** = Bladder Pump; **ESP** = Electric Submersible Pump; **RFPP** = Reverse Flow Peristaltic Pump; **SM** = Straw Method (Tubing Gravity Drain); **O** = Other (Specify)

NOTES: Stabilization Criteria for Range of Variation of Last Three Consecutive Readings:-**pH:** ± 0.1 unit **Specific Conductance:** ± 5% **Dissolved Oxygen:** all readings ≤ 10% saturation; optionally, ± 0.2 mg/L **Turbidity:** all readings ≤ 10 NTU; or ± 10%

GROUNDWATER SAMPLING LOG

SITE NAME: LCP Chemical Site		SITE LOCATION: Brunswick, GA
WELL NO: MW-115B	SAMPLE ID: MW-115B	DATE: 10/3/12

PURGING DATA

WELL DIAMETER (inches): 2	TUBING DIAMETER (inches): 1/4	WELL SCREEN INTERVAL (btoc) DEPTH: 29 feet to 33 feet	STATIC DEPTH TO WATER (feet btoc): 5.6	PURGE PUMP TYPE OR BAILER: PP

WELL VOLUME PURGE: 1 WELL VOLUME = (TOTAL WELL DEPTH – STATIC DEPTH TO WATER) X WELL CAPACITY
(only fill out if applicable)
= (feet – feet) X 0.16 gallons/foot = gallons

EQUIPMENT VOLUME PURGE: 1 EQUIPMENT VOL. = PUMP VOLUME + (TUBING CAPACITY X TUBING LENGTH) + FLOW CELL VOLUME
(only fill out if applicable)
= +.10 gallons (0.0026 gallons/foot X 33 feet) + .10 gallons = 0.29 gallons

INITIAL PUMP OR TUBING DEPTH IN WELL (feet btoc): 30.5	FINAL PUMP OR TUBING DEPTH IN WELL (feet btoc): 30.5	PURGING INITIATED AT: 0903	PURGING ENDED AT: 0929	TOTAL VOLUME PURGED (gallons): 1.1

TIME	VOLUME PURGED (gallons)	CUMUL. VOLUME PURGED (gallons)	PURGE RATE (gpm)	DEPTH TO WATER (feet btoc)	pH (standard units)	TEMP. (^{O}C)	SP COND. (mS/cm)	DISSOLVED OXYGEN (% saturation)	TURBIDITY (NTUs)	ORP (mV)	SP Gravity (sg)
0925	1.00	1.00	0.05	5.65	9.48	22.80	4.914	3.1	6.24	-200.6	
0927	0.05	1.05	0.03	5.65	9.48	22.77	4.915	2.9	6.04	-197.1	
0929	0.05	1.10	0.03	5.65	9.49	22.79	4.914	2.9	5.45	-193.9	0.999

WELL CAPACITY (Gallons Per Foot): **0.75"** = 0.02; **1"** = 0.04; **1.25"** = 0.06; **2"** = 0.16; **3"** = 0.37; **4"** = 0.65; **5"** = 1.02; **6"** = 1.47; **12"** = 5.88
TUBING INSIDE DIA. CAPACITY (Gal./Ft.): **1/8"** = 0.0006; **3/16"** = 0.0014; **1/4"** = 0.0026; **5/16"** = 0.004; **3/8"** = 0.006; **1/2"** = 0.010; **5/8"** = 0.016
BTOC= Below top of casing- which included above grade riser.

PURGING EQUIPMENT CODES: **B** = Bailer; **BP** = Bladder Pump; **ESP** = Electric Submersible Pump; **PP =** Peristaltic Pump; **O** = Other (Specify)

SAMPLING DATA

SAMPLED BY (PRINT) / AFFILIATION: Maria Johnson/Parsons	SAMPLER(S) SIGNATURE(S): Maria Johnson	SAMPLING INITIATED AT: 0935	SAMPLING ENDED AT: 0951

PUMP OR TUBING DEPTH IN WELL (feet): 30.5	TUBING MATERIAL CODE: Teflon-lined PE	FIELD-FILTERED: Yes/**SM 4500 Sulfide** FILTER SIZE: 0.45 µm Filtration Equipment Type: Syringe
FIELD DECONTAMINATION: PUMP Y **No**	TUBING Y **No (replaced)**	DUPLICATE: No

SAMPLE CONTAINER SPECIFICATION				SAMPLE PRESERVATION			INTENDED ANALYSIS AND/OR METHOD	SAMPLING EQUIPMENT CODE	SAMPLE PUMP FLOW RATE (mL per minute)
SAMPLE ID CODE	# CONTAINERS	MATERIAL CODE	VOLUME	PRESERVATIVE USED	TOTAL VOL ADDED IN FIELD (mL)	FINAL pH			
MW-115B	1	PE	250mL	HNO3	--	--	6010B TAL Metals/7470A Hg	APP	250
MW-115B	1	PE	125mL	--	--		3500 FE/ 9040B pH	APP	125
MW-115B	1	PE	250mL	--	--	--	6010B Dissolved Silica	APP	250
MW-115B	1	PE	125mL	--	--	--	9056A_28D Chloride &	APP	125
MW-115B	1	AG	125mL	--	--	--	SM 5310 DOC	APP	125
MW-115B	2	PE	250mL	NaOH Zinc Acetate	--	--	SM4500 Sulfide	APP	**Field Filtered**
MW-115B	1	PE	500mL	--	--	--	2540C TDS	APP	250
MW-115B	1	PE	250mL	--	--	--	2320B Alkalinity	APP	125
MW-115B	1	AG	125mL	HCl	--	--	SM5310 TOC	APP	125

REMARKS: Per SOP, parameters stable for three readings prior to sample collection. Tubing-in-Screened-Interval purged method used. Purge water brown

MATERIAL CODES: **AG** = Amber Glass; **CG** = Clear Glass; **PE** = Polyethylene; **PP** = Polypropylene; **S** = Silicone; **T** = Teflon; **O** = Other (Specify)

SAMPLING EQUIPMENT CODES: **APP** = After Peristaltic Pump; **B** = Bailer; **BP** = Bladder Pump; **ESP** = Electric Submersible Pump; **RFPP** = Reverse Flow Peristaltic Pump; **SM** = Straw Method (Tubing Gravity Drain); **O** = Other (Specify)

NOTES: Stabilization Criteria for Range of Variation of Last Three Consecutive Readings:-**pH:** ± 0.1 unit **Specific Conductance:** ± 5% **Dissolved Oxygen:** all readings ≤ 10% saturation; optionally, ± 0.2 mg/L **Turbidity:** all readings ≤ 10 NTU; or ± 10%

GROUNDWATER SAMPLING LOG

SITE NAME: LCP Chemical Site	SITE LOCATION: Brunswick, GA	
WELL NO: MW-115C	SAMPLE ID: MW-115C	DATE: 10/3/12

PURGING DATA

WELL DIAMETER (inches): 2	TUBING DIAMETER (inches): 1/4	WELL SCREEN INTERVAL (btoc) DEPTH: 40 feet to 45 feet	STATIC DEPTH (btoc) TO WATER (feet): 6.65	PURGE PUMP TYPE OR BAILER: PP

WELL VOLUME PURGE: 1 WELL VOLUME = (TOTAL WELL DEPTH – STATIC DEPTH TO WATER) X WELL CAPACITY
(only fill out if applicable)
= (feet – feet) X 0.16 gallons/foot = gallons

EQUIPMENT VOLUME PURGE: 1 EQUIPMENT VOL. = PUMP VOLUME + (TUBING CAPACITY X TUBING LENGTH) + FLOW CELL VOLUME
(only fill out if applicable)
= +.10 gallons (0.0026 gallons/foot X 45 feet) + .10 gallons = 0.32 gallons

INITIAL PUMP OR TUBING DEPTH IN WELL (feet btoc): 42.5	FINAL PUMP OR TUBING DEPTH IN WELL (feet btoc): 42.5	PURGING INITIATED AT: 0811	PURGING ENDED AT: 0934	TOTAL VOLUME PURGED (gallons): 2.6

TIME	VOLUME PURGED (gallons)	CUMUL. VOLUME PURGED (gallons)	PURGE RATE (gpm)	DEPTH TO WATER (feet btoc)	pH (standard units)	TEMP. (^{O}C)	SP COND. (mS/cm)	DISSOLVED OXYGEN (% saturation)	TURBIDITY (NTUs)	ORP (mV)	SP Gravity (sg)
0922	2.2	2.2	0.03	7.00	11.26	23.32	49.70	2.0	4.06	-371.0	
0926	0.1	2.3	0.03	7.07	11.29	23.32	49.67	1.7	4.15	-355.5	
0930	0.2	2.5	0.05	7.11	11.31	23.21	49.65	1.6	4.06	-382.4	
0933	0.1	2.6	0.03	7.11	11.32	23.27	49.56	1.4	3.77	-379.4	1.021

WELL CAPACITY (Gallons Per Foot): **0.75"** = 0.02; **1"** = 0.04; **1.25"** = 0.06; **2"** = 0.16; **3"** = 0.37; **4"** = 0.65; **5"** = 1.02; **6"** = 1.47; **12"** = 5.88
TUBING INSIDE DIA. CAPACITY (Gal./Ft.): **1/8"** = 0.0006; **3/16"** = 0.0014; **1/4"** = 0.0026; **5/16"** = 0.004; **3/8"** = 0.006; **1/2"** = 0.010; **5/8"** = 0.016
BTOC = Below top of casing –which includes above grade riser

PURGING EQUIPMENT CODES: **B** = Bailer; **BP** = Bladder Pump; **ESP** = Electric Submersible Pump; **PP =** Peristaltic Pump; **O** = Other (Specify)

SAMPLING DATA

SAMPLED BY (PRINT) / AFFILIATION: Christine Jaynes/Parsons	SAMPLER(S) SIGNATURE(S): CJaynes	SAMPLING INITIATED AT: 0946	SAMPLING ENDED AT: 1004

PUMP OR TUBING DEPTH IN WELL (feet): 42.5	TUBING MATERIAL CODE: Teflon-lined PE	FIELD-FILTERED: Yes/**SM 4500 Sulfide** FILTER SIZE: 0.45 µm Filtration Equipment Type: Syringe
FIELD DECONTAMINATION: PUMP Y **No**	TUBING Y **No (replaced)**	DUPLICATE: No

SAMPLE CONTAINER SPECIFICATION				SAMPLE PRESERVATION			INTENDED ANALYSIS AND/OR METHOD	SAMPLING EQUIPMENT CODE	SAMPLE PUMP FLOW RATE (mL per minute)
SAMPLE ID CODE	# CONTAINERS	MATERIAL CODE	VOLUME	PRESERVATIVE USED	TOTAL VOL ADDED IN FIELD (mL)	FINAL pH			
MW-115C	1	PE	250mL	HNO3	--	--	6010B TAL Metals/7470A Hg	APP	125
MW-115C	1	PE	125mL	--	--		3500 FE/ 9040B pH	APP	125
MW-115C	1	PE	250mL	--	--	--	6010B Dissolved Silica	APP	250
MW-115C	1	PE	125mL	--	--	--	9056A_28D Chloride & Sulfate	APP	125
MW-115C	1	AG	125mL	--	--	--	SM 5310 DOC	APP	125
MW-115C	2	PE	250mL	NaOH Zinc Acetate	--	--	SM4500 Sulfide	APP	**Field-Filtered**
MW-115C	1	PE	500mL	--	--	--	2540C TDS	APP	167
MW-115C	1	PE	250mL	--	--	--	2320B Alkalinity	APP	125
MW-115C	1	AG	125mL	HCl	--	--	SM5310 TOC	APP	63

REMARKS: Per SOP, parameters stable for three readings prior to sample collection. Tubing-in-Screened- Interval purge method used. Purge water was clear, brown with purple/green bubbles.

MATERIAL CODES: **AG** = Amber Glass; **CG** = Clear Glass; **PE** = Polyethylene; **PP** = Polypropylene; **S** = Silicone; **T** = Teflon; **O** = Other (Specify)

SAMPLING EQUIPMENT CODES: **APP** = After Peristaltic Pump; **B** = Bailer; **BP** = Bladder Pump; **ESP** = Electric Submersible Pump; **RFPP** = Reverse Flow Peristaltic Pump; **SM** = Straw Method (Tubing Gravity Drain); **O** = Other (Specify)

NOTES: Stabilization Criteria for Range of Variation of Last Three Consecutive Readings:-**pH:** ± 0.1 unit **Specific Conductance:** ± 5% **Dissolved Oxygen:** all readings ≤ 10% saturation; optionally, ± 0.2 mg/L **Turbidity:** all readings ≤ 10 NTU; or ± 10%

GROUNDWATER SAMPLING LOG

SITE NAME: LCP Chemical Site		SITE LOCATION: Brunswick, GA
WELL NO: MW-519A	SAMPLE ID: MW-519B	DATE: 10/2/12

PURGING DATA

WELL DIAMETER (inches): 2	TUBING DIAMETER (inches): 1/4	WELL SCREEN INTERVAL DEPTH btoc: 34.3 feet to 37.3 feet	STATIC DEPTH TO WATER (feet btoc): 5.72	PURGE PUMP TYPE OR BAILER: PP

WELL VOLUME PURGE: 1 WELL VOLUME = (TOTAL WELL DEPTH – STATIC DEPTH TO WATER) X WELL CAPACITY
(only fill out if applicable)
= (feet – feet) X 0.16 gallons/foot = gallons

EQUIPMENT VOLUME PURGE: 1 EQUIPMENT VOL. = PUMP VOLUME + (TUBING CAPACITY X TUBING LENGTH) + FLOW CELL VOLUME
(only fill out if applicable)
= +.10 gallons (0.0026 gallons/foot X 38 feet) + .10 gallons = 0.3 gallons

INITIAL PUMP OR TUBING DEPTH IN WELL (feet btoc): 35	FINAL PUMP OR TUBING DEPTH IN WELL (feet btoc): 35	PURGING INITIATED AT: 0828	PURGING ENDED AT: 0904	TOTAL VOLUME PURGED (gallons): 1.4

TIME	VOLUME PURGED (gallons)	CUMUL. VOLUME PURGED (gallons)	PURGE RATE (gpm)	DEPTH TO WATER (feet btoc)	pH (standard units)	TEMP. (^{O}C)	SP COND. (mS/cm)	DISSOLVED OXYGEN (% saturation)	TURBIDITY (NTUs)	ORP (mV)	SP Gravity (sg)
0858	1.25	1.25	0.04	5.80	10.40	24.52	7.714	9.8	8.52	-75.3	
0900	0.05	1.30	0.03	5.80	10.41	25.52	7.735	9.9	7.57	-75.2	
0902	0.10	1.40	0.05	5.80	10.42	25.50	7.748	9.6	9.04	-77.6	1.024

WELL CAPACITY (Gallons Per Foot): **0.75"** = 0.02; **1"** = 0.04; **1.25"** = 0.06; **2"** = 0.16; **3"** = 0.37; **4"** = 0.65; **5"** = 1.02; **6"** = 1.47; **12"** = 5.88
TUBING INSIDE DIA. CAPACITY (Gal./Ft.): **1/8"** = 0.0006; **3/16"** = 0.0014; **1/4"** = 0.0026; **5/16"** = 0.004; **3/8"** = 0.006; **1/2"** = 0.010; **5/8"** = 0.016
BTOC= Below top of casing- which includes above grade riser.

PURGING EQUIPMENT CODES: **B** = Bailer; **BP** = Bladder Pump; **ESP** = Electric Submersible Pump; **PP =** Peristaltic Pump; **O** = Other (Specify)

SAMPLING DATA

SAMPLED BY (PRINT) / AFFILIATION: Maria Johnson/Parsons	SAMPLER(S) SIGNATURE(S): Maria Johnson	SAMPLING INITIATED AT: 0916	SAMPLING ENDED AT: 0939
PUMP OR TUBING DEPTH IN WELL (feet): 35	TUBING MATERIAL CODE: Teflon-lined PE	FIELD-FILTERED: Yes/**SM 4500 Sulfide** FILTER SIZE: 0.45 µm Filtration Equipment Type: Syringe	
FIELD DECONTAMINATION: PUMP Y **No**	TUBING Y **No (replaced)**	DUPLICATE: No	

SAMPLE CONTAINER SPECIFICATION				SAMPLE PRESERVATION			INTENDED ANALYSIS AND/OR METHOD	SAMPLING EQUIPMENT CODE	SAMPLE PUMP FLOW RATE (mL per minute)
SAMPLE ID CODE	# CONTAINERS	MATERIAL CODE	VOLUME	PRESERVATIVE USED	TOTAL VOL ADDED IN FIELD (mL)	FINAL pH			
MW-519A	1	PE	250mL	HNO3	--	--	6010B TAL Metals/7470A Hg	APP	125
MW-519A	1	PE	125mL	--	--		3500 FE/ 9040B pH	APP	125
MW-519A	1	PE	250mL	--	--	--	6010B Dissolved Silica	APP	125
MW-519A	1	PE	125mL	--	--	--	9056A_28D Chloride &	APP	125
MW-519A	1	AG	125mL	--	--	--	SM 5310 DOC	APP	125
MW-519A	2	PE	250mL	NaOH Zinc Acetate	--	--	SM4500 Sulfide	APP	**Field-Filtered**
MW-519A	1	PE	500mL	--	--	--	2540C TDS	APP	167
MW-519A	1	PE	250mL	--	--	--	2320B Alkalinity	APP	250
MW-519A	1	AG	125mL	HCl	--	--	SM5310 TOC	APP	125

REMARKS: Per SOP, parameters stable for three readings prior to sample collection. Tubing-in-Screened-Interval purge method was used. Purge water light brown.

MATERIAL CODES: **AG** = Amber Glass; **CG** = Clear Glass; **PE** = Polyethylene; **PP** = Polypropylene; **S** = Silicone; **T** = Teflon; **O** = Other (Specify)

SAMPLING EQUIPMENT CODES: **APP** = After Peristaltic Pump; **B** = Bailer; **BP** = Bladder Pump; **ESP** = Electric Submersible Pump; **RFPP** = Reverse Flow Peristaltic Pump; **SM** = Straw Method (Tubing Gravity Drain); **O** = Other (Specify)

NOTES: Stabilization Criteria for Range of Variation of Last Three Consecutive Readings:-**pH:** ± 0.1 unit **Specific Conductance:** ± 5% **Dissolved Oxygen:** all readings ≤ 10% saturation; optionally, ± 0.2 mg/L **Turbidity:** all readings ≤ 10 NTU; or ± 10%

GROUNDWATER SAMPLING LOG

SITE NAME: LCP Chemical Site	SITE LOCATION: Brunswick, GA
WELL NO: MW-519B	SAMPLE ID: MW-519B
DATE: 10/2/12	

PURGING DATA

WELL DIAMETER (inches): 2	TUBING DIAMETER (inches): 1/4	WELL SCREEN INTERVAL (btoc) DEPTH: 42.55 feet to 47.55 feet	STATIC DEPTH (btoc) TO WATER (feet): 5.95	PURGE PUMP TYPE OR BAILER: PP

WELL VOLUME PURGE: 1 WELL VOLUME = (TOTAL WELL DEPTH – STATIC DEPTH TO WATER) X WELL CAPACITY
(only fill out if applicable)
= (feet – feet) X 0.16 gallons/foot = gallons

EQUIPMENT VOLUME PURGE: 1 EQUIPMENT VOL. = PUMP VOLUME + (TUBING CAPACITY X TUBING LENGTH) + FLOW CELL VOLUME
(only fill out if applicable)
= +.10 gallons (0.0026 gallons/foot X 48 feet) + .10 gallons = 0.32 gallons

INITIAL PUMP OR TUBING DEPTH IN WELL (feet btoc): 45	FINAL PUMP OR TUBING DEPTH IN WELL (feet btoc): 45	PURGING INITIATED AT: 0829	PURGING ENDED AT: 1352	TOTAL VOLUME PURGED (gallons): 10.8

TIME	VOLUME PURGED (gallons)	CUMUL. VOLUME PURGED (gallons)	PURGE RATE (gpm)	DEPTH TO WATER (feet btoc)	pH (standard units)	TEMP. (^{O}C)	SP COND. (mS/cm)	DISSOLVED OXYGEN (% saturation)	TURBIDITY (NTUs)	ORP (mV)	SP Gravity (sg)
0903	0.75	0.75	0.02	7.08	11.67	25.46	41.33	2.8	424	-383.5	
0922	0.50	1.25	0.03	7.10	11.78	25.13	53.14	2.5	116	-3812	
0931	0.25	1.50	0.03	7.10	11.78	25.41	48.04	2.4	57.6	-430.5	
0940	0.25	1.75	0.03	7.08	11.76	26.19	47.58	2.2	434	-434.0	
1021	0.85	2.60	---	7.04	11.75	26.28	45.26	1.6	Over Range	-418.6	
1345	7.90	10.5	0.08	7.20	12.20	24.98	57.63	8.5	4.93	-340.0	
1348	0.20	10.7	0.06	7.15	12.22	25.08	57.63	6.5	5.24	-351.4	
1351	0.10	10.8	0.03	7.15	12.25	25.63	57.76	4.7	8.68	-347.3	1.000

WELL CAPACITY (Gallons Per Foot): **0.75"** = 0.02; **1"** = 0.04; **1.25"** = 0.06; **2"** = 0.16; **3"** = 0.37; **4"** = 0.65; **5"** = 1.02; **6"** = 1.47; **12"** = 5.88
TUBING INSIDE DIA. CAPACITY (Gal./Ft.): **1/8"** = 0.0006; **3/16"** = 0.0014; **1/4"** = 0.0026; **5/16"** = 0.004; **3/8"** = 0.006; **1/2"** = 0.010; **5/8"** = 0.016
BTOC = Below top of casing –which includes above grade riser

PURGING EQUIPMENT CODES: **B** = Bailer; **BP** = Bladder Pump; **ESP** = Electric Submersible Pump; **PP =** Peristaltic Pump; **O** = Other (Specify)

SAMPLING DATA

SAMPLED BY (PRINT) / AFFILIATION: Christine Jaynes/Parsons	SAMPLER(S) SIGNATURE(S):	SAMPLING INITIATED AT: 1358	SAMPLING ENDED AT: 1413
PUMP OR TUBING DEPTH IN WELL (feet): 45	TUBING MATERIAL CODE: Teflon-lined PE	FIELD-FILTERED: Yes/**SM 4500 Sulfide** FILTER SIZE: 0.45 μm Filtration Equipment Type: Syringe	
FIELD DECONTAMINATION: PUMP Y **No**	TUBING Y **No (replaced)**	DUPLICATE: No	

SAMPLE CONTAINER SPECIFICATION				SAMPLE PRESERVATION			INTENDED ANALYSIS AND/OR METHOD	SAMPLING EQUIPMENT CODE	SAMPLE PUMP FLOW RATE (mL per minute)
SAMPLE ID CODE	# CONTAINERS	MATERIAL CODE	VOLUME	PRESERVATIVE USED	TOTAL VOL ADDED IN FIELD (mL)	FINAL pH			
MW-519B	1	PE	250mL	HNO3	--	--	6010B TAL Metals/7470A Hg	APP	250
MW-519B	1	PE	125mL	--	--		3500 FE/ 9040B pH	APP	125
MW-519B	1	PE	250mL	--	--	--	6010B Dissolved Silica	APP	125
MW-519B	1	PE	125mL	--	--	--	9056A_28D Chloride & Sulfate	APP	125
MW-519B	1	AG	125mL	--	--	--	SM 5310 DOC	APP	125
MW-519B	2	PE	250mL	NaOH Zinc Acetate	--	--	SM4500 Sulfide	APP	**Field-Filtered**
MW-519B	1	PE	500mL	--	--	--	2540C TDS	APP	100
MW-519B	1	PE	250mL	--	--	--	2320B Alkalinity	APP	125
MW-519B	1	AG	125mL	HCl	--	--	SM5310 TOC	APP	125

REMARKS: Per SOP, parameters stable for three readings prior to sample collection. Tubing-in-Screened-Interval purge method used. Purge paused at 0940 and again at 1220. Purge water dark brown.

MATERIAL CODES: **AG** = Amber Glass; **CG** = Clear Glass; **PE** = Polyethylene; **PP** = Polypropylene; **S** = Silicone; **T** = Teflon; **O** = Other (Specify)

SAMPLING EQUIPMENT CODES: **APP** = After Peristaltic Pump; **B** = Bailer; **BP** = Bladder Pump; **ESP** = Electric Submersible Pump; **RFPP** = Reverse Flow Peristaltic Pump; **SM** = Straw Method (Tubing Gravity Drain); **O** = Other (Specify)

NOTES: Stabilization Criteria for Range of Variation of Last Three Consecutive Readings:-**pH:** ± 0.1 unit **Specific Conductance:** ± 5% **Dissolved Oxygen:** all readings ≤ 10% saturation; optionally, ± 0.2 mg/L **Turbidity:** all readings ≤ 10 NTU; or ± 10%

GROUNDWATER SAMPLING LOG

SITE NAME: LCP Chemical Site	SITE LOCATION: Brunswick, GA

WELL NO: EW-11	SAMPLE ID: EW-11	DATE: 10/3/12

PURGING DATA

WELL DIAMETER (inches): 4	TUBING DIAMETER (inches): 1/4	WELL SCREEN INTERVAL (btoc) DEPTH: 45 feet to 50 feet	STATIC DEPTH (btoc) TO WATER (feet): 3.51	PURGE PUMP TYPE OR BAILER: PP

WELL VOLUME PURGE: 1 WELL VOLUME = (TOTAL WELL DEPTH – STATIC DEPTH TO WATER) X WELL CAPACITY
(only fill out if applicable)
= (feet – feet) X 0.16 gallons/foot = gallons

EQUIPMENT VOLUME PURGE: 1 EQUIPMENT VOL. = PUMP VOLUME + (TUBING CAPACITY X TUBING LENGTH) + FLOW CELL VOLUME
(only fill out if applicable)
= +.10 gallons (0.0026 gallons/foot X 50 feet) + .10 gallons = 0.33 gallons

INITIAL PUMP OR TUBING DEPTH IN WELL (feet btoc): 47.5	FINAL PUMP OR TUBING DEPTH IN WELL (feet btoc): 47.5	PURGING INITIATED AT: 0743	PURGING ENDED AT: 0823	TOTAL VOLUME PURGED (gallons): 1.45

TIME	VOLUME PURGED (gallons)	CUMUL. VOLUME PURGED (gallons)	PURGE RATE (gpm)	DEPTH TO WATER (feet btoc)	pH (standard units)	TEMP. (°C)	SP COND. (mS/cm)	DISSOLVED OXYGEN (% saturation)	TURBIDITY (NTUs)	ORP (mV)	SP Gravity (s.g.)
0804	0.80	0.80	0.04	--	10.50	24.06	29.78	4.7	7.86	-2614.6	
0809	0.20	1.00	0.04	--	10.66	24.09	29.85	3.4	6.79	-307.4	
0813	0.15	1.15	0.04	--	10.74	24.11	29.86	2.9	6.77	-299.7	
0816	0.10	1.25	0.03	--	10.78	24.12	29.86	2.6	6.87	-298.7	
0821	0.20	1.45	0.04	--	10.84	24.13	29.88	2.2	7.08	-300.5	1.016

WELL CAPACITY (Gallons Per Foot): **0.75"** = 0.02; **1"** = 0.04; **1.25"** = 0.06; **2"** = 0.16; **3"** = 0.37; **4"** = 0.65; **5"** = 1.02; **6"** = 1.47; **12"** = 5.88
TUBING INSIDE DIA. CAPACITY (Gal./Ft.): **1/8"** = 0.0006; **3/16"** = 0.0014; **1/4"** = 0.0026; **5/16"** = 0.004; **3/8"** = 0.006; **1/2"** = 0.010; **5/8"** = 0.016
BTOC = Below top of casing –includes above grade riser

PURGING EQUIPMENT CODES: B = Bailer; **BP** = Bladder Pump; **ESP** = Electric Submersible Pump; **PP =** Peristaltic Pump; **O** = Other (Specify)

SAMPLING DATA

SAMPLED BY (PRINT) / AFFILIATION: Christine Jaynes/Parsons	SAMPLER(S) SIGNATURE(S): C Jaynes	SAMPLING INITIATED AT: 0831	SAMPLING ENDED AT: 0907

PUMP OR TUBING DEPTH IN WELL (feet): 47.5	TUBING MATERIAL CODE: Teflon lined PE	FIELD-FILTERED: Yes/**SM 4500 Sulfide** FILTER SIZE: 0.45 µm Filtration Equipment Type: Syringe

FIELD DECONTAMINATION: PUMP Y **No** TUBING Y **No (replaced)**	DUPLICATE: No

SAMPLE CONTAINER SPECIFICATION				SAMPLE PRESERVATION			INTENDED ANALYSIS AND/OR METHOD	SAMPLING EQUIPMENT CODE	SAMPLE PUMP FLOW RATE (mL per minute)
SAMPLE ID CODE	# CONTAINERS	MATERIAL CODE	VOLUME	PRESERVATIVE USED	TOTAL VOL ADDED IN FIELD (mL)	FINAL pH			
EW-11	1	PE	250mL	HNO3	--	--	6010B TAL Metals/7470A Hg	APP	125
EW-11	1	PE	125mL	--	--		3500 FE/ 9040B pH	APP	125
EW-11	1	PE	250mL	--	--	--	6010B Dissolved Silica	APP	83
EW-11	1	PE	125mL	--	--	--	9056A_28D Chloride & Sulfate	APP	125
EW-11	1	AG	125mL	--	--	--	SM 5310 DOC	APP	125
EW-11	2	PE	250mL	NaOH Zinc Acetate	--	--	SM4500 Sulfide	APP	**Field-Filtered**
EW-11	1	PE	500mL	--	--	--	2540C TDS	APP	125
EW-11	1	PE	250mL	--	--	--	2320B Alkalinity	APP	83
EW-11	1	AG	125mL	HCl	--	--	SM5310 TOC	APP	125

REMARKS: Per SOP, parameters stable for three readings prior to sample collection. Tubing in-Screened Interval purge method used. Due to small diameter access plug, unable to collect water levels throughout purge, pump set to lowest RPM to minimize drawdown. Purge water dark brown, bubbles on top of water purple/green color.

MATERIAL CODES: **AG** = Amber Glass; **CG** = Clear Glass; **PE** = Polyethylene; **PP** = Polypropylene; **S** = Silicone; **T** = Teflon; **O** = Other (Specify)

SAMPLING EQUIPMENT CODES: APP = After Peristaltic Pump; **B** = Bailer; **BP** = Bladder Pump; **ESP** = Electric Submersible Pump; **RFPP** = Reverse Flow Peristaltic Pump; **SM** = Straw Method (Tubing Gravity Drain); **O** = Other (Specify)

NOTES: Stabilization Criteria for Range of Variation of Last Three Consecutive Readings:-**pH:** ± 0.1 unit **Specific Conductance:** ± 5% **Dissolved Oxygen:** all readings ≤ 10% saturation; optionally, ± 0.2 mg/L **Turbidity:** all readings ≤ 10 NTU; or ± 10%

GROUNDWATER SAMPLING LOG

SITE NAME: LCP Chemical Site		SITE LOCATION: Brunswick, GA
WELL NO: MW-1A	SAMPLE ID: MW-1A	DATE: 11/28/12

PURGING DATA

WELL DIAMETER (inches): 2	TUBING DIAMETER (inches): 1/4	WELL SCREEN INTERVAL (btoc) DEPTH: 18 feet to 23 feet	STATIC DEPTH (btoc) TO WATER (feet): 8.61	PURGE PUMP TYPE OR BAILER: PP

WELL VOLUME PURGE: 1 WELL VOLUME = (TOTAL WELL DEPTH – STATIC DEPTH TO WATER) X WELL CAPACITY
(only fill out if applicable)
= (feet – feet) X 0.16 gallons/foot = gallons

EQUIPMENT VOLUME PURGE: 1 EQUIPMENT VOL. = (TUBING CAPACITY X TUBING LENGTH) + FLOW CELL VOLUME
(only fill out if applicable)
= (0.0026 gallons/foot X 24.5 feet) + 0.13 gallons = 0.19 gallons

INITIAL PUMP OR TUBING DEPTH IN WELL (feet btoc): 20.5	FINAL PUMP OR TUBING DEPTH IN WELL (feet btoc): 20.5	PURGING INITIATED AT: 0912	PURGING ENDED AT: 0944	TOTAL VOLUME PURGED (gallons): 1.5

TIME	VOLUME PURGED (gallons)	CUMUL. VOLUME PURGED (gallons)	PURGE RATE (gpm)	DEPTH TO WATER (feet btoc)	pH (standard units)	TEMP. (^{O}C)	SP COND. (mS/cm)	DISSOLVED OXYGEN (% saturation)	TURBIDITY (NTUs)	ORP (mV)	SP Gravity (sg)
0923	0.50	0.50	0.05	8.75	6.6	20.88	13.36	11.4	9.70	-193.7	
0928	0.25	0.75	0.05	8.75	6.7	20.96	13.41	7.3	8.61	-199.7	
0933	0.25	1.00	0.05	8.75	6.7	20.90	13.42	6.8	7.79	-204.1	
0938	0.25	1.25	0.05	8.75	6.8	20.98	13.45	6.5	7.05	-205.6	
0943	0.25	1.50	0.05	8.75	6.8	21.00	13.46	5.9	6.10	-216.1	1.006

WELL CAPACITY (Gallons Per Foot): **0.75"** = 0.02; **1"** = 0.04; **1.25"** = 0.06; **2"** = 0.16; **3"** = 0.37; **4"** = 0.65; **5"** = 1.02; **6"** = 1.47; **12"** = 5.88
TUBING INSIDE DIA. CAPACITY (Gal./Ft.): **1/8"** = 0.0006; **3/16"** = 0.0014; **1/4"** = 0.0026; **5/16"** = 0.004; **3/8"** = 0.006; **1/2"** = 0.010; **5/8"** = 0.016
BTOC = Below top of casing – feet below top of casing which includes above grade riser

PURGING EQUIPMENT CODES: **B** = Bailer; **BP** = Bladder Pump; **ESP** = Electric Submersible Pump; **PP =** Peristaltic Pump; **O** = Other (Specify)

SAMPLING DATA

SAMPLED BY (PRINT) / AFFILIATION: Maria Johnson/Parsons	SAMPLER(S) SIGNATURE(S): Maria Johnson	SAMPLING INITIATED AT: 0949	SAMPLING ENDED AT: 1017
PUMP OR TUBING DEPTH IN WELL (feet): 20.5	TUBING MATERIAL CODE: Teflon-lined PE	FIELD-FILTERED: Yes/**SM 4500 Sulfide** FILTER SIZE: 0.45 μm Filtration Equipment Type: Syringe	
FIELD DECONTAMINATION: PUMP Y **No**	TUBING Y **No (replaced)**	DUPLICATE: No	

SAMPLE CONTAINER SPECIFICATION				SAMPLE PRESERVATION			INTENDED ANALYSIS AND/OR METHOD	SAMPLING EQUIPMENT CODE	SAMPLE PUMP FLOW RATE (mL per minute)
SAMPLE ID CODE	# CONTAINERS	MATERIAL CODE	VOLUME	PRESERVATIVE USED	TOTAL VOL ADDED IN FIELD (mL)	FINAL pH			
MW-1A	1	PE	250mL	HNO3	--	--	6010B TAL Metals/7470A Hg	APP	250
MW-1A	1	PE	125mL	--	--		3500 FE/ 9040B pH	APP	125
MW-1A	1	PE	250mL	--	--	--	6010B Dissolved Silica	APP	125
MW-1A	1	PE	125mL	--	--	--	9056A_28D Chloride & Sulfate	APP	125
MW-1A	1	AG	125mL	--	--	--	SM 5310 DOC	APP	125
MW-1A	2	PE	250mL	NaOH Zinc Acetate	--	--	SM4500 Sulfide	APP	**Field-Filtered**
MW-1A	1	PE	500mL	--	--	--	2540C TDS	APP	167
MW-1A	1	PE	250mL	--	--	--	2320B Alkalinity	APP	125
MW-1A	1	AG	125mL	HCl	--	--	SM5310 TOC	APP	125

REMARKS: Per SOP, parameters stable for three readings prior to sampling. Tubing–in-Screen-Interval purge method used. Purge water "tea" colored.

MATERIAL CODES: **AG** = Amber Glass; **CG** = Clear Glass; **PE** = Polyethylene; **PP** = Polypropylene; **S** = Silicone; **T** = Teflon; **O** = Other (Specify)

SAMPLING EQUIPMENT CODES: **APP** = After Peristaltic Pump; **B** = Bailer; **BP** = Bladder Pump; **ESP** = Electric Submersible Pump; **RFPP** = Reverse Flow Peristaltic Pump; **SM** = Straw Method (Tubing Gravity Drain); **O** = Other (Specify)

NOTES: Stabilization Criteria for Range of Variation of Last Three Consecutive Readings:-**pH:** ± 0.1 unit **Specific Conductance:** ± 5% **Dissolved Oxygen:** all readings ≤ 10% saturation; optionally, ± 0.2 mg/L **Turbidity:** all readings ≤ 10 NTU; or ± 10%

GROUNDWATER SAMPLING LOG

SITE NAME: LCP Chemical Site	SITE LOCATION: Brunswick, GA	
WELL NO: MW-1B	SAMPLE ID: MW-1B	DATE: 11/27/12

PURGING DATA

WELL DIAMETER (inches): 2	TUBING DIAMETER (inches): 1/4	WELL SCREEN INTERVAL (btoc) DEPTH: 33 feet to 38 feet	STATIC DEPTH (btoc) TO WATER (feet): 8.85	PURGE PUMP TYPE OR BAILER: PP

WELL VOLUME PURGE: **1 WELL VOLUME** = (TOTAL WELL DEPTH – STATIC DEPTH TO WATER) X WELL CAPACITY
(only fill out if applicable)
= (feet – feet) X 0.16 gallons/foot = gallons

EQUIPMENT VOLUME PURGE: **1 EQUIPMENT VOL.** = (TUBING CAPACITY X TUBING LENGTH) + FLOW CELL VOLUME
(only fill out if applicable)
= (0.0026 gallons/foot X 39.5 feet) + 0.13 gallons = 0.23 gallons

INITIAL PUMP OR TUBING DEPTH IN WELL (feet btoc): 35.5	FINAL PUMP OR TUBING DEPTH IN WELL (feet btoc): 35.5	PURGING INITIATED AT: 1355	PURGING ENDED AT: 1552	TOTAL VOLUME PURGED (gallons): 1.75

TIME	VOLUME PURGED (gallons)	CUMUL. VOLUME PURGED (gallons)	PURGE RATE (gpm)	DEPTH TO WATER (feet btoc)	pH (standard units)	TEMP. (^{O}C)	SP COND. (mS/cm)	DISSOLVED OXYGEN (% saturation)	TURBIDITY (NTUs)	ORP (mV)	SP Gravity (sg)
1456	0.75	0.75	0.012	8.85	6.5	22.67	6.309	4.7	1.55	-117.0	
1508	0.25	1.00	0.02	8.89	6.5	22.27	6.288	2.8	1.15	-137.8	
1527	0.25	1.25	0.03	8.89	6.5	22.52	6.2666	2.8	1.03	-140.0	
1536	0.25	1.50	0.03	8.89	6.5	22.34	6.261	3.3	0.95	-143.6	
1550	0.25	1.75	0.018	8.89	6.5	22.01	6.260	3.2	0.61	-144.7	1.004

WELL CAPACITY (Gallons Per Foot): **0.75"** = 0.02; **1"** = 0.04; **1.25"** = 0.06; **2"** = 0.16; **3"** = 0.37; **4"** = 0.65; **5"** = 1.02; **6"** = 1.47; **12"** = 5.88
TUBING INSIDE DIA. CAPACITY (Gal./Ft.): **1/8"** = 0.0006; **3/16"** = 0.0014; **1/4"** = 0.0026; **5/16"** = 0.004; **3/8"** = 0.006; **1/2"** = 0.010; **5/8"** = 0.016
BTOC = Below top of casing – feet below top of casing which includes above grade riser

PURGING EQUIPMENT CODES: **B** = Bailer; **BP** = Bladder Pump; **ESP** = Electric Submersible Pump; **PP =** Peristaltic Pump; **O** = Other (Specify)

SAMPLING DATA

SAMPLED BY (PRINT) / AFFILIATION: Maria Johnson/Parsons	SAMPLER(S) SIGNATURE(S): Maria Johnson	SAMPLING INITIATED AT: 1559	SAMPLING ENDED AT: 1643

PUMP OR TUBING DEPTH IN WELL (feet): 35.5	TUBING MATERIAL CODE: Teflon-lined PE	FIELD-FILTERED: Yes/**SM 4500 Sulfide** FILTER SIZE: 0.45 μm Filtration Equipment Type: Syringe

FIELD DECONTAMINATION: PUMP Y **No** TUBING Y **No (replaced)** DUPLICATE: No

SAMPLE CONTAINER SPECIFICATION				SAMPLE PRESERVATION			INTENDED ANALYSIS AND/OR METHOD	SAMPLING EQUIPMENT CODE	SAMPLE PUMP FLOW RATE (mL per minute)
SAMPLE ID CODE	# CONTAINERS	MATERIAL CODE	VOLUME	PRESERVATIVE USED	TOTAL VOL ADDED IN FIELD (mL)	FINAL pH			
MW-1B	1	PE	250mL	HNO3	--	--	6010B TAL Metals/7470A Hg	APP	125
MW-1B	1	PE	125mL	--	--		3500 FE/ 9040B pH	APP	63
MW-1B	1	PE	250mL	--	--	--	6010B Dissolved Silica	APP	83
MW-1B	1	PE	125mL	--	--	--	9056A_28D Chloride & Sulfate	APP	125
MW-1B	1	AG	125mL	--	--	--	SM 5310 DOC	APP	125
MW-1B	2	PE	250mL	NaOH Zinc Acetate	--	--	SM4500 Sulfide	APP	**Field-Filtered**
MW-1B	1	PE	500mL	--	--	--	2540C TDS	APP	83
MW-1B	1	PE	250mL	--	--	--	2320B Alkalinity	APP	125
MW-1B	1	AG	125mL	HCl	--	--	SM5310 TOC	APP	63

REMARKS: Per SOP, parameters stable for three readings prior to sampling. Tubing–in-Screen-Interval purge method used. Purge water "tea" colored. 1419 to 1447 pause purge to assist C. Jaynes.

MATERIAL CODES: **AG** = Amber Glass; **CG** = Clear Glass; **PE** = Polyethylene; **PP** = Polypropylene; **S** = Silicone; **T** = Teflon; **O** = Other (Specify)

SAMPLING EQUIPMENT CODES: **APP** = After Peristaltic Pump; **B** = Bailer; **BP** = Bladder Pump; **ESP** = Electric Submersible Pump; **RFPP** = Reverse Flow Peristaltic Pump; **SM** = Straw Method (Tubing Gravity Drain); **O** = Other (Specify)

NOTES: Stabilization Criteria for Range of Variation of Last Three Consecutive Readings:-**pH:** ± 0.1 unit **Specific Conductance:** ± 5% **Dissolved Oxygen:** all readings ≤ 10% saturation; optionally, ± 0.2 mg/L **Turbidity:** all readings ≤ 10 NTU; or ± 10%

GROUNDWATER SAMPLING LOG

SITE NAME: LCP Chemical Site	SITE LOCATION: Brunswick, GA

WELL NO: MW-1C	SAMPLE ID: MW-1C	DATE: 11/26/12

PURGING DATA

WELL DIAMETER (inches): 2	TUBING DIAMETER (inches): 1/4	WELL SCREEN INTERVAL (btoc) DEPTH:48.5 feet to 53.5 feet	STATIC DEPTH (btoc) TO WATER (feet): 10.3	PURGE PUMP TYPE OR BAILER: PP

WELL VOLUME PURGE: 1 WELL VOLUME = (TOTAL WELL DEPTH – STATIC DEPTH TO WATER) X WELL CAPACITY
(only fill out if applicable)
= (feet – feet) X 0.16 gallons/foot = gallons

EQUIPMENT VOLUME PURGE: 1 EQUIPMENT VOL. = (TUBING CAPACITY X TUBING LENGTH) + FLOW CELL VOLUME
(only fill out if applicable)
= s (0.0026 gallons/foot X 55 feet) + 0.13 gallons = 0.27 gallons

INITIAL PUMP OR TUBING DEPTH IN WELL (feet btoc): 51.0	FINAL PUMP OR TUBING DEPTH IN WELL (feet btoc): 51.0	PURGING INITIATED AT: 1414	PURGING ENDED AT: 1524	TOTAL VOLUME PURGED (gallons): 1.95

TIME	VOLUME PURGED (gallons)	CUMUL. VOLUME PURGED (gallons)	PURGE RATE (gpm)	DEPTH TO WATER (feet btoc)	pH (standard units)	TEMP. (^{O}C)	SP COND. (mS/cm)	DISSOLVED OXYGEN (% saturation)	TURBIDITY (NTUs)	ORP (mV)	SP Gravity (sg)
1439	0.75	0.75	0.03	10.5	6.75	22.98	69.34	4.3	--	-156.1	
1453	0.35	1.10	0.025	10.5	6.74	22.24	69.00	3.2	0.35	-162.9	
1506	0.30	1.40	0.027	10.5	6.74	22.39	69.04	2.8	1.34	-170.9	
1516	0.25	1.65	0.025	10.5	6.74	22.40	69.00	2.3	1.21	-177.4	
1524	0.30	1.95	0.038	10.5	6.74	22.31	69.02	2.3	1.90	-179.6	1.040

WELL CAPACITY (Gallons Per Foot): **0.75"** = 0.02; **1"** = 0.04; **1.25"** = 0.06; **2"** = 0.16; **3"** = 0.37; **4"** = 0.65; **5"** = 1.02; **6"** = 1.47; **12"** = 5.88
TUBING INSIDE DIA. CAPACITY (Gal./Ft.): **1/8"** = 0.0006; **3/16"** = 0.0014; **1/4"** = 0.0026; **5/16"** = 0.004; **3/8"** = 0.006; **1/2"** = 0.010; **5/8"** = 0.016
BTOC = Below top of casing – feet below top of casing which includes above grade riser

PURGING EQUIPMENT CODES: **B** = Bailer; **BP** = Bladder Pump; **ESP** = Electric Submersible Pump; **PP =** Peristaltic Pump; **O** = Other (Specify)

SAMPLING DATA

SAMPLED BY (PRINT) / AFFILIATION: Maria Johnson/Parsons	SAMPLER(S) SIGNATURE(S): Maria Johnson	SAMPLING INITIATED AT: 1534	SAMPLING ENDED AT: 1614

PUMP OR TUBING DEPTH IN WELL (feet): 51.0	TUBING MATERIAL CODE: Teflon-lined PE	FIELD-FILTERED: Yes FILTER SIZE: 0.45 µm Filtration Equipment Type: Syringe

FIELD DECONTAMINATION: PUMP Y N TUBING Y N (replaced)	DUPLICATE: No

SAMPLE CONTAINER SPECIFICATION				SAMPLE PRESERVATION			INTENDED ANALYSIS AND/OR METHOD	SAMPLING EQUIPMENT CODE	SAMPLE PUMP FLOW RATE (mL per minute)
SAMPLE ID CODE	# CONTAINERS	MATERIAL CODE	VOLUME	PRESERVATIVE USED	TOTAL VOL ADDED IN FIELD (mL)	FINAL pH			
MW-1C	1	PE	250mL	HNO3	--	--	6010B TAL Metals/ 7470A Hg	APP	83
MW-1C	1	PE	125mL	--	--		3500 FE/ 9040B pH	APP	63
MW-1C	1	PE	250mL	--	--	--	6010B Dissolved Silica	APP	250
MW-1C	1	PE	125mL	--	--	--	9056A_28D Chloride & Sulfate	APP	63
MW-1C	1	AG	125mL	--	--	--	SM 5310 DOC	APP	125
MW-1C	2	PE	250mL	NaOH Zinc Acetate	--	--	SM4500 Sulfide	APP	**Field-Filtered**
MW-1C	1	PE	500mL	--	--	--	2540C TDS	APP	63
MW-1C	1	PE	250mL	--	--	--	2320B Alkalinity	APP	63
MW-1C	1	AG	125mL	HCl	--	--	SM5310 TOC	APP	63

REMARKS: Per SOP, parameters stable for three readings prior to sampling. Tubing–in-Screen Interval purge method was used. Initial purge water was very dark brown with sandy slugs, and the turbidity was too high for the meter to read. Water cleared throughout purge.

MATERIAL CODES: **AG** = Amber Glass; **CG** = Clear Glass; **PE** = Polyethylene; **PP** = Polypropylene; **S** = Silicone; **T** = Teflon; **O** = Other (Specify)

SAMPLING EQUIPMENT CODES: **APP** = After Peristaltic Pump; **B** = Bailer; **BP** = Bladder Pump; **ESP** = Electric Submersible Pump; **RFPP** = Reverse Flow Peristaltic Pump; **SM** = Straw Method (Tubing Gravity Drain); **O** = Other (Specify)

NOTES: Stabilization Criteria for Range of Variation of Last Three Consecutive Readings:-**pH:** ± 0.1 unit **Specific Conductance:** ± 5% **Dissolved Oxygen:** all readings ≤ 10% saturation; optionally, ± 0.2 mg/L **Turbidity:** all readings ≤ 10 NTU; or ± 10%

GROUNDWATER SAMPLING LOG

SITE NAME: LCP Chemical Site	SITE LOCATION: Brunswick, GA	
WELL NO: MW-2A	SAMPLE ID: MW-2A	DATE: 11/28/12

PURGING DATA

WELL DIAMETER (inches): 2	TUBING DIAMETER (inches): 1/4	WELL SCREEN INTERVAL (btoc) DEPTH:18 feet to 23 feet	STATIC DEPTH (btoc) TO WATER (feet): 8.41	PURGE PUMP TYPE OR BAILER: PP

WELL VOLUME PURGE: 1 WELL VOLUME = (TOTAL WELL DEPTH – STATIC DEPTH TO WATER) X WELL CAPACITY
(only fill out if applicable)
= (feet – feet) X 0.16 gallons/foot = gallons

EQUIPMENT VOLUME PURGE: 1 EQUIPMENT VOL. = (TUBING CAPACITY X TUBING LENGTH) + FLOW CELL VOLUME
(only fill out if applicable)
= (0.0026 gallons/foot X 24.5 feet) + 0.13 gallons = 0.19 gallons

INITIAL PUMP OR TUBING DEPTH IN WELL (feet btoc): 20.5	FINAL PUMP OR TUBING DEPTH IN WELL (feet btoc): 20.5	PURGING INITIATED AT: 1028	PURGING ENDED AT: 1101	TOTAL VOLUME PURGED (gallons): 1.25

TIME	VOLUME PURGED (gallons)	CUMUL. VOLUME PURGED (gallons)	PURGE RATE (gpm)	DEPTH TO WATER (feet btoc)	pH (standard units)	TEMP. (°C)	SP COND. (mS/cm)	DISSOLVED OXYGEN (% saturation)	TURBIDITY (NTUs)	ORP (mV)	SP Gravity (sg)
1040	0.25	0.25	0.02	8.55	7.7	19.99	7.172	8.3	4.83	-166.2	
1045	0.25	0.50	0.05	8.55	7.0	20.07	7.185	6.8	4.57	-167.9	
1050	0.25	0.75	0.05	8.55	7.0	20.22	7.192	5.4	4.00	-171.1	
1055	0.25	1.00	0.05	8.55	6.9	20.30	7.194	4.8	4.82	-183.3	
1100	0.25	1.25	0.05	8.55	7.0	20.40	7.193	4.1	3.72	-183.2	1.003

WELL CAPACITY (Gallons Per Foot): **0.75"** = 0.02; **1"** = 0.04; **1.25"** = 0.06; **2"** = 0.16; **3"** = 0.37; **4"** = 0.65; **5"** = 1.02; **6"** = 1.47; **12"** = 5.88
TUBING INSIDE DIA. CAPACITY (Gal./Ft.): **1/8"** = 0.0006; **3/16"** = 0.0014; **1/4"** = 0.0026; **5/16"** = 0.004; **3/8"** = 0.006; **1/2"** = 0.010; **5/8"** = 0.016
BTOC = Below top of casing – feet below top of casing which includes above grade riser

PURGING EQUIPMENT CODES: **B** = Bailer; **BP** = Bladder Pump; **ESP** = Electric Submersible Pump; **PP =** Peristaltic Pump; **O** = Other (Specify)

SAMPLING DATA

SAMPLED BY (PRINT) / AFFILIATION: Maria Johnson/Parsons	SAMPLER(S) SIGNATURE(S): Maria Johnson	SAMPLING INITIATED AT: 1106	SAMPLING ENDED AT: 1130

PUMP OR TUBING DEPTH IN WELL (feet): 20.5	TUBING MATERIAL CODE: Teflon-lined PE	FIELD-FILTERED: Yes/**SM 4500 Sulfide** FILTER SIZE: 0.45 μm Filtration Equipment Type: Syringe

FIELD DECONTAMINATION: PUMP Y **No** TUBING Y **No (replaced)** DUPLICATE: No

SAMPLE CONTAINER SPECIFICATION				SAMPLE PRESERVATION			INTENDED ANALYSIS AND/OR METHOD	SAMPLING EQUIPMENT CODE	SAMPLE PUMP FLOW RATE (mL per minute)
SAMPLE ID CODE	# CONTAINERS	MATERIAL CODE	VOLUME	PRESERVATIVE USED	TOTAL VOL ADDED IN FIELD (mL)	FINAL pH			
MW-2A	1	PE	250mL	HNO3	--	--	6010B TAL Metals/7470A Hg	APP	125
MW-2A	1	PE	125mL	--	--		3500 FE/ 9040B pH	APP	125
MW-2A	1	PE	250mL	--	--	--	6010B Dissolved Silica	APP	250
MW-2A	1	PE	125mL	--	--	--	9056A_28D Chloride & Sulfate	APP	125
MW-2A	1	AG	125mL	--	--	--	SM 5310 DOC	APP	125
MW-2A	2	PE	250mL	NaOH Zinc Acetate	--	--	SM4500 Sulfide	APP	**Field-Filtered**
MW-2A	1	PE	500mL	--	--	--	2540C TDS	APP	125
MW-2A	1	PE	250mL	--	--	--	2320B Alkalinity	APP	250
MW-2A	1	AG	125mL	HCl	--	--	SM5310 TOC	APP	125

REMARKS: Per SOP, parameters stable for three readings before sampling. Tubing –in-Screen-Interval purge method used. Purge water "tea" colored, slight sulfur-like odor.

MATERIAL CODES: **AG** = Amber Glass; **CG** = Clear Glass; **PE** = Polyethylene; **PP** = Polypropylene; **S** = Silicone; **T** = Teflon; **O** = Other (Specify)

SAMPLING EQUIPMENT CODES: **APP** = After Peristaltic Pump; **B** = Bailer; **BP** = Bladder Pump; **ESP** = Electric Submersible Pump; **RFPP** = Reverse Flow Peristaltic Pump; **SM** = Straw Method (Tubing Gravity Drain); **O** = Other (Specify)

NOTES: Stabilization Criteria for Range of Variation of Last Three Consecutive Readings:-**pH:** ± 0.1 unit **Specific Conductance:** ± 5% **Dissolved Oxygen:** all readings ≤ 10% saturation; optionally, ± 0.2 mg/L **Turbidity:** all readings ≤ 10 NTU; or ± 10%

GROUNDWATER SAMPLING LOG

SITE NAME: LCP Chemical Site		SITE LOCATION: Brunswick, GA
WELL NO: MW-2B	SAMPLE ID: MW-2B	DATE: 11/28/12

PURGING DATA

WELL DIAMETER (inches): 2	TUBING DIAMETER (inches): 1/4	WELL SCREEN INTERVAL (btoc) DEPTH: 33 feet to 38 feet	STATIC DEPTH (btoc) TO WATER (feet): 8.31	PURGE PUMP TYPE OR BAILER: PP

WELL VOLUME PURGE: 1 WELL VOLUME = (TOTAL WELL DEPTH – STATIC DEPTH TO WATER) X WELL CAPACITY
(only fill out if applicable)
= (feet – feet) X 0.16 gallons/foot = gallons

EQUIPMENT VOLUME PURGE: 1 EQUIPMENT VOL. = (TUBING CAPACITY X TUBING LENGTH) + FLOW CELL VOLUME
(only fill out if applicable)
= (0.0026 gallons/foot X 39.5 feet) + 0.13 gallons = 0.23 gallons

INITIAL PUMP OR TUBING DEPTH IN WELL (feet btoc): 35.5	FINAL PUMP OR TUBING DEPTH IN WELL (feet btoc): 35.5	PURGING INITIATED AT: 0752	PURGING ENDED AT: 0828	TOTAL VOLUME PURGED (gallons): 1.50

TIME	VOLUME PURGED (gallons)	CUMUL. VOLUME PURGED (gallons)	PURGE RATE (gpm)	DEPTH TO WATER (feet btoc)	pH (standard units)	TEMP. (^{O}C)	SP COND. (mS/cm)	DISSOLVED OXYGEN (% saturation)	TURBIDITY (NTUs)	ORP (mV)	SP Gravity (sg)
0806	0.50	0.50	0.036	8.4	6.26	19.84	5.917	16.8	3.26	-121.8	
0812	0.25	0.75	0.04	8.4	6.24	19.95	5.955	12.0	3.14	-131.2	
0817	0.25	1.00	0.05	8.4	6.2	19.98	5.962	9.9	2.88	-132.1	
0822	0.25	1.25	0.05	8.4	6.2	20.07	5.972	8.2	2.39	-140.1	
0828	0.25	1.50	0.04	8.4	6.2	20.09	5.976	8.0	1.53	-142.1	1.002

WELL CAPACITY (Gallons Per Foot): **0.75"** = 0.02; **1"** = 0.04; **1.25"** = 0.06; **2"** = 0.16; **3"** = 0.37; **4"** = 0.65; **5"** = 1.02; **6"** = 1.47; **12"** = 5.88
TUBING INSIDE DIA. CAPACITY (Gal./Ft.): **1/8"** = 0.0006; **3/16"** = 0.0014; **1/4"** = 0.0026; **5/16"** = 0.004; **3/8"** = 0.006; **1/2"** = 0.010; **5/8"** = 0.016
BTOC = Below top of casing – feet below top of casing which includes above grade riser

PURGING EQUIPMENT CODES: B = Bailer; **BP** = Bladder Pump; **ESP** = Electric Submersible Pump; **PP =** Peristaltic Pump; **O** = Other (Specify)

SAMPLING DATA

SAMPLED BY (PRINT) / AFFILIATION: Maria Johnson/Parsons	SAMPLER(S) SIGNATURE(S): Maria Johnson	SAMPLING INITIATED AT: 0835	SAMPLING ENDED AT: 0857
PUMP OR TUBING DEPTH IN WELL (feet): 35.5	TUBING MATERIAL CODE: Teflon-lined PE	FIELD-FILTERED: Yes/**SM 4500 Sulfide** FILTER SIZE: 0.45 μm Filtration Equipment Type: Syringe	
FIELD DECONTAMINATION: PUMP Y **No**	TUBING Y **No (replaced)**	DUPLICATE: No	

SAMPLE CONTAINER SPECIFICATION				SAMPLE PRESERVATION			INTENDED ANALYSIS AND/OR METHOD	SAMPLING EQUIPMENT CODE	SAMPLE PUMP FLOW RATE (mL per minute)
SAMPLE ID CODE	# CONTAINERS	MATERIAL CODE	VOLUME	PRESERVATIVE USED	TOTAL VOL ADDED IN FIELD (mL)	FINAL pH			
MW-2B	1	PE	250mL	HNO3	--	--	6010B TAL Metals/7470A Hg	APP	250
MW-2B	1	PE	125mL	--	--		3500 FE/ 9040B pH	APP	125
MW-2B	1	PE	250mL	--	--	--	6010B Dissolved Silica	APP	250
MW-2B	1	PE	125mL	--	--	--	9056A_28D Chloride & Sulfate	APP	125
MW-2B	1	AG	125mL	--	--	--	SM 5310 DOC	APP	125
MW-2B	2	PE	250mL	NaOH Zinc Acetate	--	--	SM4500 Sulfide	APP	**Field-Filtered**
MW-2B	1	PE	500mL	--	--	--	2540C TDS	APP	167
MW-2B	1	PE	250mL	--	--	--	2320B Alkalinity	APP	250
MW-2B	1	AG	125mL	HCl	--	--	SM5310 TOC	APP	125

REMARKS: Per SOP Parameters stable for three readings before sampling. Tubing–in-Screen-Interval purge method used. Purge water very brown, indistinguishable sulfur-like odor

MATERIAL CODES: **AG** = Amber Glass; **CG** = Clear Glass; **PE** = Polyethylene; **PP** = Polypropylene; **S** = Silicone; **T** = Teflon; **O** = Other (Specify)

SAMPLING EQUIPMENT CODES: APP = After Peristaltic Pump; **B** = Bailer; **BP** = Bladder Pump; **ESP** = Electric Submersible Pump; **RFPP** = Reverse Flow Peristaltic Pump; **SM** = Straw Method (Tubing Gravity Drain); **O** = Other (Specify)

NOTES: Stabilization Criteria for Range of Variation of Last Three Consecutive Readings:-**pH:** ± 0.1 unit **Specific Conductance:** ± 5% **Dissolved Oxygen:** all readings ≤ 10% saturation; optionally, ± 0.2 mg/L **Turbidity:** all readings ≤ 10 NTU; or ± 10%

GROUNDWATER SAMPLING LOG

SITE NAME: LCP Chemical Site	SITE LOCATION: Brunswick, GA	
WELL NO: MW-2C	SAMPLE ID: MW-2C-**MID**	DATE: 11/27/12

PURGING DATA

WELL DIAMETER (inches): 2	TUBING DIAMETER (inches): 1/4	WELL SCREEN INTERVAL (btoc) DEPTH: 48 feet to 53 feet	STATIC DEPTH (btoc) TO WATER (feet): 9.22	PURGE PUMP TYPE OR BAILER: PP

WELL VOLUME PURGE: 1 WELL VOLUME = (TOTAL WELL DEPTH – STATIC DEPTH TO WATER) X WELL CAPACITY
(only fill out if applicable)
= (feet – feet) X 0.16 gallons/foot = gallons

EQUIPMENT VOLUME PURGE: 1 EQUIPMENT VOL. = (TUBING CAPACITY X TUBING LENGTH) + FLOW CELL VOLUME
(only fill out if applicable)
= (0.0026 gallons/foot X 55 feet) + 0.13 gallons = 0.27 gallons

INITIAL PUMP OR TUBING DEPTH IN WELL (feet btoc): 53.5	FINAL PUMP OR TUBING DEPTH IN WELL (feet btoc): 53.5	PURGING INITIATED AT: 1103	PURGING ENDED AT: 1351	TOTAL VOLUME PURGED (gallons): 2.35

TIME	VOLUME PURGED (gallons)	CUMUL. VOLUME PURGED (gallons)	PURGE RATE (gpm)	DEPTH TO WATER (feet btoc)	pH (standard units)	TEMP. (^{O}C)	SP COND. (mS/cm)	DISSOLVED OXYGEN (% saturation)	TURBIDITY (NTUs)	ORP (mV)	SP Gravity (sg)
1242	0.55	0.55	0.019	11.97	8.54	23.56	52.40	1.4	--	-353.8	
1250	0.25	0.80	0.03	11.67	7.89	23.20	51.19	1.4	--	-335.4	
1300	0.25	1.05	0.03	12.15	7.48	22.89	50.47	0.9	---	-312.5	
1309	0.25	1.30	0.03	12.49	7.41	22.21	50.29	0.5	--	-320.5	
1319	0.25	1.55	0.03	12.75	7.60	22.36	50.33	0.6	--	-346.6	
1328	0.25	1.80	0.03	12.90	7.74	22.65	50.27	0.1	--	-371.9	
1341	0.30	2.10	0.02	13.06	7.75	22.83	50.29	0.4	--	-381.2	
1349	0.25	2.35	0.03	13.06	7.74	22.27	50.29	0.4	--	-387.4	1.024

WELL CAPACITY (Gallons Per Foot): **0.75"** = 0.02; **1"** = 0.04; **1.25"** = 0.06; **2"** = 0.16; **3"** = 0.37; **4"** = 0.65; **5"** = 1.02; **6"** = 1.47; **12"** = 5.88
TUBING INSIDE DIA. CAPACITY (Gal./Ft.): **1/8"** = 0.0006; **3/16"** = 0.0014; **1/4"** = 0.0026; **5/16"** = 0.004; **3/8"** = 0.006; **1/2"** = 0.010; **5/8"** = 0.016
BTOC = Below top of casing – feet below top of casing which includes above grade riser

PURGING EQUIPMENT CODES: **B** = Bailer; **BP** = Bladder Pump; **ESP** = Electric Submersible Pump; **PP =** Peristaltic Pump; **O** = Other (Specify)

SAMPLING DATA

SAMPLED BY (PRINT) / AFFILIATION: Christine Jaynes/Parsons	SAMPLER(S) SIGNATURE(S): Jaynes	SAMPLING INITIATED AT: 1358	SAMPLING ENDED AT: 1507
PUMP OR TUBING DEPTH IN WELL (feet): 53.5	TUBING MATERIAL CODE: Teflon-lined PE	FIELD-FILTERED: Yes/**SM 4500 Sulfide** FILTER SIZE: 0.45 µm Filtration Equipment Type: Syringe	
FIELD DECONTAMINATION: PUMP Y **No**	TUBING Y **No (replaced)**	DUPLICATE: **Yes**	

SAMPLE CONTAINER SPECIFICATION				SAMPLE PRESERVATION			INTENDED ANALYSIS AND/OR METHOD	SAMPLING EQUIPMENT CODE	SAMPLE PUMP FLOW RATE (mL per minute)
SAMPLE ID CODE	# CONTAINERS	MATERIAL CODE	VOLUME	PRESERVATIVE USED	TOTAL VOL ADDED IN FIELD (mL)	FINAL pH			
MW-2C-MID	2	PE	250mL	HNO3	--	--	6010B TAL Metals/7470A Hg	APP	83
MW-2C-MID	2	PE	125mL	--	--		3500 FE/ 9040B pH	APP	63
MW-2C-MID	2	PE	250mL	--	--	--	6010B Dissolved Silica	APP	71
MW-2C-MID	2	PE	125mL	--	--	--	9056A_28D Chloride & Sulfate	APP	83
MW-2C-MID	2	AG	125mL	--	--	--	SM 5310 DOC	APP	63
MW-2C-MID	4	PE	250mL	NaOH Zinc Acetate	--	--	SM4500 Sulfide	APP	**Field-Filtered**
MW-2C-MID	2	PE	500mL	--	--	--	2540C TDS	APP	71
MW-2C-MID	2	PE	250mL	--	--	--	2320B Alkalinity	APP	71
MW-2C-MID	2	AG	125mL	HCl	--	--	SM5310 TOC	APP	83

REMARKS: Per SOP Parameters stable for three readings before sampling. Tubing –in-Screen-Interval purge method used. Turbidity too low for the meter to read; meter calibration was verified between readings. Purge paused from 1120-1230 water level recovered to 9.74ft during that time. Purge water clear, brown. Black "resign" noted on tubing interior wall and in filters.

MATERIAL CODES: **AG** = Amber Glass; **CG** = Clear Glass; **PE** = Polyethylene; **PP** = Polypropylene; **S** = Silicone; **T** = Teflon; **O** = Other (Specify)

SAMPLING EQUIPMENT CODES: **APP** = After Peristaltic Pump; **B** = Bailer; **BP** = Bladder Pump; **ESP** = Electric Submersible Pump; **RFPP** = Reverse Flow Peristaltic Pump; **SM** = Straw Method (Tubing Gravity Drain); **O** = Other (Specify)

NOTES: Stabilization Criteria for Range of Variation of Last Three Consecutive Readings: **pH:** $\pm$ 0.1 unit **Specific Conductance:** $\pm$ 5% **Dissolved Oxygen:** all readings $\leq$ 10% saturation; optionally, $\pm$ 0.2 mg/L **Turbidity:** all readings $\leq$ 10 NTU; or $\pm$ 10%

GROUNDWATER SAMPLING LOG

SITE NAME: LCP Chemical Site		SITE LOCATION: Brunswick, GA
WELL NO: MW-2C	SAMPLE ID: MW-2C-**TOP**	DATE: 11/27/12

PURGING DATA

WELL DIAMETER (inches): 2	TUBING DIAMETER (inches): 1/4	WELL SCREEN INTERVAL (btoc) DEPTH: 48 feet to 53 feet	STATIC DEPTH (btoc) TO WATER (feet): 12.0	PURGE PUMP TYPE OR BAILER: PP

WELL VOLUME PURGE: 1 WELL VOLUME = (TOTAL WELL DEPTH – STATIC DEPTH TO WATER) X WELL CAPACITY
(only fill out if applicable)
= (feet – feet) X 0.16 gallons/foot = gallons

EQUIPMENT VOLUME PURGE: 1 EQUIPMENT VOL. = (TUBING CAPACITY X TUBING LENGTH) + FLOW CELL VOLUME
(only fill out if applicable)
= (0.0026 gallons/foot X 55 feet) + 0.13 gallons = 0.27 gallons

INITIAL PUMP OR TUBING DEPTH IN WELL (feet btoc): 51	FINAL PUMP OR TUBING DEPTH IN WELL (feet btoc): 51	PURGING INITIATED AT: 1527	PURGING ENDED AT: 1622	TOTAL VOLUME PURGED (gallons): 1.15

TIME	VOLUME PURGED (gallons)	CUMUL. VOLUME PURGED (gallons)	PURGE RATE (gpm)	DEPTH TO WATER (feet btoc)	pH (standard units)	TEMP. (^{o}C)	SP COND. (mS/cm)	DISSOLVED OXYGEN (% saturation)	TURBIDITY (NTUs)	ORP (mV)	SP Gravity (sg)
1535	0.27 in tubing &flow-thru	0.27	0.03	12.32	7.14	22.70	49.73	5.8	--	-181.4	
1544	0.25 in bucket	0.25in bucket	0.03	12.54	6.96	22.41	48.43	2.2	--	-183.0	
1554	0.25	0.50 in bucket	0.025	12.69	6.83	22.08	47.98	1.8	--	-191.1	
1609	0.35	0.85 in bucket	0.027	12.77	6.80	21.92	47.90	2.4	--	-206.3	
1620	0.30	1.15 in bucket	0.027	12.82	6.80	21.67	48.04	2.8	--	-217.9	1.022

WELL CAPACITY (Gallons Per Foot): **0.75"** = 0.02; **1"** = 0.04; **1.25"** = 0.06; **2"** = 0.16; **3"** = 0.37; **4"** = 0.65; **5"** = 1.02; **6"** = 1.47; **12"** = 5.88
TUBING INSIDE DIA. CAPACITY (Gal./Ft.): **1/8"** = 0.0006; **3/16"** = 0.0014; **1/4"** = 0.0026; **5/16"** = 0.004; **3/8"** = 0.006; **1/2"** = 0.010; **5/8"** = 0.016
BTOC = Below top of casing – feet below top of casing which includes above grade riser

PURGING EQUIPMENT CODES: **B** = Bailer; **BP** = Bladder Pump; **ESP** = Electric Submersible Pump; **PP =** Peristaltic Pump; **O** = Other (Specify)

SAMPLING DATA

SAMPLED BY (PRINT) / AFFILIATION: Christine Jaynes/Parsons	SAMPLER(S) SIGNATURE(S): CJaynes	SAMPLING INITIATED AT: 1627	SAMPLING ENDED AT: 1707
PUMP OR TUBING DEPTH IN WELL (feet): 51	TUBING MATERIAL CODE: Teflon-lined PE	FIELD-FILTERED: Yes/**SM 4500 Sulfide** FILTER SIZE: 0.45 μm; Filtration Equipment Type: Syringe	
FIELD DECONTAMINATION: PUMP Y **No**	TUBING Y **No (replaced)**	DUPLICATE: **No**	

SAMPLE CONTAINER SPECIFICATION				SAMPLE PRESERVATION			INTENDED ANALYSIS AND/OR METHOD	SAMPLING EQUIPMENT CODE	SAMPLE PUMP FLOW RATE (mL per minute)
SAMPLE ID CODE	# CONTAINERS	MATERIAL CODE	VOLUME	PRESERVATIVE USED	TOTAL VOL ADDED IN FIELD (mL)	FINAL pH			
MW-2C-TOP	1	PE	250mL	HNO3	--	--	6010B TAL Metals/7470A Hg	APP	63
MW-2C-TOP	1	PE	125mL	--	--		3500 FE/ 9040B pH	APP	63
MW-2C-TOP	1	PE	250mL	--	--	--	6010B Dissolved Silica	APP	63
MW-2C-TOP	1	PE	125mL	--	--	--	9056A_28D Chloride & Sulfate	APP	63
MW-2C-TOP	1	AG	125mL	--	--	--	SM 5310 DOC	APP	63
MW-2C-TOP	2	PE	250mL	NaOH Zinc Acetate	--	--	SM4500 Sulfide	APP	**Field-Filtered**
MW-2C-TOP	1	PE	500mL	--	--	--	2540C TDS	APP	71
MW-2C-TOP	1	PE	250mL	--	--	--	2320B Alkalinity	APP	63
MW-2C-TOP	1	AG	125mL	HCl	--	--	SM5310 TOC	APP	63

REMARKS: Per SOP, parameters stable for three readings prior to sampling. Turbidity was too low for the meter to read; meter calibration was verified between readings. Purge water clear, brown. Black "resign" **not** noted in the filters.

MATERIAL CODES: **AG** = Amber Glass; **CG** = Clear Glass; **PE** = Polyethylene; **PP** = Polypropylene; **S** = Silicone; **T** = Teflon; **O** = Other (Specify)

SAMPLING EQUIPMENT CODES: **APP** = After Peristaltic Pump; **B** = Bailer; **BP** = Bladder Pump; **ESP** = Electric Submersible Pump; **RFPP** = Reverse Flow Peristaltic Pump; **SM** = Straw Method (Tubing Gravity Drain); **O** = Other (Specify)

NOTES: Stabilization Criteria for Range of Variation of Last Three Consecutive Readings:-**pH:** ± 0.1 unit **Specific Conductance:** ± 5% **Dissolved Oxygen:** all readings ≤ 10% saturation; optionally, ± 0.2 mg/L **Turbidity:** all readings ≤ 10 NTU; or ± 10%

GROUNDWATER SAMPLING LOG

SITE NAME: LCP Chemical Site	SITE LOCATION: Brunswick, GA	
WELL NO: MW-3A	SAMPLE ID: MW-3A	DATE: 11/28/12

PURGING DATA

WELL DIAMETER (inches): 2	TUBING DIAMETER (inches): 1/4	WELL SCREEN INTERVAL (btoc) DEPTH: 18 feet to 23 feet	STATIC DEPTH (btoc) TO WATER (feet): 8.9	PURGE PUMP TYPE OR BAILER: PP

WELL VOLUME PURGE: 1 WELL VOLUME = (TOTAL WELL DEPTH – STATIC DEPTH TO WATER) X WELL CAPACITY
(only fill out if applicable)
= (feet – feet) X 0.16 gallons/foot = gallons

EQUIPMENT VOLUME PURGE: 1 EQUIPMENT VOL. = (TUBING CAPACITY X TUBING LENGTH) + FLOW CELL VOLUME
(only fill out if applicable)
= (0.0026 gallons/foot X 24.5 feet) + 0.13 gallons = 0.19 gallons

INITIAL PUMP OR TUBING DEPTH IN WELL (feet btoc): 20.5	FINAL PUMP OR TUBING DEPTH IN WELL (feet btoc): 20.5	PURGING INITIATED AT: 1418	PURGING ENDED AT: 1457	TOTAL VOLUME PURGED (gallons): 1.2

TIME	VOLUME PURGED (gallons)	CUMUL. VOLUME PURGED (gallons)	PURGE RATE (gpm)	DEPTH TO WATER (feet btoc)	pH (standard units)	TEMP. (^{O}C)	SP COND. (mS/cm)	DISSOLVED OXYGEN (% saturation)	TURBIDITY (NTUs)	ORP (mV)	SP Gravity (sg)
1430	0.25	0.25	0.02	9.4	6.8	21.14	47.42	5.5	-1.43	-217.4	
1435	0.25	0.50	0.05	9.4	6.8	21.03	47.44	4.7	-1.36	-254.5	
1440	0.20	0.70	0.04	9.4	6.8	20.55	47.44	3.1	-1.21	-256.0	
1450	0.30	1.00	0.03	9.4	6.9	20.80	47.25	2.7	-0.87	-194.8	
1456	0.20	1.20	0.03	9.35	6.9	20.92	47.11	3.2	-0.72	-240.9	1.022

WELL CAPACITY (Gallons Per Foot): **0.75"** = 0.02; **1"** = 0.04; **1.25"** = 0.06; **2"** = 0.16; **3"** = 0.37; **4"** = 0.65; **5"** = 1.02; **6"** = 1.47; **12"** = 5.88
TUBING INSIDE DIA. CAPACITY (Gal./Ft.): **1/8"** = 0.0006; **3/16"** = 0.0014; **1/4"** = 0.0026; **5/16"** = 0.004; **3/8"** = 0.006; **1/2"** = 0.010; **5/8"** = 0.016
BTOC = Below top of casing – feet below top of casing which includes above grade riser

PURGING EQUIPMENT CODES: **B** = Bailer; **BP** = Bladder Pump; **ESP** = Electric Submersible Pump; **PP =** Peristaltic Pump; **O** = Other (Specify)

SAMPLING DATA

SAMPLED BY (PRINT) / AFFILIATION: Maria Johnson/Parsons	SAMPLER(S) SIGNATURE(S): Maria Johnson	SAMPLING INITIATED AT: 1503	SAMPLING ENDED AT: 1528
PUMP OR TUBING DEPTH IN WELL (feet): 20.5	TUBING MATERIAL CODE: Teflon-lined PE	FIELD-FILTERED: Yes/**SM 4500 Sulfide** FILTER SIZE: 0.45 µm Filtration Equipment Type: Syringe	
FIELD DECONTAMINATION: PUMP Y **No**	TUBING Y **No (replaced)**	DUPLICATE: No	

SAMPLE CONTAINER SPECIFICATION				SAMPLE PRESERVATION			INTENDED ANALYSIS AND/OR METHOD	SAMPLING EQUIPMENT CODE	SAMPLE PUMP FLOW RATE (mL per minute)
SAMPLE ID CODE	# CONTAINERS	MATERIAL CODE	VOLUME	PRESERVATIVE USED	TOTAL VOL ADDED IN FIELD (mL)	FINAL pH			
MW-3A	1	PE	250mL	HNO3	--	--	6010B TAL Metals/7470A Hg	APP	125
MW-3A	1	PE	125mL	--	--		3500 FE/ 9040B pH	APP	125
MW-3A	1	PE	250mL	--	--	--	6010B Dissolved Silica	APP	250
MW-3A	1	PE	125mL	--	--	--	9056A_28D Chloride & Sulfate	APP	125
MW-3A	1	AG	125mL	--	--	--	SM 5310 DOC	APP	125
MW-3A	2	PE	250mL	NaOH Zinc Acetate	--	--	SM4500 Sulfide	APP	**Field-Filtered**
MW-3A	1	PE	500mL	--	--	--	2540C TDS	APP	250
MW-3A	1	PE	250mL	--	--	--	2320B Alkalinity	APP	250
MW-3A	1	AG	125mL	HCl	--	--	SM5310 TOC	APP	125

REMARKS: Per SOP, parameters stable for three readings prior to sampling. Tubing–in-Screen-Interval purge method used. Turbidity was too low for the meter to read and negative values were recorded; meter calibration was verified between readings.

MATERIAL CODES: **AG** = Amber Glass; **CG** = Clear Glass; **PE** = Polyethylene; **PP** = Polypropylene; **S** = Silicone; **T** = Teflon; **O** = Other (Specify)

SAMPLING EQUIPMENT CODES: **APP** = After Peristaltic Pump; **B** = Bailer; **BP** = Bladder Pump; **ESP** = Electric Submersible Pump; **RFPP** = Reverse Flow Peristaltic Pump; **SM** = Straw Method (Tubing Gravity Drain); **O** = Other (Specify)

NOTES: Stabilization Criteria for Range of Variation of Last Three Consecutive Readings:-**pH:** ± 0.1 unit **Specific Conductance:** ± 5% **Dissolved Oxygen:** all readings ≤ 10% saturation; optionally, ± 0.2 mg/L **Turbidity:** all readings ≤ 10 NTU; or ± 10%

GROUNDWATER SAMPLING LOG

SITE NAME: LCP Chemical Site	SITE LOCATION: Brunswick, GA	
WELL NO: MW-115A	SAMPLE ID: MW-115A	DATE: 11/28/12

PURGING DATA

WELL DIAMETER (inches): 2	TUBING DIAMETER (inches): 1/4	WELL SCREEN INTERVAL (btoc) DEPTH: 15.25 feet to 20.25 feet	STATIC DEPTH TO WATER (feet btoc): 7.36	PURGE PUMP TYPE OR BAILER: PP

WELL VOLUME PURGE: 1 WELL VOLUME = (TOTAL WELL DEPTH – STATIC DEPTH TO WATER) X WELL CAPACITY
(only fill out if applicable)
= (feet – feet) X 0.16 gallons/foot = gallons

EQUIPMENT VOLUME PURGE: 1 EQUIPMENT VOL. = (TUBING CAPACITY X TUBING LENGTH) + FLOW CELL VOLUME
(only fill out if applicable)
= (0.0026 gallons/foot X 20.5 feet) + 0.13 gallons = 0.18 gallons

INITIAL PUMP OR TUBING DEPTH IN WELL (feet btoc): 20.5	FINAL PUMP OR TUBING DEPTH IN WELL (feet btoc): 20.5	PURGING INITIATED AT: 1255	PURGING ENDED AT: 1323	TOTAL VOLUME PURGED (gallons): 1.9

TIME	VOLUME PURGED (gallons)	CUMUL. VOLUME PURGED (gallons)	PURGE RATE (gpm)	DEPTH TO WATER (feet btoc)	pH (standard units)	TEMP. (^{O}C)	SP COND. (mS/cm)	DISSOLVED OXYGEN (% saturation)	TURBIDITY (NTUs)	ORP (mV)	SP Gravity (sg)
1303	0.50	0.50	0.06	7.60	7.4	20.95	5.027	11.7	-1.42	-154.6	
1308	0.35	0.85	0.07	7.60	7.4	21.24	4.927	9.0	-1.62	-162.8	
1312	0.35	1.20	0.09	7.60	7.4	21.41	4.919	6.5	-1.28	-162.0	
1317	0.30	1.50	0.06	7.60	7.4	21.54	4.834	5.4	-1.41	-166.3	
1322	0.40	1.90	0.08	7.60	7.4	21.57	4.793	4.3	-1.52	-171.5	1.000

WELL CAPACITY (Gallons Per Foot): **0.75"** = 0.02; **1"** = 0.04; **1.25"** = 0.06; **2"** = 0.16; **3"** = 0.37; **4"** = 0.65; **5"** = 1.02; **6"** = 1.47; **12"** = 5.88
TUBING INSIDE DIA. CAPACITY (Gal./Ft.): **1/8"** = 0.0006; **3/16"** = 0.0014; **1/4"** = 0.0026; **5/16"** = 0.004; **3/8"** = 0.006; **1/2"** = 0.010; **5/8"** = 0.016
BTOC = Below top of casing – feet below top of casing which includes above grade riser

PURGING EQUIPMENT CODES: **B** = Bailer; **BP** = Bladder Pump; **ESP** = Electric Submersible Pump; **PP =** Peristaltic Pump; **O** = Other (Specify)

SAMPLING DATA

SAMPLED BY (PRINT) / AFFILIATION: Maria Johnson/Parsons	SAMPLER(S) SIGNATURE(S): Maria Johnson	SAMPLING INITIATED AT: 1330	SAMPLING ENDED AT: 1351

PUMP OR TUBING DEPTH IN WELL (feet): 20.5	TUBING MATERIAL CODE: Teflon-lined PE	FIELD-FILTERED: Yes/**SM 4500 Sulfide** FILTER SIZE: 0.45 µm Filtration Equipment Type: Syringe

FIELD DECONTAMINATION: PUMP Y **No** TUBING Y **No (replaced)** DUPLICATE: No

SAMPLE CONTAINER SPECIFICATION				SAMPLE PRESERVATION			INTENDED ANALYSIS AND/OR METHOD	SAMPLING EQUIPMENT CODE	SAMPLE PUMP FLOW RATE (mL per minute)
SAMPLE ID CODE	# CONTAINERS	MATERIAL CODE	VOLUME	PRESERVATIVE USED	TOTAL VOL ADDED IN FIELD (mL)	FINAL pH			
MW-115A	1	PE	250mL	HNO3	--	--	6010B TAL Metals/7470A Hg	APP	250
MW-115A	1	PE	125mL	--	--		3500 FE/ 9040B pH	APP	125
MW-115A	1	PE	250mL	--	--	--	6010B Dissolved Silica	APP	250
MW-115A	1	PE	125mL	--	--	--	9056A_28D Chloride & Sulfate	APP	125
MW-115A	1	AG	125mL	--	--	--	SM 5310 DOC	APP	125
MW-115A	2	PE	250mL	NaOH Zinc Acetate	--	--	SM4500 Sulfide	APP	**Field-Filtered**
MW-115A	1	PE	500mL	--	--	--	2540C TDS	APP	167
MW-115A	1	PE	250mL	--	--	--	2320B Alkalinity	APP	250
MW-115A	1	AG	125mL	HCl	--	--	SM5310 TOC	APP	42

REMARKS: Per SOP, parameters stable for three readings before sampling. Tubing–in-Screen-Interval purge method used. Turbidity was too low for the meter to read and negative values were recorded; meter calibration was verified between readings. Purge water dark brown.

MATERIAL CODES: **AG** = Amber Glass; **CG** = Clear Glass; **PE** = Polyethylene; **PP** = Polypropylene; **S** = Silicone; **T** = Teflon; **O** = Other (Specify)

SAMPLING EQUIPMENT CODES: **APP** = After Peristaltic Pump; **B** = Bailer; **BP** = Bladder Pump; **ESP** = Electric Submersible Pump; **RFPP** = Reverse Flow Peristaltic Pump; **SM** = Straw Method (Tubing Gravity Drain); **O** = Other (Specify)

NOTES: Stabilization Criteria for Range of Variation of Last Three Consecutive Readings:**-pH:** ± 0.1 unit **Specific Conductance:** ± 5% **Dissolved Oxygen:** all readings ≤ 10% saturation; optionally, ± 0.2 mg/L **Turbidity:** all readings ≤ 10 NTU; or ± 10%

GROUNDWATER SAMPLING LOG

SITE NAME: LCP Chemical Site	SITE LOCATION: Brunswick, GA	
WELL NO: MW-115B	SAMPLE ID: MW-115B	DATE: 11/28/12

PURGING DATA

WELL DIAMETER (inches): 2	TUBING DIAMETER (inches): 1/4	WELL SCREEN INTERVAL (btoc) DEPTH: 31.5 feet to 33 feet	STATIC DEPTH (btoc) TO WATER (feet): 7.00	PURGE PUMP TYPE OR BAILER: PP

WELL VOLUME PURGE: 1 WELL VOLUME = (TOTAL WELL DEPTH – STATIC DEPTH TO WATER) X WELL CAPACITY
(only fill out if applicable)
= (feet – feet) X 0.16 gallons/foot = gallons

EQUIPMENT VOLUME PURGE: 1 EQUIPMENT VOL. = (TUBING CAPACITY X TUBING LENGTH) + FLOW CELL VOLUME
(only fill out if applicable)
= (0.0026 gallons/foot X 36.25 feet) + 0.13 gallons = 0.22 gallons

INITIAL PUMP OR TUBING DEPTH IN WELL (feet btoc): 32.25	FINAL PUMP OR TUBING DEPTH IN WELL (feet btoc): 32.25	PURGING INITIATED AT: 0755	PURGING ENDED AT: 1312	TOTAL VOLUME PURGED (gallons): 9.5

TIME	VOLUME PURGED (gallons)	CUMUL. VOLUME PURGED (gallons)	PURGE RATE (gpm)	DEPTH TO WATER (feet btoc)	pH (standard units)	TEMP. (^{O}C)	SP COND. (mS/cm)	DISSOLVED OXYGEN (% saturation)	TURBIDITY (NTUs)	ORP (mV)	SP Gravity (sg)
0807	0.25	0.25	0.02	7.05	7.49	19.64	5.873	7.7	0.67	-116.9	
0811	0.25	0.50	0.06	7.07	7.86	19.89	5.907	5.6	0.67	-164.2	
0816	0.25	0.75	0.05	7.07	7.10	19.92	5.925	4.8	1.09	-136.4	
0822	0.25	1.00	0.04	7.06	6.94	20.13	5.919	3.7	1.64	-133.4	
0828	0.25	1.25	0.04	7.07	6.40	20.06	5.967	3.5	0.73	-118.9	
0836	0.25	1.60	0.03	7.07	9.58	20.06	5.978	3.1	1.63	-236.0	
0845	0.40	2.00	0.04	7.11	10.59	19.97	5.980	2.9	1.70	-234.7	
0853	0.28	2.28	0.04	7.06	11.20	19.99	5.994	2.9	0.65	-251.4	
0859	0.22	2.50	0.04	7.08	10.41	20.08	5.995	2.9	0.99	-220.9	
0906	0.25	2.75	0.04	7.06	10.46	20.04	5.991	3.0	0.85	-229.6	
0912	0.25	3.00	0.04	7.06	10.69	20.04	5.989	3.3	0.66	-228.5	
0925	0.25	3.25	0.02	7.08	9.10	20.06	6.009	3.0	0.86	-169.9	
0933	0.50	3.75	0.06	7.07	9.43	19.95	5.985	3.0	0.56	-199.7	
0939	0.30	4.05	0.05	7.07	9.27	19.94	5.986	3.0	0.56	-193.2	
0945	0.20	4.25	0.03	7.07	9.16	19.92	5.980	3.2	0.64	-189.3	
0952	0.25	4.50	0.04	7.07	8.58	19.97	5.990	3.2	0.58	-188.8	
1002	0.50	5.00	0.08	7.08	8.00	20.09	5.996	3.2	0.68	-175.4	
1008	0.20	5.20	0.03	7.08	7.86	20.16	6.016	3.1	0.57	-172.4	
1018	0.30	5.50	0.03	7.08	7.74	20.28	6.017	3.1	0.57	-176.4	
1025	0.25	5.75	0.04	7.08	10.38	20.30	6.018	2.9	0.57	-308.3	
1032	0.25	6.00	0.04	7.08	10.44	20.35	6.010	2.9	0.59	-297.3	
1040	0.25	6.25	0.04	7.08	10.76	20.28	6.021	2.9	0.69	-273.4	
1058	0.75	7.00	0.04	7.08	11.57	20.12	6.010	2.8	0.62	-272.8	
1109	0.50	7.50	0.05	7.10	11.07	20.31	6.006	2.9	0.76	-255.4	
1125	0.75	8.25	0.05	7.09	10.70	20.45	6.018	2.8	0.57	-265.7	
1137	0.50	8.75	0.04	7.11	11.43	20.63	6.028	2.9	0.57	-269.0	
1258	0.25	9.00	0.04	7.04	9.88	19.89	5.971	5.1	0.59	-306.7	
1305	0.25	9.25	0.04	7.05	9.02	20.51	6.029	2.6	0.57	-274.4	
1311	0.25	9.11	0.04	7.06	8.97	20.48	6.042	2.4	0.59	-269.4	1.004

WELL CAPACITY (Gallons Per Foot): **0.75"** = 0.02; **1"** = 0.04; **1.25"** = 0.06; **2"** = 0.16; **3"** = 0.37; **4"** = 0.65; **5"** = 1.02; **6"** = 1.47; **12"** = 5.88
TUBING INSIDE DIA. CAPACITY (Gal./Ft.): **1/8"** = 0.0006; **3/16"** = 0.0014; **1/4"** = 0.0026; **5/16"** = 0.004; **3/8"** = 0.006; **1/2"** = 0.010; **5/8"** = 0.016
BTOC = Below top of casing – feet below top of casing which includes above grade riser

PURGING EQUIPMENT CODES: **B** = Bailer; **BP** = Bladder Pump; **ESP** = Electric Submersible Pump; **PP =** Peristaltic Pump; **O** = Other (Specify)

SAMPLING DATA

SAMPLED BY (PRINT) / AFFILIATION:	SAMPLER(S) SIGNATURE(S):	SAMPLING INITIATED AT:	SAMPLING ENDED AT:
Christine Jaynes/Parsons	CJaynes	1321	1346

PUMP OR TUBING DEPTH IN WELL (feet)	TUBING MATERIAL CODE	FIELD-FILTERED	Filtration Equipment Type
32.25	Teflon-lined PE	Yes/**SM 4500 Sulfide** FILTER SIZE: 0.45 μm	Syringe

FIELD DECONTAMINATION: PUMP Y **No** TUBING Y **No (replaced)** DUPLICATE: No

SAMPLE CONTAINER SPECIFICATION				SAMPLE PRESERVATION			INTENDED ANALYSIS AND/OR METHOD	SAMPLING EQUIPMENT CODE	SAMPLE PUMP FLOW RATE (mL per minute)
SAMPLE ID CODE	# CONTAINERS	MATERIAL CODE	VOLUME	PRESERVATIVE USED	TOTAL VOL ADDED IN FIELD (mL)	FINAL pH			
MW-115B	1	PE	250mL	HNO3	--	--	6010B TAL Metals/7470A Hg	APP	125
MW-115B	1	PE	125mL	--	--		3500 FE/ 9040B pH	APP	125
MW-115B	1	PE	250mL	--	--	--	6010B Dissolved Silica	APP	---
MW-115B	1	PE	125mL	--	--	--	9056A_28D Chloride & Sulfate	APP	63
MW-115B	1	AG	125mL	--	--	--	SM 5310 DOC	APP	125
MW-115B	2	PE	250mL	NaOH Zinc Acetate	--	--	SM4500 Sulfide	APP	**Field-Filtered**
MW-115B	1	PE	500mL	--	--	--	2540C TDS	APP	--
MW-115B	1	PE	250mL	--	--	--	2320B Alkalinity	APP	83
MW-115B	1	AG	125mL	HCl	--	--	SM5310 TOC	APP	--

REMARKS: Tubing–in-Screen-Interval purge method used. Unable to stabilize pH, Per Jim, ok to collect sample. Purge water clear brown. Sample collection times recorded incorrectly and therefore unable to calculate mL/min for some of the samples.

MATERIAL CODES: **AG** = Amber Glass; **CG** = Clear Glass; **PE** = Polyethylene; **PP** = Polypropylene; **S** = Silicone; **T** = Teflon; **O** = Other (Specify)

SAMPLING EQUIPMENT CODES: **APP** = After Peristaltic Pump; **B** = Bailer; **BP** = Bladder Pump; **ESP** = Electric Submersible Pump; **RFPP** = Reverse Flow Peristaltic Pump; **SM** = Straw Method (Tubing Gravity Drain); **O** = Other (Specify)

NOTES: Stabilization Criteria for Range of Variation of Last Three Consecutive Readings:-**pH:** ± 0.1 unit **Specific Conductance:** ± 5% **Dissolved Oxygen:** all readings ≤ 10% saturation; optionally, ± 0.2 mg/L **Turbidity:** all readings ≤ 10 NTU; or ± 10%

GROUNDWATER SAMPLING LOG

SITE NAME: LCP Chemical Site		SITE LOCATION: Brunswick, GA
WELL NO: MW-115C	SAMPLE ID: MW-115C	DATE: 11/27/12

PURGING DATA

WELL DIAMETER (inches): 2	TUBING DIAMETER (inches): 1/4	WELL SCREEN INTERVAL (btoc) DEPTH:43.5 feet to 45 feet	STATIC DEPTH (btoc) TO WATER (feet): 9.4	PURGE PUMP TYPE OR BAILER: PP

WELL VOLUME PURGE: 1 WELL VOLUME = (TOTAL WELL DEPTH – STATIC DEPTH TO WATER) X WELL CAPACITY
(only fill out if applicable)
= (feet – feet) X 0.16 gallons/foot = gallons

EQUIPMENT VOLUME PURGE: 1 EQUIPMENT VOL. = (TUBING CAPACITY X TUBING LENGTH) + FLOW CELL VOLUME
(only fill out if applicable)
= (0.0026 gallons/foot X 48.25 feet) + 0.13 gallons = 0.25 gallons

INITIAL PUMP OR TUBING DEPTH IN WELL (feet btoc): 44.25	FINAL PUMP OR TUBING DEPTH IN WELL (feet btoc): 44.25	PURGING INITIATED AT: 1043	PURGING ENDED AT: 1254	TOTAL VOLUME PURGED (gallons): 1.75

TIME	VOLUME PURGED (gallons)	CUMUL. VOLUME PURGED (gallons)	PURGE RATE (gpm)	DEPTH TO WATER (feet btoc)	pH (standard units)	TEMP. (^{O}C)	SP COND. (mS/cm)	DISSOLVED OXYGEN (% saturation)	TURBIDITY (NTUs)	ORP (mV)	SP Gravity (sg)
1058	0.45	0.45	0.03	10.05	10.3	21.88	52.29	4.1	-2.24	-206.0	
1103	0.13	0.58	0.03	10.10	10.3	21.91	52.35	3.9	-2.44	-207.2	
1108	0.17	0.75	0.03	10.10	10.4	21.78	52.39	3.6	-2.50	-214.6	
1116	0.25	1.00	0.03	10.10	10.5	21.88	52.33	4.0	-2.52	-215.9	
1237	0.25	1.25	0.03	9.25	10.5	22.52	52.50	2.9	-2.53	-273.6	
1244	0.25	1.50	0.04	9.95	10.5	22.64	52.51	3.1	-2.47	-231.0	
1252	0.25	1.75	0.03	10.05	10.4	22.59	52.46	2.5	-2.47	-284.4	1.026

WELL CAPACITY (Gallons Per Foot): **0.75"** = 0.02; **1"** = 0.04; **1.25"** = 0.06; **2"** = 0.16; **3"** = 0.37; **4"** = 0.65; **5"** = 1.02; **6"** = 1.47; **12"** = 5.88
TUBING INSIDE DIA. CAPACITY (Gal./Ft.): **1/8"** = 0.0006; **3/16"** = 0.0014; **1/4"** = 0.0026; **5/16"** = 0.004; **3/8"** = 0.006; **1/2"** = 0.010; **5/8"** = 0.016
BTOC = Below top of casing – feet below top of casing which includes above grade riser

PURGING EQUIPMENT CODES: **B** = Bailer; **BP** = Bladder Pump; **ESP** = Electric Submersible Pump; **PP =** Peristaltic Pump; **O** = Other (Specify)

SAMPLING DATA

SAMPLED BY (PRINT) / AFFILIATION: Maria Johnson/Parsons	SAMPLER(S) SIGNATURE(S):	SAMPLING INITIATED AT: 1301	SAMPLING ENDED AT: 1335
PUMP OR TUBING DEPTH IN WELL (feet): 44.25	TUBING MATERIAL CODE: Teflon-lined PE	FIELD-FILTERED: Yes/**SM 4500 Sulfide** FILTER SIZE: 0.45 µm Filtration Equipment Type: Syringe	
FIELD DECONTAMINATION: PUMP Y **No**	TUBING Y **No (replaced)**	DUPLICATE: No	

SAMPLE CONTAINER SPECIFICATION				SAMPLE PRESERVATION			INTENDED ANALYSIS AND/OR METHOD	SAMPLING EQUIPMENT CODE	SAMPLE PUMP FLOW RATE (mL per minute)
SAMPLE ID CODE	# CONTAINERS	MATERIAL CODE	VOLUME	PRESERVATIVE USED	TOTAL VOL ADDED IN FIELD (mL)	FINAL pH			
MW-115C	1	PE	250mL	HNO3	--	--	6010B TAL Metals/7470A Hg	APP	125
MW-115C	1	PE	125mL	--	--		3500 FE/ 9040B pH	APP	125
MW-115C	1	PE	250mL	--	--	--	6010B Dissolved Silica	APP	125
MW-115C	1	PE	125mL	--	--	--	9056A_28D Chloride & Sulfate	APP	125
MW-115C	1	AG	125mL	--	--	--	SM 5310 DOC	APP	63
MW-115C	2	PE	250mL	NaOH Zinc Acetate	--	--	SM4500 Sulfide	APP	**Field-Filtered**
MW-115C	1	PE	500mL	--	--	--	2540C TDS	APP	125
MW-115C	1	PE	250mL	--	--	--	2320B Alkalinity	APP	83
MW-115C	1	AG	125mL	HCl	--	--	SM5310 TOC	APP	125

REMARKS: Per SOP, parameters stable for three readings before sampling. Tubing–in-Screen-Interval purge method used. Turbidity was too low for the meter to read and negative values were recorded; meter calibration was verified between readings. Pump shut off several times during purge due to trying to achieve low flow rate and reduce drawdown.

MATERIAL CODES: **AG** = Amber Glass; **CG** = Clear Glass; **PE** = Polyethylene; **PP** = Polypropylene; **S** = Silicone; **T** = Teflon; **O** = Other (Specify)

SAMPLING EQUIPMENT CODES: **APP** = After Peristaltic Pump; **B** = Bailer; **BP** = Bladder Pump; **ESP** = Electric Submersible Pump; **RFPP** = Reverse Flow Peristaltic Pump; **SM** = Straw Method (Tubing Gravity Drain); **O** = Other (Specify)

NOTES: Stabilization Criteria for Range of Variation of Last Three Consecutive Readings:-**pH:** ± 0.1 unit **Specific Conductance:** ± 5% **Dissolved Oxygen:** all readings ≤ 10% saturation; optionally, ± 0.2 mg/L **Turbidity:** all readings ≤ 10 NTU; or ± 10%

GROUNDWATER SAMPLING LOG

SITE NAME: LCP Chemical Site	SITE LOCATION: Brunswick, GA	
WELL NO: MW-519A	SAMPLE ID: MW-519A	DATE: 11/28/12

PURGING DATA

WELL DIAMETER (inches): 2	TUBING DIAMETER (inches): 1/4	WELL SCREEN INTERVAL (btoc) DEPTH: 32.3 feet to 37.3 feet	STATIC DEPTH (btoc) TO WATER (feet): 7.35	PURGE PUMP TYPE OR BAILER: PP

WELL VOLUME PURGE: 1 WELL VOLUME = (TOTAL WELL DEPTH – STATIC DEPTH TO WATER) X WELL CAPACITY
(only fill out if applicable)
= (feet – feet) X 0.16 gallons/foot = gallons

EQUIPMENT VOLUME PURGE: 1 EQUIPMENT VOL. = (TUBING CAPACITY X TUBING LENGTH) + FLOW CELL VOLUME
(only fill out if applicable)
= (0.0026 gallons/foot X 38.8 feet) + 0.13 gallons = 0.23 gallons

INITIAL PUMP OR TUBING DEPTH IN WELL (feet btoc): 34.8	FINAL PUMP OR TUBING DEPTH IN WELL (feet btoc): 34.8	PURGING INITIATED AT: 1418	PURGING ENDED AT: 1515	TOTAL VOLUME PURGED (gallons): 1.5

TIME	VOLUME PURGED (gallons)	CUMUL. VOLUME PURGED (gallons)	PURGE RATE (gpm)	DEPTH TO WATER (feet btoc)	pH (standard units)	TEMP. (^{o}C)	SP COND. (mS/cm)	DISSOLVED OXYGEN (% saturation)	TURBIDITY (NTUs)	ORP (mV)	SP Gravity (sg)
1443	0.50	0.50	0.02	7.40	5.89	20.08	7.800	8.2	2.44	-20.9	
1450	0.25	0.75	0.04	7.40	5.78	20.08	7.834	6.6	2.05	25.5	
1458	0.25	1.00	0.03	7.39	5.73	20.49	7.871	5.6	2.43	24.9	
1505	0.25	1.25	0.04	7.40	5.71	20.61	7.901	5.3	2.28	27.3	
1513	0.25	1.50	0.03	7.41	5.72	20.65	7.925	5.2	1.88	26.4	1.004

WELL CAPACITY (Gallons Per Foot): **0.75"** = 0.02; **1"** = 0.04; **1.25"** = 0.06; **2"** = 0.16; **3"** = 0.37; **4"** = 0.65; **5"** = 1.02; **6"** = 1.47; **12"** = 5.88
TUBING INSIDE DIA. CAPACITY (Gal./Ft.): **1/8"** = 0.0006; **3/16"** = 0.0014; **1/4"** = 0.0026; **5/16"** = 0.004; **3/8"** = 0.006; **1/2"** = 0.010; **5/8"** = 0.016
BTOC = Below top of casing – feet below top of casing which includes above grade riser

PURGING EQUIPMENT CODES: **B** = Bailer; **BP** = Bladder Pump; **ESP** = Electric Submersible Pump; **PP =** Peristaltic Pump; **O** = Other (Specify)

SAMPLING DATA

SAMPLED BY (PRINT) / AFFILIATION: Christine Jaynes/Parsons	SAMPLER(S) SIGNATURE(S):	SAMPLING INITIATED AT: 1520	SAMPLING ENDED AT: 1548
PUMP OR TUBING DEPTH IN WELL (feet): 34.8	TUBING MATERIAL CODE: Teflon-lined PE	FIELD-FILTERED: Yes/**SM 4500 Sulfide** FILTER SIZE: 0.45 µm Filtration Equipment Type: Syringe	
FIELD DECONTAMINATION: PUMP Y **No**	TUBING Y **No (replaced)**	DUPLICATE: No	

SAMPLE CONTAINER SPECIFICATION				SAMPLE PRESERVATION			INTENDED ANALYSIS AND/OR METHOD	SAMPLING EQUIPMENT CODE	SAMPLE PUMP FLOW RATE (mL per minute)
SAMPLE ID CODE	# CONTAINERS	MATERIAL CODE	VOLUME	PRESERVATIVE USED	TOTAL VOL ADDED IN FIELD (mL)	FINAL pH			
MW-519A	1	PE	250mL	HNO3	--	--	6010B TAL Metals/7470A Hg	APP	83
MW-519A	1	PE	125mL	--	--		3500 FE/ 9040B pH	APP	125
MW-519A	1	PE	250mL	--	--	--	6010B Dissolved Silica	APP	125
MW-519A	1	PE	125mL	--	--	--	9056A_28D Chloride & Sulfate	APP	125
MW-519A	1	AG	125mL	--	--	--	SM 5310 DOC	APP	63
MW-519A	2	PE	250mL	NaOH Zinc Acetate	--	--	SM4500 Sulfide	APP	**Field-Filtered**
MW-519A	1	PE	500mL	--	--	--	2540C TDS	APP	71
MW-519A	1	PE	250mL	--	--	--	2320B Alkalinity	APP	250
MW-519A	1	AG	125mL	HCl	--	--	SM5310 TOC	APP	63

REMARKS: Per SOP, parameters stable for three readings before sampling. Tubing–in-Screen-Interval purge method used. Purge water clear brown, air/CO2 bubbles in tubing, slight odor noted.

MATERIAL CODES: **AG** = Amber Glass; **CG** = Clear Glass; **PE** = Polyethylene; **PP** = Polypropylene; **S** = Silicone; **T** = Teflon; **O** = Other (Specify)

SAMPLING EQUIPMENT CODES: **APP** = After Peristaltic Pump; **B** = Bailer; **BP** = Bladder Pump; **ESP** = Electric Submersible Pump; **RFPP** = Reverse Flow Peristaltic Pump; **SM** = Straw Method (Tubing Gravity Drain); **O** = Other (Specify)

NOTES: Stabilization Criteria for Range of Variation of Last Three Consecutive Readings:-**pH:** ± 0.1 unit **Specific Conductance:** ± 5% **Dissolved Oxygen:** all readings ≤ 10% saturation; optionally, ± 0.2 mg/L **Turbidity:** all readings ≤ 10 NTU; or ± 10%

GROUNDWATER SAMPLING LOG

SITE NAME: LCP Chemical Site		SITE LOCATION: Brunswick, GA
WELL NO: MW-519B	SAMPLE ID: MW-519B	DATE: 11/27/12

PURGING DATA

WELL DIAMETER (inches): 2	TUBING DIAMETER (inches): 1/4	WELL SCREEN INTERVAL (btoc) DEPTH: 42.55 feet to 47.55 feet	STATIC DEPTH (btoc) TO WATER (feet): 9.4	PURGE PUMP TYPE OR BAILER: PP

WELL VOLUME PURGE: 1 WELL VOLUME = (TOTAL WELL DEPTH – STATIC DEPTH TO WATER) X WELL CAPACITY
(only fill out if applicable)
= (feet – feet) X 0.16 gallons/foot = gallons

EQUIPMENT VOLUME PURGE: 1 EQUIPMENT VOL. = (TUBING CAPACITY X TUBING LENGTH) + FLOW CELL VOLUME
(only fill out if applicable)
= (0.0026 gallons/foot X 49.5 feet) + 0.13 gallons = 0.26 gallons

INITIAL PUMP OR TUBING DEPTH IN WELL (feet btoc): 45.05	FINAL PUMP OR TUBING DEPTH IN WELL (feet btoc): 45.05	PURGING INITIATED AT: 0755	PURGING ENDED AT: 0851	TOTAL VOLUME PURGED (gallons): 2.26

TIME	VOLUME PURGED (gallons)	CUMUL. VOLUME PURGED (gallons)	PURGE RATE (gpm)	DEPTH TO WATER (feet btoc)	pH (standard units)	TEMP. (^{O}C)	SP COND. (mS/cm)	DISSOLVED OXYGEN (% saturation)	TURBIDITY (NTUs)	ORP (mV)	SP Gravity (sg)
0812	0.75	0.75	0.04	11.2	8.96	21.12	63.67	9.2	-2.19	-220.8	
0821	0.35	1.10	0.04	11.8	8.92	21.32	63.55	9.5	-2.20	-238.4	
0829	0.30	1.40	0.04	11.9	8.98	21.57	63.78	9.2	-2.35	-304.9	
0835	0.30	1.70	0.05	12.05	9.11	21.75	64.50	7.4	-2.38	-298.6	
0842	0.30	2.00	0.04	12.05	9.19	21.78	65.01	8.8	-2.49	-287.5	
0850	0.26	2.26	0.03	12.13	9.22	21.85	65.42	8.1	-2.37	-327.9	1.032

WELL CAPACITY (Gallons Per Foot): **0.75"** = 0.02; **1"** = 0.04; **1.25"** = 0.06; **2"** = 0.16; **3"** = 0.37; **4"** = 0.65; **5"** = 1.02; **6"** = 1.47; **12"** = 5.88
TUBING INSIDE DIA. CAPACITY (Gal./Ft.): **1/8"** = 0.0006; **3/16"** = 0.0014; **1/4"** = 0.0026; **5/16"** = 0.004; **3/8"** = 0.006; **1/2"** = 0.010; **5/8"** = 0.016
BTOC = Below top of casing – feet below top of casing which includes above grade riser

PURGING EQUIPMENT CODES: **B** = Bailer; **BP** = Bladder Pump; **ESP** = Electric Submersible Pump; **PP =** Peristaltic Pump; **O** = Other (Specify)

SAMPLING DATA

SAMPLED BY (PRINT) / AFFILIATION: Maria Johnson/Parsons	SAMPLER(S) SIGNATURE(S): Maria Johnson	SAMPLING INITIATED AT: 0857	SAMPLING ENDED AT: 0927

PUMP OR TUBING DEPTH IN WELL (feet): 45.05	TUBING MATERIAL CODE: Teflon-lined PE	FIELD-FILTERED: Yes/**SM 4500 Sulfide** FILTER SIZE: 0.45 µm Filtration Equipment Type: Syringe
FIELD DECONTAMINATION: PUMP Y **No** TUBING Y **No (replaced)**		DUPLICATE: No

SAMPLE CONTAINER SPECIFICATION				SAMPLE PRESERVATION			INTENDED ANALYSIS AND/OR METHOD	SAMPLING EQUIPMENT CODE	SAMPLE PUMP FLOW RATE (mL per minute)
SAMPLE ID CODE	# CONTAINERS	MATERIAL CODE	VOLUME	PRESERVATIVE USED	TOTAL VOL ADDED IN FIELD (mL)	FINAL pH			
MW-519B	1	PE	250mL	HNO3	--	--	6010B TAL Metals/7470A Hg	APP	125
MW-519B	1	PE	125mL	--	--		3500 FE/ 9040B pH	APP	125
MW-519B	1	PE	250mL	--	--	--	6010B Dissolved Silica	APP	125
MW-519B	1	PE	125mL	--	--	--	9056A_28D Chloride & Sulfate	APP	63
MW-519B	1	AG	125mL	--	--	--	SM 5310 DOC	APP	125
MW-519B	2	PE	250mL	NaOH Zinc Acetate	--	--	SM4500 Sulfide	APP	**Field-Filtered**
MW-519B	1	PE	500mL	--	--	--	2540C TDS	APP	83
MW-519B	1	PE	250mL	--	--	--	2320B Alkalinity	APP	83
MW-519B	1	AG	125mL	HCl	--	--	SM5310 TOC	APP	125

REMARKS: Per SOP, parameters stable for three readings before sampling. Tubing–in-Screen Interval purge method was used. Pump was set to lowest setting possible however, water levels continued to drop but less than 100mL/ min. Turbidity was too low for the meter to read and negative values were recorded; meter calibration was verified between readings.

MATERIAL CODES: **AG** = Amber Glass; **CG** = Clear Glass; **PE** = Polyethylene; **PP** = Polypropylene; **S** = Silicone; **T** = Teflon; **O** = Other (Specify)

SAMPLING EQUIPMENT CODES: **APP** = After Peristaltic Pump; **B** = Bailer; **BP** = Bladder Pump; **ESP** = Electric Submersible Pump; **RFPP** = Reverse Flow Peristaltic Pump; **SM** = Straw Method (Tubing Gravity Drain); **O** = Other (Specify)

NOTES: Stabilization Criteria for Range of Variation of Last Three Consecutive Readings:-**pH:** $\pm$ 0.1 unit **Specific Conductance:** $\pm$ 5% **Dissolved Oxygen:** all readings $\leq$ 10% saturation; optionally, $\pm$ 0.2 mg/L **Turbidity:** all readings $\leq$ 10 NTU; or $\pm$ 10%

GROUNDWATER SAMPLING LOG

SITE NAME: LCP Chemical Site		SITE LOCATION: Brunswick, GA
WELL NO: MW-519B	SAMPLE ID: MW-519B-**TOP**	DATE: 11/27/12

PURGING DATA

WELL DIAMETER (inches): 2	TUBING DIAMETER (inches): 1/4	WELL SCREEN INTERVAL (btoc) DEPTH: 42.55 feet to 47.55 feet	STATIC DEPTH (btoc) TO WATER (feet): 11.7	PURGE PUMP TYPE OR BAILER: PP

WELL VOLUME PURGE: 1 WELL VOLUME = (TOTAL WELL DEPTH – STATIC DEPTH TO WATER) X WELL CAPACITY
(only fill out if applicable)
= (feet – feet) X 0.16 gallons/foot = gallons

EQUIPMENT VOLUME PURGE: 1 EQUIPMENT VOL. = (TUBING CAPACITY X TUBING LENGTH) + FLOW CELL VOLUME
(only fill out if applicable)
= (0.0026 gallons/foot X 49.5 feet) + 0.13 gallons = 0.26 gallons

INITIAL PUMP OR TUBING DEPTH IN WELL (feet btoc): 42.55	FINAL PUMP OR TUBING DEPTH IN WELL (feet btoc): 42.55	PURGING INITIATED AT: 0939	PURGING ENDED AT: 1014	TOTAL VOLUME PURGED (gallons): 1.1

TIME	VOLUME PURGED (gallons)	CUMUL. VOLUME PURGED (gallons)	PURGE RATE (gpm)	DEPTH TO WATER (feet btoc)	pH (standard units)	TEMP. (^{O}C)	SP COND. (mS/cm)	DISSOLVED OXYGEN (% saturation)	TURBIDITY (NTUs)	ORP (mV)	SP Gravity (sg)
0951	0.45	0.45	0.04	11.70	9.0	22.10	65.13	6.3	-2.44	-323.6	
1000	0.30	0.75	0.03	11.95	8.9	22.19	65.11	5.6	-2.54	-299.2	
1011	0.35	1.10	0.03	12.36	8.87	22.67	65.12	5.5	-2.53	-271.0	Not Recorded

WELL CAPACITY (Gallons Per Foot): **0.75"** = 0.02; **1"** = 0.04; **1.25"** = 0.06; **2"** = 0.16; **3"** = 0.37; **4"** = 0.65; **5"** = 1.02; **6"** = 1.47; **12"** = 5.88
TUBING INSIDE DIA. CAPACITY (Gal./Ft.): **1/8"** = 0.0006; **3/16"** = 0.0014; **1/4"** = 0.0026; **5/16"** = 0.004; **3/8"** = 0.006; **1/2"** = 0.010; **5/8"** = 0.016
BTOC = Below top of casing – feet below top of casing which includes above grade riser

PURGING EQUIPMENT CODES: **B** = Bailer; **BP** = Bladder Pump; **ESP** = Electric Submersible Pump; **PP =** Peristaltic Pump; **O** = Other (Specify)

SAMPLING DATA

SAMPLED BY (PRINT) / AFFILIATION: David w/Mutch and Associates	SAMPLER(S) SIGNATURE(S):	SAMPLING INITIATED AT: 1033	SAMPLING ENDED AT: 1104
PUMP OR TUBING DEPTH IN WELL (feet): 47.55	TUBING MATERIAL CODE: Teflon-lined PE	FIELD-FILTERED: Yes/**SM 4500 Sulfide** FILTER SIZE: 0.45 μm Filtration Equipment Type: Syringe	
FIELD DECONTAMINATION: PUMP Y **No**	TUBING Y **No (replaced)**	DUPLICATE: Y N	

SAMPLE CONTAINER SPECIFICATION				SAMPLE PRESERVATION			INTENDED ANALYSIS AND/OR METHOD	SAMPLING EQUIPMENT CODE	SAMPLE PUMP FLOW RATE (mL per minute)
SAMPLE ID CODE	# CONTAINERS	MATERIAL CODE	VOLUME	PRESERVATIVE USED	TOTAL VOL ADDED IN FIELD (mL)	FINAL pH			
MW-519B TOP	1	PE	250mL	HNO3	--	--	6010B TAL Metals/7470A Hg	APP	--
MW-519B TOP	1	PE	125mL	--	--		3500 FE/ 9040B pH	APP	--
MW-519B TOP	1	PE	250mL	--	--	--	6010B Dissolved Silica	APP	---
MW-519B TOP	1	PE	125mL	--	--	--	9056A_28D Chloride & Sulfate	APP	--
MW-519B TOP	1	AG	125mL	--	--	--	SM 5310 DOC	APP	--
MW-519B TOP	2	PE	250mL	NaOH Zinc Acetate	--	--	SM4500 Sulfide	APP	**Field-Filtered**
MW-519B TOP	1	PE	500mL	--	--	--	2540C TDS	APP	--
MW-519B TOP	1	PE	250mL	--	--	--	2320B Alkalinity	APP	--
MW-519B TOP	1	AG	125mL	HCl	--	--	SM5310 TOC	APP	--

REMARKS: Per SOP, parameters stable for three readings before sampling. Sample collection times not recorded and therefore unable to determine mL/min. David with Mutch and Associates collected top of screen samples.

MATERIAL CODES: **AG** = Amber Glass; **CG** = Clear Glass; **PE** = Polyethylene; **PP** = Polypropylene; **S** = Silicone; **T** = Teflon; **O** = Other (Specify)

SAMPLING EQUIPMENT CODES: **APP** = After Peristaltic Pump; **B** = Bailer; **BP** = Bladder Pump; **ESP** = Electric Submersible Pump; **RFPP** = Reverse Flow Peristaltic Pump; **SM** = Straw Method (Tubing Gravity Drain); **O** = Other (Specify)

NOTES: Stabilization Criteria for Range of Variation of Last Three Consecutive Readings:-**pH:** ± 0.1 unit **Specific Conductance:** ± 5% **Dissolved Oxygen:** all readings ≤ 10% saturation; optionally, ± 0.2 mg/L **Turbidity:** all readings ≤ 10 NTU; or ± 10%

GROUNDWATER SAMPLING LOG

SITE NAME: LCP Chemical Site	SITE LOCATION: Brunswick, GA

WELL NO: SW-1	SAMPLE ID: SW-1	DATE: 11/27/12

PURGING DATA

WELL DIAMETER (inches): 4	TUBING DIAMETER (inches): 1/4	WELL SCREEN INTERVAL (btoc) DEPTH: 42 feet to 47 feet	STATIC DEPTH (btoc) TO WATER (feet): 9.48	PURGE PUMP TYPE OR BAILER: PP

WELL VOLUME PURGE: 1 WELL VOLUME = (TOTAL WELL DEPTH – STATIC DEPTH TO WATER) X WELL CAPACITY
(only fill out if applicable)
= (feet – feet) X 0.16 gallons/foot = gallons

EQUIPMENT VOLUME PURGE: 1 EQUIPMENT VOL. = (TUBING CAPACITY X TUBING LENGTH) + FLOW CELL VOLUME
(only fill out if applicable)
= (0.0026 gallons/foot X 48.5 feet) + 0.13 gallons = 0.26 gallons

INITIAL PUMP OR TUBING DEPTH IN WELL (feet btoc): 45.5	FINAL PUMP OR TUBING DEPTH IN WELL (feet btoc): 45.5	PURGING INITIATED AT: 0810	PURGING ENDED AT: 0937	TOTAL VOLUME PURGED (gallons): 1.25

TIME	VOLUME PURGED (gallons)	CUMUL. VOLUME PURGED (gallons)	PURGE RATE (gpm)	DEPTH TO WATER (feet btoc)	pH (standard units)	TEMP. (^{O}C)	SP COND. (mS/cm)	DISSOLVED OXYGEN (% saturation)	TURBIDITY (NTUs)	ORP (mV)	SP Gravity (sg)
0837	0.25	0.25	0.01	9.50	6.65	18.79	43.14	3.7	--	-87.4	
0852	0.25	0.50	0.02	9.50	6.65	19.18	43.05	3.0	--	-104.1	
0906	0.25	0.75	0.02	9.52	6.65	19.36	43.05	2.6	--	-112.0	
0922	0.25	1.00	0.02	9.49	6.66	19.76	43.03	2.3	--	-119.5	
0936	0.25	1.25	0.02	9.52	6.66	20.23	43.01	2.4	--	-123.5	1.022

WELL CAPACITY (Gallons Per Foot): **0.75"** = 0.02; **1"** = 0.04; **1.25"** = 0.06; **2"** = 0.16; **3"** = 0.37; **4"** = 0.65; **5"** = 1.02; **6"** = 1.47; **12"** = 5.88
TUBING INSIDE DIA. CAPACITY (Gal./Ft.): **1/8"** = 0.0006; **3/16"** = 0.0014; **1/4"** = 0.0026; **5/16"** = 0.004; **3/8"** = 0.006; **1/2"** = 0.010; **5/8"** = 0.016
BTOC = Below top of casing – feet below top of casing which includes above grade riser

PURGING EQUIPMENT CODES: **B** = Bailer; **BP** = Bladder Pump; **ESP** = Electric Submersible Pump; **PP =** Peristaltic Pump; **O** = Other (Specify)

SAMPLING DATA

SAMPLED BY (PRINT) / AFFILIATION: Christine Jaynes/Parsons	SAMPLER(S) SIGNATURE(S): CJaynes	SAMPLING INITIATED AT: 0950	SAMPLING ENDED AT: 1042

PUMP OR TUBING DEPTH IN WELL (feet): 45.5	TUBING MATERIAL CODE: Teflon-lined PE	FIELD-FILTERED: Yes/**SM 4500 Sulfide** FILTER SIZE: 0.45 µm Filtration Equipment Type: Syringe

FIELD DECONTAMINATION: PUMP Y **No**	TUBING Y **No (replaced)**	DUPLICATE: No

SAMPLE CONTAINER SPECIFICATION				SAMPLE PRESERVATION			INTENDED ANALYSIS AND/OR METHOD	SAMPLING EQUIPMENT CODE	SAMPLE PUMP FLOW RATE (mL per minute)
SAMPLE ID CODE	# CONTAINERS	MATERIAL CODE	VOLUME	PRESERVATIVE USED	TOTAL VOL ADDED IN FIELD (mL)	FINAL pH			
SW-1	1	PE	250mL	HNO3	--	--	6010B TAL Metals/7470A Hg	APP	83
SW-1	1	PE	125mL	--	--		3500 FE/ 9040B pH	APP	42
SW-1	1	PE	250mL	--	--	--	6010B Dissolved Silica	APP	50
SW-1	1	PE	125mL	--	--	--	9056A_28D Chloride & Sulfate	APP	63
SW-1	1	AG	125mL	--	--	--	SM 5310 DOC	APP	63
SW-1	2	PE	250mL	NaOH Zinc Acetate	--	--	SM4500 Sulfide	APP	**Field-Filtered**
SW-1	1	PE	500mL	--	--	--	2540C TDS	APP	55
SW-1	1	PE	250mL	--	--	--	2320B Alkalinity	APP	42
SW-1	1	AG	125mL	HCl	--	--	SM5310 TOC	APP	63

REMARKS: Per SOP, parameters stable for three readings before sampling. Tubing–in-Screen-Interval purge method used. Turbidity was too low for the meter to read; meter calibration was verified between readings. Purge water clear brown.

MATERIAL CODES: **AG** = Amber Glass; **CG** = Clear Glass; **PE** = Polyethylene; **PP** = Polypropylene; **S** = Silicone; **T** = Teflon; **O** = Other (Specify)

SAMPLING EQUIPMENT CODES: **APP** = After Peristaltic Pump; **B** = Bailer; **BP** = Bladder Pump; **ESP** = Electric Submersible Pump; **RFPP** = Reverse Flow Peristaltic Pump; **SM** = Straw Method (Tubing Gravity Drain); **O** = Other (Specify)

NOTES: Stabilization Criteria for Range of Variation of Last Three Consecutive Readings:-**pH:** ± 0.1 unit **Specific Conductance:** ± 5% **Dissolved Oxygen:** all readings ≤ 10% saturation; optionally, ± 0.2 mg/L **Turbidity:** all readings ≤ 10 NTU; or ± 10%

APPENDIX D. SPARGING FLOW RATES

Date	Time	Pressure (psi)	Flow (CFM)	Pressure Factor	CO2 Temp (F)	Temp Factor	Air SCFM	Corrected CO2 SCFM	Log
10/29/2012	9:37	10	6	0.60	62.00	1.00	10.0	8.1	**Start**
10/29/2012	9:43	8	6	0.65	62.00	1.00	9.2	7.5	**Ramping Up Period**
10/29/2012	9:45	12.5	6	0.54	62.00	1.00	11.1	9.0	
10/29/2012	9:50	17.5	5.5	0.46	62.00	1.00	12.0	9.7	
10/29/2012	10:03	17	5.5	0.46	61.80	1.00	11.8	9.6	
10/29/2012	10:27	18	8	0.45	61.80	1.00	17.7	14.4	
10/29/2012	10:30	18.5	9	0.44	61.80	1.00	20.3	16.4	
10/29/2012	10:32	18.8	11	0.44	61.80	1.00	25.0	20.2	
10/29/2012	10:35	19	11	0.44	61.80	1.00	25.1	20.4	
10/29/2012	10:36	19	11	0.44	61.80	1.00	25.1	20.4	**Steady state run**
10/29/2012	10:55	19	11	0.44	61.80	1.00	25.1	20.4	
10/29/2012	10:56	20	16	0.42	61.20	1.00	37.7	30.5	**Ramping Up Period**
10/29/2012	10:59	21	19	0.41	61.20	1.00	46.0	37.3	
10/29/2012	11:02	21.5	20	0.41	61.20	1.00	49.1	39.8	
10/29/2012	11:05	22	21	0.40	61.20	1.00	52.3	42.4	
10/29/2012	13:05	21.8	21.8	0.40	49.20	0.98	55.3	44.8	
10/29/2012	15:14	21.8	21.8	0.40	49.20	0.98	55.3	44.8	**Shut down**
10/30/2012	10:45	22.5	10.5	0.40	58.80	1.00	26.6	21.6	**Start**
10/30/2012	10:56	24.5	15	0.38	58.80	1.00	40.1	32.5	
10/30/2012	11:18	23.5	13	0.38	60.00	1.00	33.8	27.4	
10/30/2012	11:35	22.5	13	0.40	58.80	1.00	33.0	26.7	
10/30/2012	12:02	22	13.2	0.40	58.40	1.00	33.1	26.8	
10/30/2012	12:50	21.5	13.4	0.41	59.40	1.00	33.0	26.8	
10/30/2012	14:00	20.6	13.5	0.42	59.30	1.00	32.5	26.3	
10/30/2012	15:18	21.5	20	0.41	60.00	1.00	49.3	39.9	**ramp up**
10/30/2012	15:31	22	19.8	0.40	60.00	1.00	49.4	40.0	
10/30/2012	16:16	22	19.5	0.40	55.00	0.99	49.2	39.8	
10/30/2012	17:02	21.5	19.5	0.41	53.90	0.99	48.6	39.4	
10/30/2012	18:28	21.5	20	0.41	39.70	0.96	51.3	41.5	
10/30/2012	18:31	21.5	20	0.41	39.70	0.96	51.3	41.5	**shutdown**

Date	Time	Pressure (psi)	Flow (CFM)	Pressure Factor	CO2 Temp (F)	Temp Factor	Air SCFM	Corrected CO2 SCFM	Log
10/31/2012	11:05	22	7.5	0.40	71.70	1.02	18.3	14.8	**Start**
10/31/2012	11:07	23.8	10	0.38	70.80	1.02	25.7	20.8	**Ramping Up Period**
10/31/2012	11:09	24.2	12	0.38	69.00	1.02	31.2	25.3	
10/31/2012	11:12	24	12.5	0.38	67.80	1.02	32.4	26.3	
10/31/2012	11:18	23.5	13	0.38	66.00	1.01	33.4	27.1	
10/31/2012	11:20	23.8	13.8	0.38	65.60	1.01	35.8	29.0	
10/31/2012	11:29	23.5	13.5	0.38	63.80	1.01	34.8	28.2	
10/31/2012	11:31	24	14.2	0.38	63.80	1.01	37.1	30.1	
10/31/2012	11:39	24	14.5	0.38	63.60	1.01	37.9	30.7	
10/31/2012	11:41	24.4	15	0.38	63.50	1.01	39.6	32.1	
10/31/2012	11:48	24.4	15.2	0.38	62.70	1.01	40.2	32.6	
10/31/2012	11:50	24.6	16	0.37	62.60	1.01	42.6	34.5	
10/31/2012	12:01	24.6	16	0.37	62.00	1.00	42.6	34.5	
10/31/2012	12:36	24.2	16	0.38	62.90	1.01	42.1	34.1	
10/31/2012	12:43	24.2	16.2	0.38	62.90	1.01	42.6	34.5	
10/31/2012	12:46	24.25	16.5	0.38	63.10	1.01	43.5	35.2	
10/31/2012	12:48	24.4	17	0.38	63.10	1.01	44.9	36.4	
10/31/2012	12:55	24.5	17.8	0.38	62.90	1.01	47.2	38.2	
10/31/2012	14:00	23.5	17.8	0.38	64.20	1.01	45.9	37.2	
10/31/2012	14:18	23.5	18.4	0.38	65.60	1.01	47.3	38.3	
10/31/2012	14:21	23.7	19	0.38	65.50	1.01	49.1	39.8	**Ramping Up**
10/31/2012	14:23	23.7	19.4	0.38	65.40	1.01	50.2	40.6	
10/31/2012	14:25	24	20	0.38	65.30	1.01	52.1	42.2	
10/31/2012	14:33	24.5	21.6	0.38	62.20	1.00	57.4	46.5	
10/31/2012	14:48	24.5	22.1	0.38	57.20	0.99	59.3	48.0	
10/31/2012	15:30	24.2	22.5	0.38	50.30	0.98	60.7	49.1	**Ramping Down**
10/31/2012	15:45	24	22.5	0.38	50.90	0.98	60.3	48.8	
10/31/2012	15:47	24	22	0.38	50.90	0.98	58.9	47.7	
10/31/2012	15:53	23.6	22.6	0.38	51.00	0.98	59.9	48.5	
10/31/2012	15:57	23.2	22	0.39	54.60	0.99	57.3	46.4	
10/31/2012	17:15	22.2	22.5	0.40	55.00	0.99	57.0	46.2	
10/31/2012	18:20	21.9	22.6	0.40	44.20	0.97	58.0	47.0	
10/31/2012	18:30	21.9	22.6	0.40	41.50	0.96	58.3	47.3	**Shutdown**

Date	Time	Pressure (psi)	Flow (CFM)	Pressure Factor	CO2 Temp (F)	Temp Factor	Air SCFM	Corrected CO2 SCFM	Log
11/1/2012	8:33	21	10.8	0.41	47.40	0.98	26.9	21.8	**Start**
11/1/2012	8:35	21.3	13	0.41	46.50	0.97	32.7	26.5	**Ramping Up Period**
11/1/2012	8:37	21.6	14.3	0.40	45.60	0.97	36.3	29.4	
11/1/2012	8:39	22.8	15	0.39	44.90	0.97	39.4	31.9	
11/1/2012	8:52	21.5	15	0.41	44.60	0.97	38.1	30.8	
11/1/2012	8:53	22.6	17.2	0.39	44.70	0.97	45.0	36.4	
11/1/2012	8:57	23.2	19.6	0.39	45.10	0.97	52.0	42.1	
11/1/2012	9:00	23.9	21	0.38	45.50	0.97	56.7	45.9	
11/1/2012	9:02	24.1	21.9	0.38	45.50	0.97	59.5	48.2	
11/1/2012	9:13	24.5	21.8	0.38	42.00	0.97	60.2	48.8	
11/1/2012	9:15	24.8	21.7	0.38	41.30	0.96	59.1	47.9	
11/1/2012	9:40	25	20.9	0.38	46.00	0.97	56.7	45.9	**air=49F**
11/1/2012	10:00	24.9	20.8	0.37	49.20	0.98	57.2	46.3	
11/1/2012	10:37	24.5	20.6	0.38	47.60	0.98	56.3	45.6	
11/1/2012	10:39	24.6	21	0.37	47.60	0.98	57.5	46.6	
11/1/2012	11:02	24.5	20.9	0.38	49.20	0.98	56.9	46.1	
11/1/2012	11:40	24.4	20.9	0.38	51.00	0.98	56.6	45.8	
11/1/2012	12:20	24	21	0.38	52.80	0.99	56.1	45.4	
11/1/2012	12:21	24.2	22	0.38	52.80	0.99	59.0	47.8	
11/1/2012	13:00	24	22	0.38	48.70	0.98	59.2	48.0	
11/1/2012	13:04	24.1	23	0.38	48.70	0.98	62.1	50.3	
11/1/2012	13:25	23.6	23	0.38	45.30	0.97	61.7	50.0	
11/1/2012	14:30	23	23	0.39	55.40	0.99	59.5	48.2	
11/1/2012	15:15	22.7	23.1	0.39	55.20	0.99	59.3	48.0	
11/1/2012	15:25	23.5	27	0.38	54.50	0.99	70.9	57.4	
11/1/2012	15:30	24	29.5	0.38	51.20	0.98	79.0	64.0	
11/1/2012	16:00	24.5	29.6	0.38	22.60	0.93	85.1	68.9	**Adjusted main PrReg**
11/1/2012	16:05	24.3	28.8	0.38	23.10	0.93	82.2	66.6	
11/1/2012	17:50	24	28.8	0.38	1.70	0.89	85.4	69.2	
11/1/2012	18:00	23.5	27.5	0.38	-5.70	0.87	81.8	66.3	
11/1/2012	18:10	24.8	28.5	0.37	-10.20	0.87	88.5	71.7	
11/1/2012	18:15	24.8	28.5	0.37	-10.00	0.87	88.5	71.7	**shutdown**

Date	Time	Pressure (psi)	Flow (CFM)	Pressure Factor	CO2 Temp (F)	Temp Factor	Air SCFM	Corrected CO2 SCFM	Log
11/2/2012	8:45	23	5.5	0.39	38.40	0.96	14.7	11.9	**Start**
11/2/2012	8:48	22	8.5	0.40	37.90	0.96	22.2	18.0	**Ramping Up Period**
11/2/2012	8:52	23	12.5	0.39	37.70	0.96	33.5	27.1	
11/2/2012	8:54	24	15.9	0.38	37.50	0.96	43.8	35.4	
11/2/2012	8:57	24.4	17	0.38	38.40	0.96	47.2	38.2	
11/2/2012	8:59	24.75	18.5	0.37	38.80	0.96	51.8	41.9	
11/2/2012	9:14	24.9	18.5	0.37	38.60	0.96	52.0	42.1	
11/2/2012	9:28	25.1	18.5	0.37	53.00	0.99	50.8	41.1	
11/2/2012	9:35	25.25	18.5	0.37	50.90	0.98	51.2	41.4	
11/2/2012	9:42	25	18.1	0.37	51.40	0.98	49.7	40.3	
11/2/2012	10:06	25.25	18	0.37	56.40	0.99	49.3	39.9	
11/2/2012	10:07	25	17.5	0.37	56.10	0.99	47.6	38.6	
11/2/2012	10:46	25.1	17.4	0.37	63.10	1.01	46.8	37.9	
11/2/2012	11:38	25.25	17.4	0.37	68.50	1.02	46.5	37.7	
11/2/2012	11:39	25	16.4	0.37	68.50	1.02	43.6	35.3	
11/2/2012	12:50	24.5	16.5	0.38	71.20	1.02	43.1	34.9	
11/2/2012	13:48	24.5	16.5	0.38	71.00	1.02	43.1	34.9	
11/2/2012	13:50	24.5	16.9	0.38	71.00	1.02	44.1	35.7	
11/2/2012	15:00	24.5	18	0.38	70.70	1.02	47.0	38.1	
11/2/2012	15:15	24.5	17.5	0.38	72.30	1.02	45.6	36.9	
11/2/2012	16:05	24.5	18.6	0.38	71.90	1.02	48.5	39.3	
11/2/2012	16:55	24.5	18.6	0.38	69.90	1.02	48.7	39.4	
11/2/2012	16:57	24.6	19	0.37	69.60	1.02	49.9	40.4	
11/2/2012	17:40	24.6	19	0.37	64.90	1.01	50.3	40.8	
11/2/2012	17:46	24.6	20	0.37	64.90	1.01	53.0	42.9	
11/2/2012	17:52	24.7	20	0.37	63.60	1.01	53.2	43.1	
11/2/2012	18:00	24.7	20	0.37	63.30	1.01	53.3	43.1	
11/2/2012	18:01	24.7	20	0.37	63.30	1.01	53.3	43.1	**Shut down**

Date	Time	Pressure (psi)	Flow (CFM)	Pressure Factor	CO2 Temp (F)	Temp Factor	Air SCFM	Corrected CO2 SCFM	Log
11/5/2012	11:22	24	5.5	0.38	78.40	1.04	14.0	11.3	**Start**
11/5/2012	11:24	21	5.5	0.41	78.40	1.04	12.9	10.4	**Ramping Up Period**
11/5/2012	11:25	20	5.5	0.42	78.40	1.04	12.5	10.2	
11/5/2012	11:26	19.5	7	0.43	78.00	1.03	15.7	12.8	
11/5/2012	11:29	20.6	10	0.42	76.40	1.03	23.3	18.9	
11/5/2012	11:31	21.2	13	0.41	76.00	1.03	30.8	24.9	
11/5/2012	11:34	22.4	15.4	0.40	75.70	1.03	37.7	30.6	
11/5/2012	11:36	23	17	0.39	75.50	1.03	42.3	34.3	
11/5/2012	11:38	23.5	18	0.38	75.30	1.03	45.4	36.8	
11/5/2012	11:41	23.9	19.5	0.38	75.00	1.03	49.8	40.3	
11/5/2012	12:15	23.9	19.8	0.39	61.50	1.00	50.6	41.0	**air=59F**
11/5/2012	12:40	23.9	19.9	0.38	59.70	1.00	51.7	41.9	
11/5/2012	13:15	23.4	20	0.39	57.30	0.99	52.1	42.2	
11/5/2012	14:00	23.2	20.5	0.39	55.00	0.99	53.4	43.2	
11/5/2012	14:45	22.4	20.2	0.40	69.20	1.02	50.1	40.6	
11/5/2012	14:49	22.6	21.3	0.39	69.20	1.02	53.1	43.0	**ramp up**
11/5/2012	14:52	22.8	22.5	0.39	54.80	0.99	58.0	47.0	**ramp up**
11/5/2012	14:54	23	23.75	0.39	54.10	0.99	61.6	49.9	**ramp up**
11/5/2012	15:03	23.4	24.75	0.39	46.50	0.97	65.9	53.3	**air=66F**
11/5/2012	15:07	23.5	25	0.38	44.70	0.97	66.9	54.2	**ramp up**
11/5/2012	15:15	23.5	25	0.38	37.50	0.96	67.9	55.0	**see note**
11/5/2012	15:28	23.8	25.1	0.38	36.60	0.96	68.8	55.8	
11/5/2012	16:05	23.6	25.5	0.38	24.40	0.93	71.3	57.8	
11/5/2012	16:06	23.2	24.3	0.39	24.80	0.93	67.2	54.4	**ramp down**
11/5/2012	16:46	23.2	24.5	0.39	22.60	0.93	68.1	55.1	
11/5/2012	16:48	23.2	24.5	0.39	23.10	0.93	68.0	55.1	**ramp down**
11/5/2012	17:30	23.2	24.5	0.39	9.10	0.90	70.0	56.7	
11/5/2012	17:45	23.2	24.5	0.39	1.70	0.89	71.1	57.6	**Shut down**

Date	Time	Pressure (psi)	Flow (CFM)	Pressure Factor	CO2 Temp (F)	Temp Factor	Air SCFM	Corrected CO2 SCFM	Log
11/6/2012	8:00			1.00		0.88	0.0	0.0	**Start**
11/6/2012	8:02	20	11	0.42	50.90	0.98	26.4	21.4	**ramp up air temp 55F Frost on CO2 GP line at 0835hrs**
11/6/2012	8:06	19.4	15	0.43	49.60	0.98	35.5	28.8	
11/6/2012	8:10	20	16.5	0.42	48.70	0.98	39.8	32.2	
11/6/2012	8:15	20.6	19	0.42	48.30	0.98	46.7	37.8	
11/6/2012	8:24	20.8	21	0.41	47.40	0.98	52.0	42.1	
11/6/2012	8:28	21.2	21.4	0.41	45.30	0.97	53.8	43.6	
11/6/2012	8:35	21.4	23	0.41	44.90	0.97	58.2	47.1	
11/6/2012	8:50	22	23.3	0.40	39.20	0.96	60.6	49.1	**stdy state**
11/6/2012	8:55	22.4	25	0.40	36.60	0.96	66.1	53.5	**ramp up**
11/6/2012	9:01	22.4	25	0.41	33.00	0.95	64.8	52.5	**steady state air temp 57 F**
11/6/2012	9:30	23	25	0.40	22.40	0.93	67.3	54.5	
11/6/2012	10:06	23	25	0.39	29.30	0.94	68.1	55.2	
11/6/2012	10:55	22.7	24.75	0.39	35.90	0.95	66.0	53.5	
11/6/2012	11:41	22.7	24.75	0.39	47.10	0.98	64.6	52.3	
11/6/2012	12:00	22.4	24.5	0.40	49.60	0.98	63.1	51.1	
11/6/2012	12:03	22.6	26	0.39	50.50	0.98	67.2	54.4	**ramp up**
11/6/2012	12:29	22.6	26	0.39	47.60	0.98	67.6	54.7	
11/6/2012	12:30	22.8	28	0.39	47.30	0.98	73.2	59.3	**ramp up**
11/6/2012	12:40	23	28	0.39	43.30	0.97	74.2	60.1	**steady state air temp 65-50 F**
11/6/2012	13:30	23.2	28.5	0.39	33.20	0.95	77.5	62.8	
11/6/2012	14:15	23.2	29	0.39	12.00	0.91	82.4	66.7	
11/6/2012	15:00	22.9	29	0.39	6.90	0.90	82.6	66.9	
11/6/2012	16:19	22.8	29	0.39	2.80	0.89	83.1	67.3	
11/6/2012	17:00	22.8	29	0.39	-5.30	0.87	84.6	68.5	
11/6/2012	17:17	22.8	29	0.39	-8.90	0.87	85.3	69.1	
11/6/2012	17:30	22.8	28.5	0.39	-13.80	0.86	84.7	68.6	
11/6/2012	17:32	20.8	0	0.41		0.88			**shut down**

Date	Time	Pressure (psi)	Flow (CFM)	Pressure Factor	CO2 Temp (F)	Temp Factor	Air SCFM	Corrected CO2 SCFM	Log
11/7/2012	7:30	19.4	8	0.43	40.10	0.96	19.3	15.6	Start
11/7/2012	7:33	19.4	14.5	0.43	39.30	0.96	35.0	28.4	ramp up air = 42 F Ice on CO2 all lines at 0744 hrs
11/7/2012	7:35	19.8	17	0.43	38.40	0.96	41.6	33.7	
11/7/2012	7:37	19.2	20	0.43	37.70	0.96	48.2	39.0	
11/7/2012	7:40	20.2	22.6	0.42	36.60	0.96	56.2	45.5	
11/7/2012	7:42	21	25	0.41	35.90	0.95	63.7	51.6	
11/7/2012	7:44	21.6	28.3	0.40	35.00	0.95	73.4	59.5	
11/7/2012	8:00	22.6	29	0.39	-17.00	0.85	86.4	70.0	
11/7/2012	8:15	22.6	29	0.39	-23.50	0.84	87.7	71.0	stdy state
11/7/2012	8:16	21.6	21.5	0.40	-26.00	0.83	63.6	51.5	
11/7/2012	8:22			0.39		0.88	0.0	0.0	shutdown-ice on rubber CO2 deliv hose
11/7/2012	8:49	16	0	0.39		0.88	0.0	0.0	restart
11/7/2012	8:53	18	18	0.45	37.40	0.96	41.9	33.9	ramp up
11/7/2012	8:55	19.4	21	0.43	37.20	0.96	50.9	41.3	ramp up
11/7/2012	9:28	20.8	22	0.41	35.60	0.95	55.7	45.2	steady state
11/7/2012	9:30	21.2	25	0.41	35.60	0.95	64.1	51.9	
11/7/2012	9:50	21.6	25	0.40	26.90	0.94	65.9	53.4	
11/7/2012	9:57		0	1.00		0.88	0.0	0.0	shutdown - install new hose
11/7/2012	10:06	20.9	25	0.41	43.80	0.97	62.5	50.6	startup
11/7/2012	10:10	21.4	27.5	0.41	43.50	0.97	69.7	56.5	ramp up
11/7/2012	10:25	22	28	0.40	33.90	0.95	73.6	59.6	
11/7/2012	10:27	22.2	28.5	0.40	32.50	0.95	75.5	61.2	ramp up
11/7/2012	10:57	22.7	28.7	0.39	12.50	0.91	80.4	65.1	
11/7/2012	11:34	22.8	29	0.39	10.70	0.91	81.7	66.2	
11/7/2012	12:15	22.8	29	0.39	12.20	0.91	81.5	66.0	
11/7/2012	12:45	22.9	29	0.39	10.70	0.91	81.9	66.4	
11/7/2012	13:30	22.8	29	0.39	2.40	0.89	83.2	67.4	steady state
11/7/2012	14:00	22.6	28.5	0.39	8.00	0.90	80.4	65.1	
11/7/2012	14:30	22.6	29	0.39	1.70	0.89	82.9	67.1	
11/7/2012	15:00	22.6	28.3	0.39	-5.50	0.87	82.2	66.5	
11/7/2012	15:33	22.5	28.2	0.40	-3.70	0.88	81.3	65.9	
11/7/2012	15:35	22.5	28.2	0.40	-4.60	0.88	81.5	66.0	ramp up
11/7/2012	15:39	22.6	28.6	0.39	-12.00	0.86	84.2	68.2	ramp up
11/7/2012	16:10	22.6	29	0.39	-19.70	0.85	86.9	70.4	
11/7/2012	16:35	22.1	28	0.40	-16.80	0.85	82.2	66.6	steady state
11/7/2012	17:08	22.4	28	0.40	-19.70	0.85	83.5	67.6	
11/7/2012	17:30	22	28	0.40	-33.60	0.82	85.2	69.1	
11/7/2012	17:45	22	28	0.40	-36.60	0.81	85.9	69.5	shutdown
11/7/2012	17:47	19	0	0.44		0.88			

Date	Time	Pressure (psi)	Flow (CFM)	Pressure Factor	CO2 Temp (F)	Temp Factor	Air SCFM	Corrected CO2 SCFM	Log
11/8/2012	8:32	18.4	12.5	0.44	53.20	0.99	28.5	23.1	**Start**
11/8/2012	8:39	18.8	16.75	0.44	52.80	0.99	38.7	31.4	**ramp up air = 42 F ice forming @0913hrs CO2 temp =36.8F**
11/8/2012	8:41	19.6	20	0.43	53.30	0.99	47.3	38.3	
11/8/2012	8:44	20	23	0.42	51.40	0.98	55.2	44.7	
11/8/2012	8:57	20.8	26	0.41	51.40	0.98	63.8	51.7	
11/8/2012	9:12	21	26.4	0.41	40.60	0.96	66.6	53.9	
11/8/2012	9:14	21	26.4	0.41	36.80	0.96	67.1	54.4	
11/8/2012	9:15	21.6	28.2	0.40	36.30	0.95	73.0	59.1	
11/8/2012	9:16	21.6	28.2	0.40	36.30	0.95	73.0	59.1	**steady state ice on1/2 inch line**
11/8/2012	9:45	21.8	28.2	0.40	16.80	0.92	76.4	61.9	
11/8/2012	10:20	22	28.5	0.40	13.60	0.91	77.3	62.6	
11/8/2012	10:22	22.2	29	0.40	14.30	0.91	78.5	63.6	**ramp up 100 psi @GasPnl**
11/8/2012	11:11	22.2	29.5	0.40	5.70	0.90	82.7	67.0	**steady state**
11/8/2012	12:01	22.2	29	0.40	9.60	0.90	80.6	65.3	
11/8/2012	12:30	22.1	29	0.40	11.40	0.91	80.1	64.9	
11/8/2012	12:33	22.1	29	0.40	12.00	0.91	80.0	64.8	**RAMP UP**
11/8/2012	13:07	22	29	0.40	15.90	0.92	79.1	64.1	**steady state**
11/8/2012	13:33	22	29	0.40	15.90	0.92	79.1	64.1	
11/8/2012	14:00	22	29	0.40	16.00	0.92	79.1	64.1	
11/8/2012	14:39	21.9	29	0.40	11.60	0.91	79.6	64.5	**RAMP UP**
11/8/2012	15:37	21.8	29.5	0.40	3.30	0.89	82.2	66.6	**steady state 1700 hrs ice on chicago ftgs at well**
11/8/2012	16:06	21.6	29.6	0.40	-3.70	0.88	83.3	67.5	
11/8/2012	16:36	21.8	29	0.40	-8.70	0.87	83.0	67.2	
11/8/2012	17:00	21.9	28.8	0.40	-10.20	0.87	82.9	67.1	
11/8/2012	17:30	21.9	28.4	0.40	-28.20	0.83	85.2	69.0	
11/8/2012	17:33	18.4	0	0.44		0.88			**shutdown**

11/9/2012	9:07	22	10	0.40	53.20	0.99	25.3	20.5	**Start**
11/9/2012	9:09	18.1	13	0.45	678.00	2.19	13.3	10.7	**ramp up air = 42 F Gas panel =100 psig @ 0933 hrs**
11/9/2012	9:11	18.9	17.8	0.44	676.10	2.18	18.6	15.1	
11/9/2012	9:13	19.8	21.2	0.43	66.20	1.01	49.2	39.8	
11/9/2012	9:15	20.5	24.2	0.42	65.10	1.01	57.4	46.5	
11/9/2012	9:18	20.9	26	0.41	62.70	1.01	62.6	50.7	
11/9/2012	9:31	20.9	26.5	0.41	52.10	0.98	65.2	52.8	
11/9/2012	9:33	21.6	28.8	0.40	50.30	0.98	72.5	58.7	
11/9/2012	9:45	21.6	29.5	0.40	23.50	0.93	78.3	63.5	**steady state**
11/9/2012	10:18	21.7	29.5	0.40	15.00	0.91	80.0	64.8	
11/9/2012	10:48	21.7	29.5	0.40	16.50	0.92	79.5	64.4	
11/9/2012	11:45	21.6	29.3	0.40	15.60	0.91	79.1	64.1	
11/9/2012	12:35	21.5	29	0.41	25.10	0.93	76.6	62.0	
11/9/2012	13:12	21.5	29.5	0.41	18.10	0.92	79.0	64.0	
11/9/2012	14:00	21.6	29	0.40	13.10	0.91	78.7	63.8	
11/9/2012	14:55	21.4	29.3	0.41	12.20	0.91	79.2	64.2	
11/9/2012	16:04	21.4	29.3	0.41	4.10	0.89	80.6	65.3	
11/9/2012	16:38	21.4	28.8	0.41	-13.60	0.86	82.4	66.7	
11/9/2012	17:04	21.6	28.1	0.40	-22.60	0.84	82.5	66.8	
11/9/2012	17:32	21.8	28.3	0.40	-25.50	0.84	84.1	68.1	
11/9/2012	17:33	18	0	0.45		0.88			**shutdown**

Date	Time	Pressure (psi)	Flow (CFM)	Pressure Factor	CO2 Temp (F)	Temp Factor	Air SCFM	Corrected CO2 SCFM	Log
11/12/2012	15:33	21.8	7	0.40	68.50	1.02	17.1	13.9	**Start**
11/12/2012	15:38	22.6	9.5	0.39	68.50	1.02	23.7	19.2	**ramp up air = 66 F**
11/12/2012	15:40	23.2	11	0.39	66.90	1.01	28.0	22.7	
11/12/2012	15:41	24	12.75	0.38	65.80	1.01	33.2	26.9	
11/12/2012	16:02	23	12.5	0.39	60.80	1.00	32.0	25.9	
11/12/2012	16:04	23.4	14	0.39	60.80	1.00	36.2	29.3	
11/12/2012	16:07	23.6	14.5	0.38	60.80	1.00	37.7	30.6	
11/12/2012	16:08	24	16	0.38	60.80	1.00	42.1	34.1	
11/12/2012	16:18	24	16	0.38	59.30	1.00	42.2	34.2	
11/12/2012	17:14	24	16	0.38	51.90	0.98	42.8	34.7	**steady state**
11/12/2012	17:35	24	16	0.38	49.10	0.98	43.0	34.8	
11/12/2012	18:20	23.2	16	0.38	48.20	0.98	43.1	34.9	
11/12/2012	18:23	23.3	17	0.39	48.20	0.98	45.0	36.4	**ramp up**
11/12/2012	18:25	23.4	19	0.39	48.50	0.98	50.4	40.8	
11/12/2012	18:28	24	20	0.38	48.50	0.98	53.8	43.6	
11/12/2012	18:45	23.9	20	0.38	41.70	0.96	54.4	44.1	**Steady state; shutdown**
11/12/2012	19:33	23.9	20	0.38	34.80	0.95	55.2	44.7	
11/12/2012	19:58	23.9	20	0.38	34.80	0.95	55.2	44.7	

Date	Time	Pressure (psi)	Flow (CFM)	Pressure Factor	CO2 Temp (F)	Temp Factor	Air SCFM	Corrected CO2 SCFM	Log
11/13/2012	11:40	20	4	0.42	83.40	1.05	9.0	7.3	**Start**
11/13/2012	11:41	18.6	4	0.44	83.40	1.05	8.7	7.0	
11/13/2012	11:42	19.9	9	0.42	84.20	1.05	20.2	16.4	
11/13/2012	11:45	21	13	0.41	82.90	1.04	30.2	24.5	
11/13/2012	11:47	21.6	15	0.40	81.30	1.04	35.6	28.8	
11/13/2012	11:49	22.8	18	0.39	80.20	1.04	44.2	35.8	
11/13/2012	11:51	23.2	19	0.39	79.30	1.04	47.2	38.3	
11/13/2012	11:54	23.9	20.2	0.38	78.90	1.04	51.2	41.5	
11/13/2012	11:58	23.9	20.2	0.38	77.90	1.03	51.3	41.5	
11/13/2012	12:03	23.9	20.2	0.38	77.10	1.03	51.4	41.6	
11/13/2012	12:24	23.9	20.2	0.38	77.10	1.03	51.4	41.6	**shutdown-foaming @ SW-1**
11/13/2012	15:30	18.8	5.5	0.44	80.40	1.04	12.1	9.8	**re-start**
11/13/2012	15:31	18.8	5.5	0.44	80.40	1.04	12.1	9.8	
11/13/2012	15:35	19.2	10	0.43	80.20	1.04	22.2	18.0	
11/13/2012	15:37	19.9	13	0.42	79.00	1.04	29.5	23.9	
11/13/2012	15:39	20.8	15.3	0.41	78.60	1.04	35.7	28.9	**ramp up**
11/13/2012	15:41	21.6	18	0.40	77.70	1.03	43.0	34.8	
11/13/2012	15:44	22.8	20.2	0.39	76.80	1.03	49.9	40.4	
11/13/2012	15:46	23.4	21.5	0.39	75.50	1.03	54.1	43.8	
11/13/2012	15:48	24	23	0.38	74.30	1.03	58.9	47.7	
11/13/2012	16:08	24.6	22.8	0.37	59.90	1.00	61.0	49.4	
11/13/2012	16:48	24.6	23	0.37	46.20	0.97	63.2	51.2	
11/13/2012	17:00	24.7	23	0.37	41.50	0.96	63.9	51.8	**steady state**
11/13/2012	17:41	24.7	23	0.37	30.30	0.94	65.4	53.0	
11/13/2012	18:00	24.7	23	0.37	-33.70	0.82	75.2	60.9	
11/13/2012	18:30	24.8	24	0.37	-33.70	0.82	78.7	63.7	**temp sensor failed… temps estimated**
11/13/2012	19:30	24.8	24	0.37	-33.70	0.82	78.7	63.7	
11/13/2012	20:15	24.4	24	0.38	32.00	0.95	67.5	54.7	
11/13/2012	21:00	24	23.5	0.38	50.00	0.98	63.1	51.1	
11/13/2012	21:08	23	18.5	0.39	50.00	0.98	48.4	39.2	
11/13/2012	21:30	22.6	18.5	0.39	50.00	0.98	47.9	38.8	
11/13/2012	22:00	22.4	18.5	0.40	50.00	0.98	47.6	38.6	
11/13/2012	22:02	22.4	18.5	0.40	50.00	0.98	47.6	38.6	**shutdown**

Date	Time	Pressure (psi)	Flow (CFM)	Pressure Factor	CO2 Temp (F)	Temp Factor	Air SCFM	Corrected CO2 SCFM	Log
11/14/2012	10:45	24	5	0.38	57.30	0.99	13.2	10.7	**Start**
11/14/2012	10:46	18.6	13	0.44	57.30	0.99	29.6	24.0	**ramp up;**
11/14/2012	10:47	19.8	16	0.43	57.30	0.99	37.7	30.6	
11/14/2012	10:49	20.2	18.8	0.42	55.90	0.99	45.0	36.4	
11/14/2012	10:51	21	20	0.41	54.30	0.99	49.1	39.8	
11/14/2012	10:54	21.4	20.8	0.41	53.60	0.99	51.7	41.9	
11/14/2012	10:56	22	22	0.40	53.20	0.99	55.7	45.1	
11/14/2012	10:58	22.6	24	0.39	52.50	0.99	61.8	50.0	
11/14/2012	11:00	23.2	25	0.39	51.80	0.98	65.5	53.0	
11/14/2012	11:02	23.6	26	0.38	51.40	0.98	68.9	55.8	
11/14/2012	11:04	24	26	0.38	51.00	0.98	69.7	56.4	
11/14/2012	11:34	24.6	26	0.37	15.60	0.91	76.0	61.6	**steady state**
11/14/2012	12:22	25	26	0.37	0.10	0.88	79.4	64.3	
11/14/2012	13:00	25	26	0.37	-8.70	0.87	80.9	65.5	
11/14/2012	13:27	25.2	26	0.37	-33.00	0.82	85.9	69.6	
11/14/2012	13:28	25	25.5	0.37	-13.90	0.86	80.3	65.0	**ramp down**
11/14/2012	14:03	25.2	25.5	0.37	-11.60	0.86	80.3	65.0	**steady state**
11/14/2012	14:30	25	25.5	0.37	-12.30	0.86	80.0	64.8	
11/14/2012	15:00	24.8	25	0.37	-18.60	0.85	79.1	64.1	
11/14/2012	15:30	24.8	25.5	0.37	-21.50	0.84	81.3	65.8	
11/14/2012	16:00	24.8	25.5	0.37	-31.40	0.82	83.1	67.3	
11/14/2012	16:30	24.8	25.5	0.37	-35.50	0.82	83.9	68.0	
11/14/2012	17:00	24.6	25.5	0.37	-33.00	0.82	83.0	67.2	
11/14/2012	17:06	22.8	15.75	0.39	-28.75	0.83	48.4	39.2	**ramp down**
11/14/2012	17:16	22	15	0.40	3.00	0.89	42.1	34.1	**steady state**
11/14/2012	17:30	21.4	14.75	0.41	25.80	0.93	38.8	31.4	
11/14/2012	17:41	21.4	15.5	0.41	25.30	0.93	40.8	33.0	**ramp up;**
11/14/2012	18:10	21.4	15.5	0.41	30.00	0.94	40.4	32.7	**steady state**
11/14/2012	18:30	21.4	15.5	0.41	40.20	0.96	39.6	32.1	
11/14/2012	19:00	21.4	15.5	0.41	41.70	0.96	39.5	32.0	
11/14/2012	19:02	19.6		0.43		0.88			**shutdown**

Date	Time	Pressure (psi)	Flow (CFM)	Pressure Factor	CO2 Temp (F)	Temp Factor	Air SCFM	Corrected CO2 SCFM	Log
11/15/2012	10:50	16		0.48		0.88			Residual Well Pressue
11/15/2012	10:51	19	5	0.44	56.30	0.99	11.5	9.4	Start
11/15/2012	10:53	21.8	12.5	0.40	56.30	0.99	31.3	25.3	ramp up
11/15/2012	10:55	22.6	16	0.39	54.50	0.99	41.0	33.2	
11/15/2012	11:15	22.2	16.75	0.40	48.90	0.98	43.0	34.8	steady statw
11/15/2012	11:45	21.8	16.75	0.40	57.20	0.99	41.8	33.9	
11/15/2012	11:28	21.5	16.5	0.41	61.70	1.00	40.5	32.8	
11/15/2012	11:45	21.8	16.75	0.40	60.90	1.00	41.5	33.6	steady state
11/15/2012	12:28	21.5	16.5	0.41	61.70	1.00	40.5	32.8	
11/15/2012	12:33	21.4	17	0.41	60.90	1.00	41.7	33.8	ramp up
11/15/2012	13:24	21.6	17	0.40	58.80	1.00	42.1	34.1	steady state
11/15/2012	14:00	21.8	17	0.40	56.10	0.99	42.5	34.4	
11/15/2012	15:00	22	17	0.40	51.60	0.98	43.1	34.9	
11/15/2012	16:00	22	17	0.40	50.00	0.98	43.3	35.1	
11/15/2012	16:40	23.2	22	0.39	49.80	0.98	57.9	46.9	ramp up
11/15/2012	16:42	24.4	25.5	0.38	49.60	0.98	69.2	56.1	
11/15/2012	17:00	25	26	0.37	2.10	0.89	79.0	64.0	
11/15/2012	17:30	25.2	25	0.37	-36.30	0.81	83.3	67.5	ramp dwn
11/15/2012	17:32	25	25	0.37	-36.30	0.81	82.9	67.1	steady state
11/15/2012	18:00	25	25	0.37	-36.30	0.81	82.9	67.1	
11/15/2012	19:00	24.8	24	0.37	-36.30	0.81	79.1	64.1	
11/15/2012	19:30	24.6	24	0.37	-36.30	0.81	78.7	63.8	
11/15/2012	19:32	24.6	25	0.37	-36.30	0.81	82.0	66.4	ramp up
11/15/2012	20:00	24.6	24	0.37	-36.30	0.81	78.7	63.8	
11/15/2012	20:02	24.6	24.5	0.37	-36.30	0.81	80.4	65.1	ramp up
11/15/2012	20:30	24.6	24.5	0.37	-36.30	0.81	80.4	65.1	
11/15/2012	20:32	24.6	25	0.37	-36.30	0.81	82.0	66.4	ramp up
11/15/2012	21:00	24.6	25	0.37	-36.30	0.81	82.0	66.4	steady state
11/15/2012	21:30	24.2	24.5	0.38	-36.30	0.81	79.6	64.5	
11/15/2012	22:00	GENERATO STOPPED ---APPROX 25 GAL FUEL IN TANK WILL CALL VENDOR IN THE AM							
11/15/2012	22:02		0	1.00		0.88	0.0	0.0	shutdown

Date	Time	Pressure (psi)	Flow (CFM)	Pressure Factor	CO2 Temp (F)	Temp Factor	Air SCFM	Corrected CO2 SCFM	Log
11/16/2012	10:50	16		0.48		0.88			**Residual Well Pressue**
11/16/2012	10:55	22	5	0.40	50.30	0.98	12.7	10.3	**Start**
11/16/2012	10:56	18	5	0.45	50.30	0.98	11.3	9.2	**ramp up**
11/16/2012	11:00	23	16	0.39	50.30	0.98	41.8	33.9	
11/16/2012	11:02	23.6	18	0.38	49.20	0.98	47.9	38.8	
11/16/2012	11:04	23.8	19.5	0.38	48.30	0.98	52.2	42.3	
11/16/2012	11:08	24.2	21.5	0.38	47.30	0.98	58.3	47.2	
11/16/2012	11:10	24.4	22.5	0.38	47.00	0.98	61.4	49.7	
11/16/2012	11:12	24.6	23	0.37	46.50	0.97	63.1	51.1	
11/16/2012	11:14	24.9	23.5	0.37	46.30	0.97	65.0	52.7	
11/16/2012	11:40	25	24.3	0.37	5.90	0.90	73.2	59.3	**steady state**
11/16/2012	12:45	25	24.5	0.37	-6.90	0.87	75.9	61.5	
11/16/2012	13:20	24.7	24.5	0.37	3.30	0.89	73.7	59.7	
11/16/2012	13:22	24.8	25	0.37	0.60	0.89	75.8	61.4	**ramp up**
11/16/2012	13:45	24.8	25	0.37	0.30	0.89	75.9	61.5	**steady state**
11/16/2012	14:05	24.8	25	0.37	-1.30	0.88	76.2	61.7	
11/16/2012	14:30	24.8	25	0.37	-3.30	0.88	76.5	62.0	
11/16/2012	15:05	24.8	25	0.37	-6.70	0.87	77.1	62.4	
11/16/2012	15:32	24.6	25	0.37	-6.70	0.87	76.7	62.1	
11/16/2012	16:00	24.6	25	0.37	-7.80	0.87	76.9	62.3	
11/16/2012	16:30	24.6	25	0.37	-7.80	0.87	76.9	62.3	
11/16/2012	16:32	24.8	26.5	0.37	-7.80	0.87	81.9	66.3	**ramp up**
11/16/2012	17:00	25	27	0.37	-25.80	0.84	87.3	70.7	**steady state**
11/16/2012	17:30	25	26.7	0.37	-32.50	0.82	87.7	71.0	
11/16/2012	18:30	24.8	26	0.37	-34.80	0.82	85.4	69.2	
11/16/2012	19:05	24.8	26	0.37	-34.80	0.82	85.4	69.2	**shut down s due to bubbling thru 519A fitting**
11/16/2012	19:27	21	28	0.41	30.90	0.94	72.0	58.3	**restart**
11/16/2012	19:35	23	27	0.39	30.90	0.94	73.3	59.4	**Gas Panel pressure maxed out at 100 psig**
11/16/2012	20:00	24	28	0.38	-25.80	0.84	88.3	71.5	
11/16/2012	20:30	24	27.5	0.38	-36.60	0.81	88.9	72.0	
11/16/2012	21:00	24	27	0.38	-36.60	0.81	87.3	70.7	
11/16/2012	21:01	24.4	27	0.38	-36.60	0.81	88.2	71.4	**ramp up**
11/16/2012	21:30	24.4	27	0.38	-36.60	0.81	88.2	71.4	
11/16/2012	21:32	24.6	28	0.37	-36.60	0.81	91.9	74.5	**ramp up**
11/16/2012	22:00	24.6	28	0.37	-36.60	0.81	91.9	74.5	
11/16/2012	22:30	24.6	28	0.37	-36.60	0.81	91.9	74.5	
11/16/2012	23:00	24.4	27.5	0.38	-36.60	0.81	89.8	72.8	
11/16/2012	23:30	24.3	27.5	0.38	-36.60	0.81	89.6	72.6	
11/16/2012	24:00:00	24.3	27.5	0.38	-36.60	0.81	89.6	72.6	
11/16/2012				1.00		0.88			**shutdown**

Date	Time	Pressure (psi)	Flow (CFM)	Pressure Factor	CO2 Temp (F)	Temp Factor	Air SCFM	Corrected CO2 SCFM	Log
11/17/2012	9:30	15.4		0.49		0.88			**Residual Well Pressue**
11/17/2012	9:33	19	11	0.44	53.90	0.99	25.5	20.7	**Start**
11/17/2012	9:35	20.6	21.5	0.42	53.90	0.99	52.2	42.3	**ramp up; gas panelat 100 psi @ 0940 hrs**
11/17/2012	9:38	22	27	0.40	53.70	0.99	68.2	55.3	
11/17/2012	9:40	22	27.2	0.40	53.70	0.99	68.7	55.7	
11/17/2012	9:43	22.4	28	0.40	52.80	0.99	71.7	58.0	
11/17/2012	10:00	23.2	29	0.39	2.30	0.89	84.1	68.1	**steady state**
11/17/2012	10:30	23.6	28	0.38	-12.90	0.86	84.8	68.7	
11/17/2012	11:00	24	28	0.38	-14.50	0.86	86.0	69.7	
11/17/2012	11:30	23.8	27.8	0.38	-9.40	0.87	84.0	68.1	
11/17/2012	11:32	23.8	28	0.38	-11.00	0.86	84.9	68.8	**ramp up**
11/17/2012	12:15	24	28	0.38	-12.90	0.86	85.7	69.4	**steady state**
11/17/2012	13:00	24.1	27.9	0.38	-11.60	0.86	85.4	69.2	
11/17/2012	13:30	24	28	0.38	-2.70	0.88	83.8	67.9	
11/17/2012	14:00	24.2	28	0.38	-6.90	0.87	85.0	68.9	
11/17/2012	14:35	24	27.8	0.38	-3.70	0.88	83.4	67.6	
11/17/2012	15:08	24	27.8	0.38	-7.30	0.87	84.1	68.1	
11/17/2012	15:12	24	28	0.38	-8.00	0.87	84.8	68.7	**ramp up**
11/17/2012	15:30	24	28	0.38	9.40	0.90	81.7	66.1	
11/17/2012	16:05	24.4	27.5	0.38	-14.50	0.86	85.4	69.2	
11/17/2012	16:30	24.4	28	0.38	-12.30	0.86	86.5	70.1	
11/17/2012	16:45	24.4	28.5	0.38	-13.00	0.86	88.2	71.4	
11/17/2012	17:00	24.5	28.5	0.38	-14.80	0.86	88.8	71.9	
11/17/2012	17:45	24.4	28	0.38	-17.40	0.85	87.5	70.9	
11/17/2012	18:06	24.4	29	0.38	-19.30	0.85	91.0	73.7	
11/17/2012	18:35	24.4	29	0.38	-19.30	0.85	91.0	73.7	
11/17/2012	19:00	24.4	28.5	0.38	-19.90	0.85	89.6	72.6	
11/17/2012	19:30	24.2	28	0.38	-19.00	0.85	87.4	70.8	
11/17/2012	20:00	24.2	28	0.38	-19.00	0.85	87.4	70.8	
11/17/2012	20:02			1.00		0.88			**shutdown**

APPENDIX E. LABORATORY ANALYTICAL DATA

Pre-Sparge Analytical Data

		Field Sample ID	EQB-100312		EW-11-100312		MW-115A-100312		MW-115A2-100312		MW-115B-100312		MW-115C-100312		MW-1A-100212		MW-1B-100212	
		Location	Equipment Blank		EW-11		MW-115A		MW-115A		MW-115B		MW-115C		MW-1A		MW-1B	
		Sample Date	10/3/2012		10/3/2012		10/3/2012		10/3/2012		10/3/2012		10/3/2012		10/2/2012		10/2/2012	
		SDG	680-83469-1		680-83469-1		680-83469-1		680-83469-1		680-83469-1		680-83469-1		680-83469-1		680-83414-1	
		Matrix	WATER		WATER		WATER		WATER		WATER		WATER		WATER		WATER	
		Sample Purpose	Equipment blank		Regular sample		Regular sample		Field duplicate		Regular sample		Regular sample		Regular sample		Regular sample	
		Sample Type	Blank water		Ground Water		Ground Water		Ground Water		Ground Water		Ground Water		Ground Water		Ground Water	
Method	Parameter Name	Units																
SM2320B	ALKALINITY, CARBONATE (AS CACO3)	mg/L	5	U	1800	H	100	U,H	100	U,H	100	U,H	3500	H	100	U,H	100	U,H
SM2320B	BICARBONATE ALKALINITY AS CACO3	mg/L	5	U	650	H	630	H	640	H	720	H	700	H	820	H	770	H
SM2320B	TOTAL ALKALINITY	mg/L	5	U	2700	H	630	H	640	H	730	H	4700	H	820	H	780	H
SM2540C	TOTAL DISSOLVED SOLIDS	mg/L	22		20000		3700		3700		3400		33000		5000		8500	
SM3500-FeD	FERROUS IRON	µg/L	100	U	2300		190		170		960		1300		1200		5400	
SM4500S2-F	SULFIDE	mg/L	1	U	17		4.5		5.8		6.3		35		7.3			
SM4500S2-F	SULFIDE, DISSOLVED	mg/L															1	U
SM5310B	DISSOLVED ORGANIC CARBON	mg/L	1	U	1700		240		230		230		1300		230		200	
SM5310B	TOTAL ORGANIC CARBON	mg/L	1	U	280		220		210		230		1500		350		190	
SW6010	ALUMINUM	mg/L	0.2	U	0.48		24		24		2.1		0.2	U	20		14	
SW6010	ANTIMONY	µg/L	20	U	20	U	20	U	20	U	20	U	20	U	20	U	20	U
SW6010	ARSENIC	mg/L	0.02	U	0.14		0.0095	J	0.0086	J	0.011	J	0.28		0.012	J	0.012	J
SW6010	BARIUM	mg/L	0.01	U	0.052		0.069		0.07		0.046		0.016		0.072		0.061	
SW6010	BERYLLIUM	mg/L	0.004	U	0.0043		0.0032	J	0.0032	J	0.011		0.0019	J	0.011		0.01	
SW6010	CADMIUM	mg/L	0.005	U	0.005	U	0.005	U	0.005	U	0.005	U	0.002	J	0.005	U	0.005	U
SW6010	CALCIUM	mg/L	0.5	U	17		17		17		12		0.56		10		14	
SW6010	CHROMIUM	mg/L	0.01	U	0.45		0.09		0.089		0.07		0.34		0.078		0.093	
SW6010	COBALT	mg/L	0.01	U	0.0035	J	0.0014	J	0.0017	J	0.01	U	0.0019	J	0.004	J	0.0011	J
SW6010	COPPER	mg/L	0.02	U	0.022		0.0065	J	0.0057	J	0.0023	J	0.022		0.0035	J	0.0041	J
SW6010	IRON	mg/L	0.1	U	2.6		1.1		1.1		0.65		1.5		2.9		8.5	
SW6010	LEAD	mg/L	0.01	U	0.01		0.019		0.019		0.013		0.01	U	0.024		0.016	
SW6010	MAGNESIUM	mg/L	0.5	U	0.1	J	3.1		3.1		0.98		0.019	J	2.5		4.2	
SW6010	MANGANESE	mg/L	0.01	U	0.044		0.35		0.35		0.0071	J	0.01	U	0.039		0.17	
SW6010	NICKEL	mg/L	0.04	U	0.06		0.012	J	0.012	J	0.008	J	0.069		0.01	J	0.0092	J
SW6010	POTASSIUM	mg/L	1	U	9.8		6.9		7		0.61	J	11		6.4		2.4	
SW6010	RESPIRABLE QUARTZ	µg/L	280	J	610000		19000		19000		18000		2000000		44000		57000	
SW6010	SELENIUM	mg/L	0.02	U	0.027		0.014	J	0.016	J	0.0083	J	0.025		0.012	J	0.0089	J
SW6010	SILVER	mg/L	0.01	U	0.01	U	0.01	U	0.01	U	0.01	U	0.01	U	0.01	U	0.01	U
SW6010	SODIUM	mg/L	1	U	7900		1200		1200		1100		13000		1500		1300	
SW6010	THALLIUM	mg/L	0.025	U	0.025	U	0.025	U	0.025	U	0.025	U	0.025	U	0.025	U	0.025	U
SW6010	VANADIUM	µg/L	10	U	1400		150		150		110		1500		120		120	
SW6010	ZINC	µg/L	20	U	43		13	J	12	J	20	U	15	J	51		28	
SW7470	MERCURY	µg/L	0.2	U	64		7.2		7		5.5		120		8.1		5	
SW9040	pH	S.U.	6.14	H	11.1	H	7.66	H	7.69	H	9.11	H	11.4	H	8.42	H	8.93	H
SW9056	CHLORIDE	mg/L	5	U	9000		1300		1300		1200		15000		1800		1600	
SW9056	SULFATE	mg/L	5	U	420		100	U	100	U	100	U	950		100	U	100	U

Analytical Lab was TestAmerica Savannah (5102 LaRoche Avenue, Savannah, GA 31404)

Qualifiers:

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	H	Sample was prepped or analyzed beyond the specified holding time
	HF	Field parameter with a holding time of 15 minutes
	F	Duplicate RPD exceeds the control limit
	B	Compound was found in the blank and sample

		Field Sample ID	MW-1C-100212		MW-2A-100312		MW-2B-100312		MW-2C-100312		MW-3A-100312		MW-519A-100212		MW-519B-100212	
		Location	MW-1C		MW-2A		MW-2B		MW-2C		MW-3A		MW-519A		MW-519B	
		Sample Date	10/2/2012		10/3/2012		10/3/2012		10/3/2012		10/3/2012		10/2/2012		10/2/2012	
		SDG	680-83414-1		680-83469-1		680-83469-1		680-83469-1		680-83469-1		680-83414-1		680-83414-1	
		Matrix	WATER		WATER		WATER		WATER		WATER		WATER		WATER	
		Sample Purpose	Regular sample		Regular sample		Regular sample		Regular sample		Regular sample		Regular sample		Regular sample	
		Sample Type	Ground Water		Ground Water		Ground Water		Ground Water		Ground Water		Ground Water		Ground Water	
Method	Parameter Name	Units														
SM2320B	ALKALINITY, CARBONATE (AS CACO3)	mg/L	4300	H	100	U,H	100	U,H	4000	H	100	H	160	H	3900	H
SM2320B	BICARBONATE ALKALINITY AS CACO3	mg/L	790	H	830	H	770	H	810	H	4800	H	820	H	780	H
SM2320B	TOTAL ALKALINITY	mg/L	5700	H	840	H	780	H	5300	H	4900	H	1000	H	5200	H
SM2540C	TOTAL DISSOLVED SOLIDS	mg/L	48000		5200		4300		38000		30000		5800		43000	
SM3500-FeD	FERROUS IRON	µg/L	3300		2200		1800		1700		490		790		2200	
SM4500S2-F	SULFIDE	mg/L			5.9		14		28		5.1					
SM4500S2-F	SULFIDE, DISSOLVED	mg/L	52										8.3		61	
SM5310B	DISSOLVED ORGANIC CARBON	mg/L	2300		280		280		1600		530		230		2100	
SM5310B	TOTAL ORGANIC CARBON	mg/L	1900		250		280		1600		440		390		1900	
SW6010	ALUMINUM	mg/L	0.28		47		4.7		0.47		16		1.3		0.73	
SW6010	ANTIMONY	µg/L	20	U	20	U	20	U	20	U	20	U	20	U	20	U
SW6010	ARSENIC	mg/L	0.32		0.021		0.012	J	0.26		0.02		0.019	J	0.39	
SW6010	BARIUM	mg/L	0.021		0.2		0.068		0.022		0.066		0.057		0.017	
SW6010	BERYLLIUM	mg/L	0.0023	J	0.01		0.011		0.0022	J	0.003	J	0.0075		0.0023	J
SW6010	CADMIUM	mg/L	0.0024	J	0.005	U	0.005	U	0.0024	J	0.005	U	0.005	U	0.0027	J
SW6010	CALCIUM	mg/L	1.4		20		14		2.5		31		11		1.6	
SW6010	CHROMIUM	mg/L	0.5		0.14		0.095		0.37		0.092		0.084		0.61	
SW6010	COBALT	mg/L	0.0031	J	0.006	J	0.01	U	0.0019	J	0.0016	J	0.01	U	0.003	J
SW6010	COPPER	mg/L	0.031		0.0053	J	0.0031	J	0.022		0.0034	J	0.0042	J	0.037	
SW6010	IRON	mg/L	2.1		6.7		1.8		1.8		1.9		0.55		2.6	
SW6010	LEAD	mg/L	0.01	U	0.032		0.017		0.01	U	0.0078	J	0.014		0.0051	J
SW6010	MAGNESIUM	mg/L	0.13	J	3.4		0.81		0.12	J	24		0.22	J	0.15	J
SW6010	MANGANESE	mg/L	0.0021	J	0.3		0.027		0.0028	J	0.18		0.0064	J	0.0036	J
SW6010	NICKEL	mg/L	0.09		0.016	J	0.0097	J	0.069		0.026	J	0.0093	J	0.1	
SW6010	POTASSIUM	mg/L	14		7.8		1.3		14		100		0.95	J	25	
SW6010	RESPIRABLE QUARTZ	µg/L	2000000		80000		30000		1900000		13000		30000		2000000	
SW6010	SELENIUM	mg/L	0.042		0.013	J	0.01	J	0.035		0.025		0.013	J	0.046	
SW6010	SILVER	mg/L	0.01	U	0.01	U	0.01	U	0.01	U	0.01	U	0.01	U	0.01	U
SW6010	SODIUM	mg/L	20000		1700		1400		13000		11000		1600		19000	
SW6010	THALLIUM	mg/L	0.025	U	0.025	U	0.025	U	0.025	U	0.025	U	0.025	U	0.025	U
SW6010	VANADIUM	µg/L	2200		170		150		1700		130		180		2300	
SW6010	ZINC	µg/L	16	J	48		9.5	J	16	J	26		20	U	18	J
SW7470	MERCURY	µg/L	110		11		4.8		110		0.16	J	7.9		120	
SW9040	pH	S.U.	11.2	H	8.68	H	9.16	H	11.3	H	8.14	H	9.71	H	11.2	H
SW9056	CHLORIDE	mg/L	19000		1800		1400		17000		13000		2100		19000	
SW9056	SULFATE	mg/L	1300		100	U	100	U	1000		100	U	100	U	1300	

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- H Sample was prepped or analyzed beyond the specified holding time
- HF Field parameter with a holding time of 15 minutes
- F Duplicate RPD exceeds the control limit
- B Compound was found in the blank and sample

Post-Sparge Analytical Data (1 week after conclusion of sparging)

		Field Sample ID	EQB-112815		MW-115A-112812		MW-115B-112812		MW-115C-112712		MW-1A-112812		MW-1B-112712		MW-1C-112612		MW-2A-112812	
		Location	Equipment Blank		MW-115A		MW-115B		MW-115C		MW-1A		MW-1B		MW-1C		MW-2A	
		Sample Date	11/28/2012		11/28/2012		11/28/2012		11/27/2012		11/28/2012		11/27/2012		11/26/2012		11/28/2012	
		SDG	680-85180-2		680-85180-2		680-85180-2		680-85137-2		680-85180-2		680-85180-2		680-85137-2		680-85180-2	
		Matrix	WATER		WATER		WATER		WATER		WATER		WATER		WATER		WATER	
		Sample Purpose	Equipment blank		Regular sample		Regular sample		Regular sample		Regular sample		Regular sample		Regular sample		Regular sample	
		Sample Type	Blank water		Ground Water		Ground Water		Ground Water		Ground Water		Ground Water		Ground Water		Ground Water	
Method	Parameter Name	Units																
SM2320B	ALKALINITY, CARBONATE (AS CACO3)	mg/L	5	U	100	U,H	100	U,H	3200	H	100	U,H	100	U,H	120	H	100	U,H
SM2320B	BICARBONATE ALKALINITY AS CACO3	mg/L	5	U	800	H	1400	H	1700	H	1500	H	1400	H	7800	H	1700	H
SM2320B	TOTAL ALKALINITY	mg/L	5	U	800	H	1400	H	5100	H	1500	H	1400	H	7900	H	1700	H
SM2540C	TOTAL DISSOLVED SOLIDS	mg/L	16		3800		4300		34000		8200		5600		48000		5100	
SM3500-FeD	FERROUS IRON	µg/L	100	U	210		5000		1500		370		7900		18000		1200	
SM4500S2-F	SULFIDE	mg/L	1	U	16		12		40		10	U	10	U	22		14	
SM5310B	DISSOLVED ORGANIC CARBON	mg/L	1.4		240		210		450	B	160		170		390	B	200	
SM5310B	TOTAL ORGANIC CARBON	mg/L	1	U	220		190		560		140		160		430		190	
SW6010	ALUMINUM	mg/L	100	U	27		5		0.2	U	6		4.6		0.2	U	23	
SW6010	ANTIMONY	µg/L	10000	U	20	U	20	U	14	J	20	U	20	U	20	U	20	U
SW6010	ARSENIC	mg/L	10	U	0.0083	J	0.016	J	0.098		0.02	U	0.012	J	0.12		0.0095	J
SW6010	BARIUM	mg/L	5	U	0.069		0.031		0.056		0.034		0.026		0.39		0.14	
SW6010	BERYLLIUM	mg/L	2	U	0.0036	J	0.013		0.0019	J	0.0018	J	0.015		0.0027	J	0.0062	
SW6010	CADMIUM	mg/L	2.5	U	0.005	U	0.005	U	0.0025	J	0.005	U	0.005	U	0.0037	J	0.005	U
SW6010	CALCIUM	mg/L	250	U	16		9		2.8		14		8.2		65		13	
SW6010	CHROMIUM	mg/L	5	U	0.087		0.096		0.34		0.03		0.13		0.32		0.089	
SW6010	COBALT	mg/L	5	U	0.0021	J	0.01	U	0.0018	J	0.0013	J	0.01	U	0.01	U	0.0022	J
SW6010	COPPER	mg/L	10	U	0.0064	J	0.0023	J	0.02		0.02	U	0.0022	J	0.0049	J	0.0033	J
SW6010	IRON	mg/L	50	U	1.3		3.8		1.1		0.69		7.5		17		1.9	
SW6010	LEAD	mg/L	5	U	0.025		0.015		0.01	U	0.01	U	0.012		0.063		0.017	
SW6010	MAGNESIUM	mg/L	250	U	2.9		7.5		0.38	J	12		4.9		19		1.4	
SW6010	MANGANESE	mg/L	5	U	0.34		0.063		0.0052	J	0.034		0.11		0.24		0.14	
SW6010	NICKEL	mg/L	20	U	0.013	J	0.0062	J	0.059		0.0054	J	0.0047	J	0.016	J	0.0079	J
SW6010	POTASSIUM	mg/L	500	U	7.6		1.1		19		25		2.1		48		8.4	
SW6010	RESPIRABLE QUARTZ	µg/L	500	U	28000		110000		470000		40000		91000		86000		50000	
SW6010	SELENIUM	mg/L	3.5	J	0.015	J	0.012	J	0.036		0.02		0.0099	J	0.032		0.017	J
SW6010	SILVER	mg/L	5	U	0.01	U	0.01	U	0.01	U	0.01	U	0.01	U	0.01	U	0.01	U
SW6010	SODIUM	mg/L	500	U	470	J	640		6600		1600		690		8700		650	
SW6010	THALLIUM	mg/L	13	U	0.025	U	0.025	U	0.025	U	0.025	U	0.025	U	0.025	U	0.025	U
SW6010	VANADIUM	µg/L	5000	U	140		130		1400		81		140		370		110	
SW6010	ZINC	µg/L	10000	U	33		11	J	18	J	15	J	49		9.5	J	18	J
SW7470	MERCURY	µg/L	0.20	U	7.6		3.9		110		1.1		3.5		21		4.5	
SW9040	pH	S.U.	5.74		7.7		6.41		9.94		6.76	H	6.46	H	6.97	H	7.19	
SW9056	CHLORIDE	mg/L	5	U	1100		1200		18000		4000		1200		25000		1500	
SW9056	SULFATE	mg/L	5	U	100	U	100	U	1100		100	U	100	U	1400		100	U

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- H — Sample was prepped or analyzed beyond the specified holding time
- HF — Field parameter with a holding time of 15 minutes
- F — Duplicate RPD exceeds the control limit
- B — Compound was found in the blank and sample

		Field Sample ID	MW-2B-112812		MW-2C-MID-112712		MW-2C-MID2-112712		MW-2C-TOP-112712		MW-3A-112812		MW-519A-112812		MW-519B-112712		MW-519B-TOP-112712		SW-1-112712	
		Location	MW-2B		MW-2C		MW-2C		MW-2C		MW-3A		MW-519A		MW-519B		MW-519B		SW-1	
		Sample Date	11/28/2012		11/27/2012		11/27/2012		11/27/2012		11/28/2012		11/28/2012		11/27/2012		11/27/2012		11/27/2012	
		SDG	680-85180-2		680-85137-2		680-85137-2		680-85180-2		680-85180-2		680-85180-2		680-85137-2		680-85137-2		680-85137-2	
		Matrix	WATER		WATER		WATER		WATER		WATER		WATER		WATER		WATER		WATER	
		Sample Purpose	Regular sample		Regular sample		Field duplicate		Regular sample		Regular sample		Regular sample		Regular sample		Regular sample		Regular sample	
		Sample Type	Ground Water		Ground Water		Ground Water		Ground Water		Ground Water		Ground Water		Ground Water		Ground Water		Ground Water	
Method	Parameter Name	Units																		
SM2320B	ALKALINITY, CARBONATE (AS $CaCO_3$)	mg/L	100	U,H	110	H	100	U,H	100	U,H	100	U,H	100	U,H	1200	H	400	H	100	U,H
SM2320B	BICARBONATE ALKALINITY AS $CaCO_3$	mg/L	1100	H	5600	H	5700	H	6000	H	7200	H	1500	H	6200	H	7100	H	5400	H
SM2320B	TOTAL ALKALINITY	mg/L	1100	H	5700	H	5800	H	6000	H	7200	H	1600	H	7400	H	7500	H	5400	H
SM2540C	TOTAL DISSOLVED SOLIDS	mg/L	4800		35000		33000		32000		30000		5400		46000		45000		24000	
SM3500-FeD	FERROUS IRON	µg/L	6200		5200		6000		6900		1800		7600		2500		4000		9900	
SM4500S2-F	SULFIDE	mg/L	19		20		20		22		18		11		43		35		15	
SM5310B	DISSOLVED ORGANIC CARBON	mg/L	210		410	B	440	B	300		330		170		580	B	550	B	310	B
SM5310B	TOTAL ORGANIC CARBON	mg/L	200		480		470		270		830		150		670		630		310	
SW6010	ALUMINUM	mg/L	6		0.2	U	0.2	U	0.2	U	5.9		2.5		0.2	U	0.2	U	0.18	J
SW6010	ANTIMONY	µg/L	20	U	14	J	19	J	9.1	J	20	U	20	U	9.4	J	20	U	20	U
SW6010	ARSENIC	mg/L	0.015	J	0.039		0.044		0.026		0.013	J	0.011	J	0.17		0.13		0.045	
SW6010	BARIUM	mg/L	0.04		0.11		0.13		0.17		0.075		0.044		0.11		0.13		0.3	
SW6010	BERYLLIUM	mg/L	0.013		0.0021	J	0.0024	J	0.003	J	0.0016	J	0.011		0.0024	J	0.0025	J	0.0042	
SW6010	CADMIUM	mg/L	0.005	U	0.005	U	0.0021	J	0.0025	J	0.005	U	0.005	U	0.003	J	0.0026	J	0.0028	J
SW6010	CALCIUM	mg/L	10		12		14		19		40		9.1		13		13		21	
SW6010	CHROMIUM	mg/L	0.11		0.25		0.32		0.3		0.044		0.11		0.38		0.39		0.2	
SW6010	COBALT	mg/L	0.01	U	0.01	U	0.01	U	0.01	U	0.01	U	0.01	U	0.0012	J	0.0013	J	0.01	U
SW6010	COPPER	mg/L	0.0026	J	0.0089	J	0.011	J	0.0087	J	0.02	U	0.02	U	0.016	J	0.014	J	0.0043	J
SW6010	IRON	mg/L	6.2		6.1		7.2		8.4		1.3		6.7		2.3		3.2		14	
SW6010	LEAD	mg/L	0.013		0.01	U	0.01	U	0.01	U	0.01	U	0.0083	J	0.01	U	0.01	U	0.01	U
SW6010	MAGNESIUM	mg/L	3.1		7		8.3		12		28		4.5		3.9		4.2		14	
SW6010	MANGANESE	mg/L	0.081		0.18		0.21		0.24		0.33		0.078		0.054		0.074		0.14	
SW6010	NICKEL	mg/L	0.0077	J	0.027	J	0.033	J	0.027	J	0.019	J	0.0044	J	0.045		0.041		0.014	J
SW6010	POTASSIUM	mg/L	2		24		28		30		120		1.5		29		29		16	
SW6010	RESPIRABLE QUARTZ	µg/L	83000		180000		190000		110000		24000		84000		210000		180000		97000	
SW6010	SELENIUM	mg/L	0.013	J	0.023		0.031		0.032		0.017	J	0.014	J	0.032		0.031		0.025	
SW6010	SILVER	mg/L	0.01	U	0.01	U	0.01	U	0.01	U	0.01	U	0.01	U	0.01	U	0.01	U	0.01	U
SW6010	SODIUM	mg/L	660		5600		6200		6300		5500		830		7300		8300		6500	
SW6010	THALLIUM	mg/L	0.025	U	0.025	U	0.025	U	0.025	U	0.025	U	0.025	U	0.025	U	0.025	U	0.025	U
SW6010	VANADIUM	µg/L	160		630		760		620		97		160		1100		1100		340	
SW6010	ZINC	µg/L	14	J	11	J	11	J	12	J	12	J	20	U	14	J	14	J	16	J
SW7470	MERCURY	µg/L	4.5		55		74		33		0.52		3.1		99		89		11	
SW9040	pH	S.U.	6.58	H	7.81		7.75		7.2	H	7.08		6.49		8.78	H	8.26	H	6.87	H
SW9056	CHLORIDE	mg/L	1400		18000		17000		16000		18000		1700		24000		25000		13000	
SW9056	SULFATE	mg/L	100	U	930		940		920		100	U	100	U	1400		1300		670	

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- H Sample was prepped or analyzed beyond the specified holding time
- HF Field parameter with a holding time of 15 minutes
- F Duplicate RPD exceeds the control limit
- B Compound was found in the blank and sample

APPENDIX F. DERIVATION OF STORATIVITY TERM TO INCLUDE CO_2 EXPANSION

The storativity of a confined, semi-confined, or an unconfined aquifer during early-time behavior (before the onset of delayed gravity drainage) is attributable to two mechanisms—aquifer compression and water expansion. The equation for conventional storativity attributable to these two mechanisms is given by Walton (1970):

$$S = \underbrace{\eta\gamma m\beta}_{\text{water expansion term}} + \underbrace{\alpha\gamma m}_{\text{aquifer compression term}}$$

Where: S = storativity

η = porosity

γ = unit weight of water

m = aquifer thickness

β = water compressibility

α = aquifer compressibility

Storativity is defined as the volume of water that an aquifer releases from storage per unit area of aquifer per unit decline in hydraulic head (Freeze and Cherry, 1979; Fetter, 2001). The concept of storativity ism illustrated in Figure A-1. When the potentiometric surface or a unit area of aquifer is reduced by a unit amount, the water within that volume of the aquifer expands. The aquifer also undergoes compression, which also releases water from storage. This is best conceptualized by considering Terzaghi's Law, a fundamental equation of geotechnical engineering:

$$\partial_T = \partial_E + p$$

Where: ∂_T = Total stress

∂_E = Effective stress

p = Pore pressure

Lowering the potentiometric surface on an aquifer reduces the pore pressure in Terzaghi's Law by a unit amount. The equation dictates that to maintain equality and support the total stress imposed by the weight of the overburden, the effective stress must be increased by a like amount. The effective stress is the stress borne by the aquifer skeleton. As this stress increases, the aquifer is subject to an elastic compression as the sand and other soil particles are packed together more tightly. As the aquifer compresses, water is released from storage.

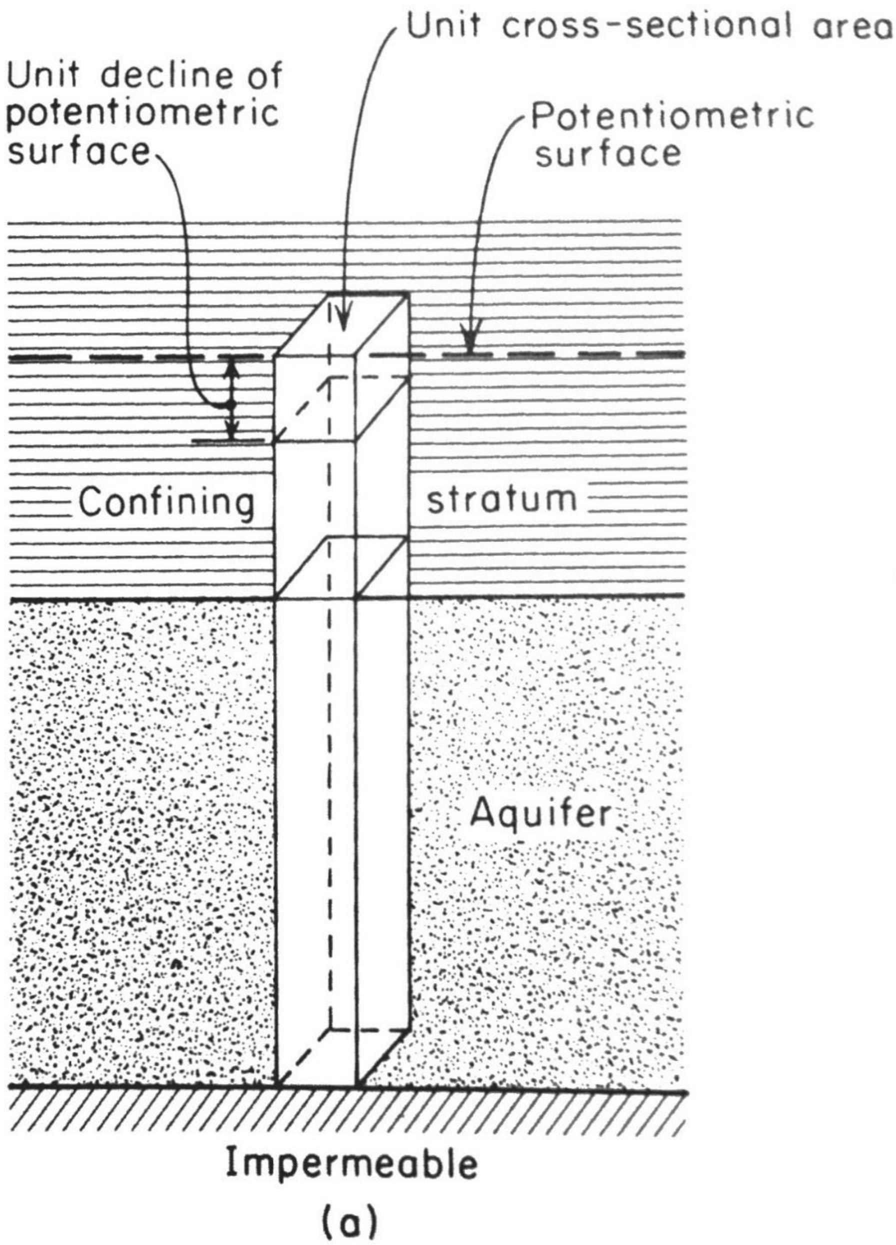


Figure A-1:

If the volume of aquifer affected by a change in potentiometric surface contains a residual saturation of a gas, like CO_2, then the gaseous phase will also undergo expansion. The resultant gas expansion will increase the partial saturation of the gas at the expense of the water saturation. In other words, as the gas expands, it will decrease water saturation and release water from storage in the aquifer. We can derive an expanded storativity equation to take into account the presence of a residual saturation of a gas, such as CO_2, in the aquifer. The derivation makes the following assumptions:

1. The gas acts an Ideal Gas
2. The temperature of the gas remains constant

3. Changes in aqueous-phase hydraulic head will produce identical changes in gaseous-phase pressure head as the capillary pressure between the aqueous-phase and the gaseous phase remains constant.

The Ideal Gas Law (Mortimer, 1967) states the following:

$PV = nRT$

Where: P = pressure

V = volume

n = number of moles of gas

R = constant

T = temperature

Solving for the volume, V, we see that if all other terms remain equal, the volume of gas is inversely proportional to the pressure.

$$V = \frac{nRT}{P}$$

Therefore, the change in the initial volume of a gas is proportional to the change in pressure and inversely proportional to the initial pressure, as follows:

$$\Delta V = \frac{\Delta P V_i}{P_i}$$

Where: ΔV = change in volume

ΔP = change in pressure

V_i = Initial volume

P_i = Initial pressure

:

Since ΔP, in this case, equals the drawdown in the aquifer(s), the equation can be re-written as:

$$\Delta V = \frac{sV_i}{P_i}$$

The initial volume of gas in the unit area of aquifer illustrated in Figure A-1 can be defined as follows:

$$V_i = s_{CO_2} nm$$

Where: s_{CO_2} = saturation of CO_2 in the pore spaces

n = total porosity

m = aquifer thickness

Substituting, this term into the above equation for ΔV, we derive the following term for storativity associated with residual gas expansion:

$$\Delta V = \frac{s_{CO_2} nms}{P_i}$$

The expanded storativity equation is given below:

$$S = \overbrace{(n - s_{CO_2})\eta\gamma m\beta}^{\text{water expansion term}} + \overbrace{\alpha\gamma m}^{\text{aquifer compression term}} + \overbrace{\frac{s_{CO_2} nms}{h_{p,total}}}^{CO_2 \text{ expansion term}}$$

Where: s_{CO_2} = residual saturation of CO_2

s = drawdown

$h_{p,total}$ = total pressure head including atm p

In the above equation, the water expansion term has been modified by changing the total porosity (η) to the water-filled saturation ($n - s_{CO2}$) to properly reflect the fact that CO_2 occupies a portion of the total porosity. However, because the water expansion term is de minimis compared to the CO_2 expansion term, the equation can be simplified by using the total porosity in this term without sacrificing any significant accuracy, as shown below:

$$S = n\gamma m\beta + \alpha\gamma m + \frac{s_{CO_2} nms}{h_{p,total}}$$

APPENDIX G. MONITORING RESULTS (3 MONTHS AFTER CONCLULSION OF SPARGING)

Introduction

Mutch Associates, LLC, in collaboration with Parsons Corporation (Parsons), have prepared this appendix describing the analytical results of the second post-sparge monitoring for the CO_2 sparging Proof of Concept test conducted at the LCP Chemical Site in Brunswick, Georgia. The Proof of Concept test was conducted in accordance with the "Final Work Plan for CO_2 Sparging Proof of Concept Test, LCP Chemical Site, Brunswick, GA" (Mutch Associates, 2012) dated September 11, 2012. The Proof of Concept test was designed to evaluate the feasibility of CO_2 sparging to remediate a sub-surface caustic brine pool (CBP) formed by historical production of industrial chemicals on the site. The purpose of the post-sparge sampling events are to assess any rebound in pH and other constituents of concern.

This appendix describes the results of the second of three post-sparge monitoring events that occurred on February 4th and 5th of 2013. The first post-sparge monitoring event occurred approximately one week after the end of the sparging on November 26th – 28th, 2012. The third and final event is scheduled to take place 6 months after the end of sparging, in May 2013.

Groundwater Sampling

In accordance with the workplan, five out of 13 monitoring wells were selected for rebound monitoring pending the outcome of pH and geochemistry results from the first post-sparging sampling round. The wells selected were SW-1, MW-1C, MW-2C, MW-519B and MW-115C. MW-1C was selected to serve as a field duplicate bringing the total number of samples to six.

The five monitoring wells were purged and sampled using the low flow "Tubing-in-Screened-Interval" method, pursuant to US EPA Region IV Environmental Investigations Standard Operating Procedure (SOP) – October 2011. The guidance document *Groundwater Sampling Guidelines for Superfund and RCRA Project Managers* was also referenced for additional technical support. Per the method, the tubing intake was lowered to the middle of the screened interval of the well, and a peristaltic pump was used to purge the groundwater at a very low flow rate. Throughout the purge process, depth to water measurements were collected to assess and maintain stable drawdown. A minimum one equipment volume was purged prior to stabilization parameters (pH, specific conductivity, dissolved oxygen, and turbidity) being collected. Although not considered stabilization parameters, temperature and oxidation reduction potential were also recorded. The field sampling logs are included as Appendix A to this report. Once the required parameters were stable for three consecutive readings, groundwater samples were collected for laboratory analysis as described in Table 3-2 of the Proof of Concept Report. The groundwater samples were preserved on ice and submitted to TestAmerica Laboratories in Savannah, GA for analysis. Once the groundwater samples had been collected, approximately 900 mL of groundwater were pumped into a graduated cylinder and the specific gravity was determined using a hydrometer.

Sampling Results

A summary of the results from the groundwater analysis is presented in Table G-1. All of the analytical data from TestAmerica and the well purge logs are provided at the end of this Appendix.

Table G-1: Summary of field and lab results from 3 month post-sparge sampling

	SW-1	MW-1C	MW-1C (duplicate)	MW-2C	MW-519B	MW-115C
pH (field)	6.72	6.88	-	8.93	8.67	11.73
pH (lab)	6.86	7.19	7.19	8.58	8.22	10.7
Hg (μg/L)	4.2	44	42	41	68	110
As (μg/L)	9.5 J	23	19 J	34	120	180
Cr (μg/L)	110	420	410	290	440	340
V (μg/L)	150	680	670	730	1100	1500
Si (mg/L)	83	78	78	130	82	2,000
Specific gravity	1.015	1.034	-	1.026	1.037	1.028

A comparison of these results to the pre-sparge and post-sparge monitoring events are shown in Table G-2 for pH, Hg, As and Cr and in Figure G-1 for pH and Hg. Note that all pH data presented in Figure G-1 is for water collected at the midpoint of the well screen.

Changes in pH

The two sparge wells (MW-1C and SW-1) both held their pH values (pH < 7.0) from the November (post-sparge) sampling event. With respect to the two monitoring wells that are within the 20 ft ROI (MW-519B and MW-2C), one well (MW-2C) decreased from 10.08 to 8.93 (midpoint of screen); the other (MW-519B) stayed steady near pH 8.7 (midpoint of screen). Values for pH of both of these wells are well below the 10.5 threshold stated in the AOC. The decrease observed in MW-519B may be the result of the continual dissolution of residual saturation of CO_2 into the water. MW-115C returned to pre-sparge pH values based on the field pH value (the laboratory pH value was 10.7). This well is ~25 ft away from MW-1C. This pH rebound is not a complete surprise based on its distance from the sparge well, and our inability to move its pH downward below pH 10 during sparging.

Changes in Mercury Concentrations

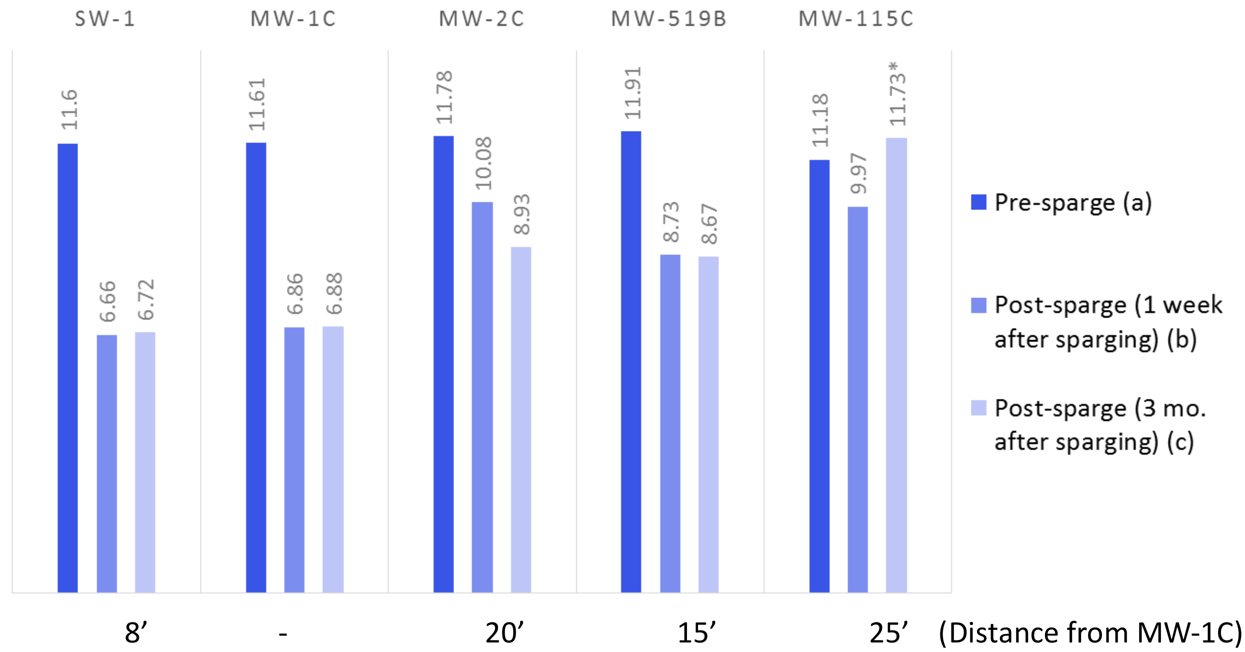
Among the two sparge wells (MW-1C and SW-1), SW-1 saw a decrease in Hg from 11 to 4.4 μg/L, while MW-1C saw an increase from 21 to 44 μg/L. The average percent removal of Hg in these two wells (relative to pre-sparge concentrations) is 78%. This is down only slightly from the average 85% removal observed after the first post-sparge monitoring event. With respect to the two monitoring wells that are within the 20 ft ROI (MW-519B and MW-2C), both showed decreases in Hg relative to the first post-sparge event. MW-519B decreased from 99 to 68 μg/L (midpoint of screen), while MW-2C decreased from 64.5 to 41 μg/L (midpoint of screen). MW-115C which was relatively unaffected by sparging showed no change in Hg concentrations and has held steady at 110 μg/L since before the Proof of Concept Test began.

Table G-2: Summary of field and lab results from 3 month post-sparge sampling

pH	Pre-sparge [a]	Post-sparge (1 week after sparging) [b]	Post-sparge (3 mo. after sparging) [c]
SW-1	11.6 mid	6.66 mid	6.72 mid
MW-1C	11.61 mid	6.86 mid	6.88 mid
MW-2C	11.78 mid	7.96 top / 10.08 mid	8.93 mid
MW-519B	11.91 mid	8.68 top / 8.73 mid	8.67 mid
MW-115C	11.18 mid	9.97 mid	11.73 mid
Hg	Pre-sparge [d]	Post-sparge (1 week after sparging)	Post-sparge (3 mo. after sparging)
SW-1	110 mid	11 mid	4.4 mid
MW-1C	110 mid	21 mid	44 mid
MW-2C	110 mid	33 top / 64.5 mid	41 mid
MW-519B	120 mid	89 top / 99 mid	68 mid
MW-115C	120 mid	110 mid	110 mid
As	Pre-sparge [d]	Post-sparge (1 week after sparging)	Post-sparge (3 mo. after sparging)
SW-1	-	45 mid	9.5 mid
MW-1C	320 mid	120 mid	23 mid
MW-2C	260 mid	26 top / 44 mid	24 mid
MW-519B	390 mid	130 top / 170 mid	120 mid
MW-115C	280 mid	98 mid	180 mid
Cr	Pre-sparge [d]	Post-sparge (1 week after sparging)	Post-sparge (3 mo. after sparging)
SW-1	-	200 mid	110 mid
MW-1C	500 mid	320 mid	420 mid
MW-2C	370 mid	300 top / 320 mid	290 mid
MW-519B	610 mid	390 top / 380 mid	440 mid
MW-115C	340 mid	340 mid	340 mid

Notation:
mid – indicates sample was collected from midpoint of well screen
top – indicates sample was collected from top of well screen
(a) pH values are from field measurements made prior to the start of sparging on October 28, 2012.
(b) Values from field measurements made at the end of the continuous monitoring period on November 11, 2012.
(c) Values are from Parsons field purge logs from February 4-5, 2012 (Appendix A).
(d) Values are from laboratory; sampling event occurring on October 1st to 3rd, 2012.

pH



* MW-115C had a post-sparge (3 mo.) laboratory pH that was significantly lower than the field reading (10.7)

Mercury

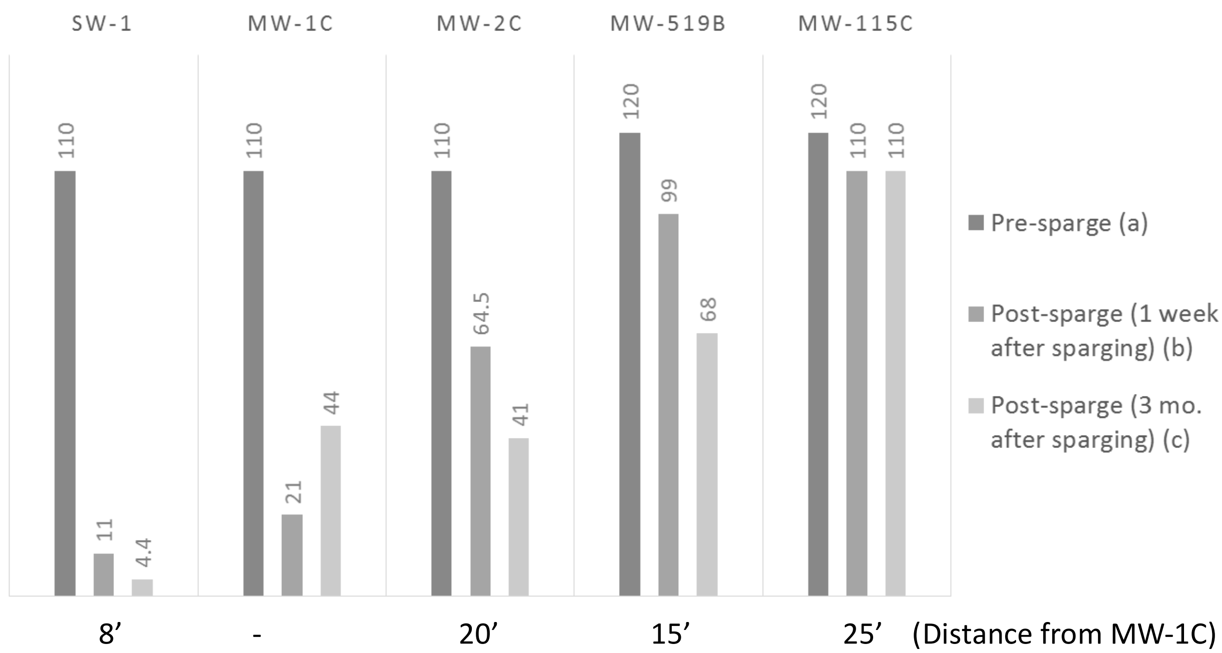


Figure G-1: Summary of pre and post sparge monitoring results for pH and Hg. All data is from the midpoint of the well screen.

Changes in Arsenic and Chromium Concentrations

Arsenic concentrations in all of the deep Satilla wells within 20 feet of MW-1C decreased from the 1 month post-sparge sampling to the 3 month post-sparge sampling. As a result, the average percent removal of As increased from 65% to 83% for MW-1C, MW-2C and MW-519B. Average chromium concentrations were essentially unchanged in deep Satilla wells in going from the 1 month to the 3 month post-sparge sampling.

Conclusions

These results show that changes in aquifer geochemistry since the post-sparge monitoring event have been mostly small, with some evidence of lower pH, Hg and As concentrations in select wells within the 20 ft ROI of CO_2 sparging. Downward movement of pH during the last 3 months of sparging inactivity at the site may be the result of dissolution of residual CO_2 saturation into groundwater. The only well which saw significant rebound was MW-115C which was greater than 25 ft from MW-1C and is not inside the 20 ft ROI.

Analytical Data from 3-month Post Sparge Monitoring Event

		Field Sample ID	EQB-020413		MW-1C-020413		MW-1C#2-020413		SW-1-020413		MW-2C-MID-020413		MW-115C-020413		MW-519B-MID-020413	
		Location	Equipment Blank		MW-1C		MW-1C#2		SW-1		MW-2C-MID		MW-115C		MW-519B-MID	
		Sample Date	2/4/2013		2/4/2013		2/4/2013		2/4/2013		2/4/2013		2/4/2013		2/4/2013	
		SDG	680-87157-1		680-87157-1		680-87157-1		680-87157-1		680-87157-1		680-87157-1		680-87157-1	
		Matrix	WATER		WATER		WATER		WATER		WATER		WATER		WATER	
		Sample Purpose	Equipment blank		Regular sample		Regular sample		Regular sample		Regular sample		Regular sample		Regular sample	
		Sample Type	Blank water		Ground Water		Ground Water		Ground Water		Ground Water		Ground Water		Ground Water	
Method	Parameter Name	Units														
SM2320B	ALKALINITY, CARBONATE (AS CACO3)	mg/L	5	U	5	U	5	U	5	U	35		97		39	
SM2320B	BICARBONATE ALKALINITY AS CACO3	mg/L	5	U	600		610		380		450		340		620	
SM2320B	TOTAL ALKALINITY	mg/L	5	U	600		610		380		490		450		660	
SM2540C	TOTAL DISSOLVED SOLIDS	mg/L	16		42,000		42,000		19,000		33,000		35,000		41,000	
SM3500-FeD	FERROUS IRON	µg/L	100	U, HF	7,300	HF	7,600	HF	8,100	HF	1,100	HF	1,600	HF	3,300	HF
SM4500S2-F	SULFIDE	mg/L	1.0	U	22		25		10	U	21		69		41	
SM5310B	DISSOLVED ORGANIC CARBON	mg/L	1.0	U	290		290		170		320		1,300		390	
SM5310B	TOTAL ORGANIC CARBON	mg/L	1.0	U	270		280		130		290		1,100		460	
SW6010	ALUMINUM	mg/L	0.2	U	0.2	U	0.2	U	0.2	U	0.2	U	0.2	U	0.2	U
SW6010	ANTIMONY	µg/L	0.02	U	0.02	U	0.02	U	0.02	U	0.037		0.011	J	0.025	
SW6010	ARSENIC	mg/L	0.02	U	0.023		0.019	J	0.0095	J	0.034		0.18		0.12	
SW6010	BARIUM	mg/L	0.01	U	0.230		0.230		0.200		0.089		0.026		0.16	
SW6010	BERYLLIUM	mg/L	0.004	U	0.0033	J	0.0033	J	0.003	J	0.002	J	0.0015	J	0.0024	J
SW6010	CADMIUM	mg/L	0.005	U	0.0025	J	0.0025	J	0.005	U	0.005	U	0.0021	J	0.0026	J
SW6010	CALCIUM	mg/L	0.5	U	29		29		19		11		0.85		18	
SW6010	CHROMIUM	mg/L	0.01	U	0.42		0.41		0.11		0.29		0.34		0.44	
SW6010	COBALT	mg/L	0.01	U	0.01	U	0.01	U	0.01	U	0.01	U	0.0021	J	0.01	U
SW6010	COPPER	mg/L	0.02	U	0.012	J	0.013	J	0.0021	J	0.01	U	0.0018	J	0.014	J
SW6010	IRON	mg/L	0.1	U	6.8		7.0		8.4		0.92		1.2		2.2	
SW6010	LEAD	mg/L	0.01	U	0.01	U	0.01	U	0.01	U	0.01	U	0.01	U	0.01	U
SW6010	MAGNESIUM	mg/L	0.5	U	11		11		14		5.6		0.097	J	7.7	
SW6010	MANGANESE	mg/L	0.01	U	0.094		0.095		0.072		0.067		0.01	U	0.11	
SW6010	NICKEL	mg/L	0.04	U	0.033	J	0.031	J	0.0078	J	0.033	J	0.067		0.045	
SW6010	POTASSIUM	mg/L	1	U	34		32		10		21		8		29	
SW6010	RESPIRABLE QUARTZ	µg/L	0.5	U	78,000		78,000		83,000		130,000		2,000,000		82,000	
SW6010	SELENIUM	mg/L	0.02	U	0.032		0.036		0.032		0.031		0.034		0.04	
SW6010	SILVER	mg/L	0.01	U	0.01	U	0.01	U	0.01	U	0.01	U	0.01	U	0.01	U
SW6010	SODIUM	mg/L	0.76	J	14,000		14,000		6,800		13,000		12,000		16,000	
SW6010	THALLIUM	mg/L	0.025	U	0.025	U	0.025	U	0.025	U	0.025	U	0.025	U	0.025	U
SW6010	VANADIUM	µg/L	0.01	U	0.68		0.67		0.15		0.73		1.5		1.1	
SW6010	ZINC	µg/L	0.02	U	0.015	J	0.016	J	0.0096	J	0.024		0.023		0.023	
SW7470	MERCURY	µg/L	0.20	U	44		42		42		41		0.11		68	
SW9040	pH	S.U.	6.26	H	7.19	H	7.19	H	6.86	H	8.58		10.7		8.22	
SW9056	CHLORIDE	mg/L	5.0	U	21,000		22,000		9,000		19,000		17,000		21,000	
SW9056	SULFATE	mg/L	5.0	U	1,400		1,400		330		920		1,000		1,400	

Analytical Lab was TestAmerica Savannah (5102 LaRoche Avenue, Savannah, GA 31404)

Qualifiers:
- U — Indicates the analyte was analyzed for but not detected.
- J — Result is less than the RL but greater than or equal to the MDL and the concentration is an approximate value.
- H — Sample was prepped or analyzed beyond the specified holding time
- HF — Field parameter with a holding time of 15 minutes
- F — Duplicate RPD exceeds the control limit

GROUNDWATER SAMPLING LOG

SITE NAME: **LCP Chemical Site**	SITE LOCATION: **Brunswick, GA**

WELL NO: **MW-1C**	SAMPLE ID: **MW-1C**	DATE: **2/4/2013**

PURGING DATA

WELL DIAMETER (inches): **2**	TUBING DIAMETER (inches): **1/4**	WELL SCREEN INTERVAL DEPTH(ft btoc): **48.5 to 53.5**	STATIC DEPTH TO WATER (ft btoc): **10.5**	PURGE PUMP TYPE OR BAILER: **PP**

EQUIPMENT VOLUME PURGE: 1 EQUIPMENT VOL. = (TUBING CAPACITY X TUBING LENGTH) + FLOW CELL VOLUME
= s (0.0026 gallons/foot X 54 feet) + 0.13 gallons = **0.27 gallons**

INITIAL PUMP OR TUBING DEPTH IN WELL (ft btoc): **50.5**	FINAL PUMP OR TUBING DEPTH IN WELL (ft btoc): **50.5**	PURGING INITIATED AT: **1349**	PURGING ENDED AT: **1540**	TOTAL VOLUME PURGED (gallons): **3.0**

TIME	VOLUME PURGED (gallons)	CUMUL. VOLUME PURGED (gallons)	PURGE RATE (gpm)	DEPTH TO WATER (feet btoc)	pH (standard units)	TEMP. (^{O}C)	SP COND. (mS/cm)	DISSOLVED OXYGEN (% saturation)	TURBIDITY (NTUs)	ORP (mV)	SP Gravity (sg)
1405	0.3	0.3	0.05	10.79	6.89	20.43	59.87	15.3	31.1	102.6	
1414	0.3	0.6	0.03	10.72	6.90	20.24	59.72	8.6	20.8	20.4	
1432	0.3	0.9	0.02	10.73	6.88	19.41	60.03	6.1	18.4	-36.8	
1439	0.3	1.2	0.04	10.74	6.87	19.63	60.22	4.0	14.6	-37.8	
1454	0.3	1.5	0.02	10.68	6.88	19.83	60.60	4.4	11.9	-50.4	
1505	0.3	1.8	0.03	10.67	6.89	20.08	60.62	3.4	13.2	-62.0	
1521	0.6	2.4	0.04	10.79	6.88	20.15	60.72	2.6	10.3	-71.5	
1531	0.3	2.7	0.03	10.79	6.88	19.99	60.61	2.4	9.83	-73.1	
1539	0.3	3.0	0.04	10.79	6.88	20.13	60.62	2.3	10.2	-71.1	1.034

WELL CAPACITY (Gallons Per Foot): **0.75"** = 0.02; **1"** = 0.04; **1.25"** = 0.06; **2"** = 0.16; **3"** = 0.37; **4"** = 0.65; **5"** = 1.02; **6"** = 1.47; **12"** = 5.88
TUBING INSIDE DIA. CAPACITY (Gal./Ft.): **1/8"** = 0.0006; **3/16"** = 0.0014; **1/4"** = 0.0026; **5/16"** = 0.004; **3/8"** = 0.006; **1/2"** = 0.010; **5/8"** = 0.016
BTOC = Below top of casing – feet below top of casing which includes above grade riser

PURGING EQUIPMENT CODES: **B** = Bailer; **BP** = Bladder Pump; **ESP** = Electric Submersible Pump; **PP =** Peristaltic Pump; **O** = Other (Specify)

SAMPLING DATA

SAMPLED BY (PRINT) / AFFILIATION: Christine Jaynes/Parsons	SAMPLER(S) SIGNATURE(S): CJaynes	SAMPLING INITIATED AT: **1548**	SAMPLING ENDED AT: **1629**

PUMP OR TUBING DEPTH IN WELL (feet): **50.5**	TUBING MATERIAL CODE: **Teflon-lined PE**	FIELD-FILTERED: Yes **SM 4500 Sulfide** FILTER SIZE: **0.45 µm** Filtration Equipment Type: **In-line filter**

FIELD DECONTAMINATION: PUMP Y **No** TUBING Yes **No (replaced)**	DUPLICATE: **Yes**

SAMPLE CONTAINER SPECIFICATION				SAMPLE PRESERVATION			INTENDED ANALYSIS AND/OR METHOD	SAMPLING EQUIPMENT CODE	Additional Comments
SAMPLE ID CODE	# CONTAINERS	MATERIAL CODE	VOLUME	PRESERVATIVE USED	TOTAL VOL ADDED IN FIELD (mL)	FINAL pH			
MW-1C	1	PE	250mL	HNO3	--	--	6010B TAL Metals/ 7470A Hg	APP	
MW-1C	1	PE	125mL	--	--		3500 FE/ 9040B pH	APP	
MW-1C	1	PE	250mL	--	--	--	6010B Dissolved Silica	APP	
MW-1C	1	PE	125mL	--	--	--	9056A_28D Chloride & Sulfate	APP	
MW-1C	1	AG	125mL	--	--	--	SM 5310 DOC	APP	
MW-1C	2	PE	250mL	NaOH Zinc Acetate	--	--	SM4500 Sulfide	APP	**Field-Filtered**
MW-1C	1	PE	500mL	--	--	--	2540C TDS	APP	
MW-1C	1	PE	250mL	--	--	--	2320B Alkalinity	APP	
MW-1C	1	AG	125mL	HCl	--	--	SM5310 TOC	APP	

REMARKS: Purge rate variability due to decreasing pump battery and the associated manual adjustments made to the pump RPM. Per SOP, parameters stable for three readings prior to sample collection; turbidity +/-10%. Tubing–in-Screen Interval purge method utilized. Purge water clear brown with very slight odor. The odor was stronger at the time of sample collection. Minimal air/CO2 bubbles noted in tubing.

MATERIAL CODES: **AG** = Amber Glass; **CG** = Clear Glass; **PE** = Polyethylene; **PP** = Polypropylene; **S** = Silicone; **T** = Teflon; **O** = Other (Specify)

SAMPLING EQUIPMENT CODES: **APP** = After Peristaltic Pump; **B** = Bailer; **BP** = Bladder Pump; **ESP** = Electric Submersible Pump; **RFPP** = Reverse Flow Peristaltic Pump; **SM** = Straw Method (Tubing Gravity Drain); **O** = Other (Specify)

NOTES: Stabilization Criteria for Range of Variation of Last Three Consecutive Readings:-**pH:** $\pm$ 0.1 unit **Specific Conductance:** $\pm$ 5% **Dissolved Oxygen:** all readings $\leq$ 10% saturation; optionally, $\pm$ 0.2 mg/L **Turbidity:** all readings $\leq$ 10 NTU; or $\pm$ 10%

GROUNDWATER SAMPLING LOG

SITE NAME: **LCP Chemical Site**	SITE LOCATION: **Brunswick, GA**	
WELL NO: **MW-2C**	SAMPLE ID: **MW-2C-MID**	DATE: **2/5/2013**

PURGING DATA

WELL DIAMETER (inches): **2**	TUBING DIAMETER (inches): **1/4**	WELL SCREEN INTERVAL DEPTH (ft btoc): **48 to 53**	STATIC DEPTH TO WATER (ft btoc): **9.55**	PURGE PUMP TYPE OR BAILER: **PP**

EQUIPMENT VOLUME PURGE: 1 EQUIPMENT VOL. = (TUBING CAPACITY X TUBING LENGTH) + FLOW CELL VOLUME
= (0.0026 gallons/foot X 54 feet) + 0.13 gallons = **0.27 gallons**

INITIAL PUMP OR TUBING DEPTH IN WELL (feet btoc): **50.5**	FINAL PUMP OR TUBING DEPTH IN WELL (feet btoc): **50.5**	PURGING INITIATED AT: **0813**	PURGING ENDED AT: **1140**	TOTAL VOLUME PURGED (gallons): **1.55**

TIME	VOLUME PURGED (gallons)	CUMUL. VOLUME PURGED (gallons)	PURGE RATE (gpm)	DEPTH TO WATER (feet btoc)	pH (standard units)	TEMP. (^{O}C)	SP COND. (mS/cm)	DISSOLVED OXYGEN (% saturation)	TURBIDITY (NTUs)	ORP (mV)	SP Gravity (sg)
0941	0.5	0.5	0.01	11.21	8.38	14.79	47.95	2.0	20.7	-336.1	
1004	0.25	0.75	0.01	11.53	8.81	16.74	49.06	1.0	21.0	-331.6	
1038	0.25	1.0	0.007	11.70	8.73	17.29	48.58	0.7	18.4	-305.1	
1105	0.2	1.2	0.007	11.71	8.79	18.20	48.41	0.7	17.4	-327.8	
1110	0.03	1.23	0.006	11.71	8.78	18.27	48.32	0.5	17.8	-339.0	
1115	0.02	1.25	0.004	11.71	8.73	18.38	48.11	0.7	15.7	-298.3	
1126	0.15	1.4	0.01	11.98	8.70	18.80	47.73	0.7	15.2	-339.4	
1133	0.1	1.5	0.01	11.92	8.89	19.10	47.86	0.6	13.8	-370.6	
1138	0.05	1.55	0.01	11.88	8.93	19.04	48.27	0.6	13.5	-344.0	1.026

WELL CAPACITY (Gallons Per Foot): **0.75"** = 0.02; **1"** = 0.04; **1.25"** = 0.06; **2"** = 0.16; **3"** = 0.37; **4"** = 0.65; **5"** = 1.02; **6"** = 1.47; **12"** = 5.88
TUBING INSIDE DIA. CAPACITY (Gal./Ft.): **1/8"** = 0.0006; **3/16"** = 0.0014; **1/4"** = 0.0026; **5/16"** = 0.004; **3/8"** = 0.006; **1/2"** = 0.010; **5/8"** = 0.016
BTOC = Below top of casing – feet below top of casing which includes above grade riser

PURGING EQUIPMENT CODES: **B** = Bailer; **BP** = Bladder Pump; **ESP** = Electric Submersible Pump; **PP =** Peristaltic Pump; **O** = Other (Specify)

SAMPLING DATA

SAMPLED BY (PRINT) / AFFILIATION: Christine Jaynes/Parsons	SAMPLER(S) SIGNATURE(S):	SAMPLING INITIATED AT: **1151**	SAMPLING ENDED AT: **Not Recorded**
PUMP OR TUBING DEPTH IN WELL (feet): **53.5**	TUBING MATERIAL CODE: **Teflon-lined PE**	FIELD-FILTERED: Yes/**SM 4500 Sulfide** FILTER SIZE: **0.45** μm Filtration Equipment Type: **In-line filter**	
FIELD DECONTAMINATION: PUMP Y **No**	TUBING Y **No (replaced)**	DUPLICATE: **No**	

SAMPLE CONTAINER SPECIFICATION				SAMPLE PRESERVATION			INTENDED ANALYSIS AND/OR METHOD	SAMPLING EQUIPMENT CODE	Additional Comments
SAMPLE ID CODE	# CONTAINERS	MATERIAL CODE	VOLUME	PRESERVATIVE USED	TOTAL VOL ADDED IN FIELD (mL)	FINAL pH			
MW-2C-MID	2	PE	250mL	HNO3	--	--	6010B TAL Metals/7470A Hg	APP	
MW-2C-MID	2	PE	125mL	--	--		3500 FE/ 9040B pH	APP	
MW-2C-MID	2	PE	250mL	--	--	--	6010B Dissolved Silica	APP	
MW-2C-MID	2	PE	125mL	--	--	--	9056A_28D Chloride & Sulfate	APP	
MW-2C-MID	2	AG	125mL	--	--	--	SM 5310 DOC	APP	
MW-2C-MID	4	PE	250mL	NaOH Zinc Acetate	--	--	SM4500 Sulfide	APP	**Field-Filtered**
MW-2C-MID	2	PE	500mL	--	--	--	2540C TDS	APP	
MW-2C-MID	2	PE	250mL	--	--	--	2320B Alkalinity	APP	
MW-2C-MID	2	AG	125mL	HCl	--	--	SM5310 TOC	APP	

REMARKS: Purge paused at 0823 and again at 0914. Parameters **not** stable prior to sample collection: pH >+/- 0.1 SU; turbidity >10 NTU. However, based on the water level, the sample was believed to be indicative of the water at the screen interval and not stagnant water in the well casing. Tubing–in-Screen-Interval purge method utilized. Purge water clear, brown odor noted.

MATERIAL CODES: **AG** = Amber Glass; **CG** = Clear Glass; **PE** = Polyethylene; **PP** = Polypropylene; **S** = Silicone; **T** = Teflon; **O** = Other (Specify)

SAMPLING EQUIPMENT CODES: **APP** = After Peristaltic Pump; **B** = Bailer; **BP** = Bladder Pump; **ESP** = Electric Submersible Pump; **RFPP** = Reverse Flow Peristaltic Pump; **SM** = Straw Method (Tubing Gravity Drain); **O** = Other (Specify)

NOTES: Stabilization Criteria for Range of Variation of Last Three Consecutive Readings:-**pH:** ± 0.1 unit **Specific Conductance:** ± 5% **Dissolved Oxygen:** all readings ≤ 10% saturation; optionally, ± 0.2 mg/L **Turbidity:** all readings ≤ 10 NTU; or ± 10%

GROUNDWATER SAMPLING LOG

SITE NAME: **LCP Chemical Site**	SITE LOCATION: **Brunswick, GA**	
WELL NO: **MW-115C**	SAMPLE ID: **MW-115C**	DATE: **2/5/2013**

PURGING DATA

WELL DIAMETER (inches): **2**	TUBING DIAMETER (inches): **1/4**	WELL SCREEN INTERVAL DEPTH (ft btoc): **43.5 to 45**	STATIC DEPTH TO WATER (feet btoc): **8.40**	PURGE PUMP TYPE OR BAILER: **PP**

EQUIPMENT VOLUME PURGE: 1 EQUIPMENT VOL. = (TUBING CAPACITY X TUBING LENGTH) + FLOW CELL VOLUME
= (0.0026 gallons/foot X 48.25 feet) + 0.13 gallons = **0.26 gallons**

INITIAL PUMP OR TUBING DEPTH IN WELL (feet btoc): **44.25**	FINAL PUMP OR TUBING DEPTH IN WELL (feet btoc): **44.25**	PURGING INITIATED AT: **1012**	PURGING ENDED AT: **1326**	TOTAL VOLUME PURGED (gallons): **2.5**

TIME	VOLUME PURGED (gallons)	CUMUL. VOLUME PURGED (gallons)	PURGE RATE (gpm)	DEPTH TO WATER (feet btoc)	pH (standard units)	TEMP. (^{O}C)	SP COND. (mS/cm)	DISSOLVED OXYGEN (% saturation)	TURBIDITY (NTUs)	ORP (mV)	SP Gravity (sg)
1205	0.8	0.8	0.019	9.85	11.24	20.00	50.44	1.0	4.16	-378.3	
1210	0.2	1.0	0.04	10.15	11.11	20.19	50.41	0.8	4.71	-384.9	
1218	0.2	1.2	0.025	10.13	11.20	20.51	50.38	0.6	3.85	-390.4	
1228	0.1	1.3	0.01	10.10	11.42	20.93	50.53	0.8	4.16	-401.5	
1233	0.15	1.45	0.03	10.20	11.39	20.85	50.44	0.8	248	-396.3	
1244	0.2	1.65	0.018	10.33	11.41	20.69	50.46	0.7	16.5	-412.3	
1252	0.25	1.9	0.006	10.46	11.38	21.02	50.41	0.7	30.9	-409.2	
1305	0.25	2.15	0.019	10.10	11.47	21.07	50.41	0.6	7.90	-391.3	
1311	0.1	2.25	0.016	10.10	11.69	21.19	50.47	0.7	3.25	-400.7	
1317	0.15	2.4	0.025	10.10	11.77	21.04	50.51	0.6	2.95	-421.6	
1323	0.1	2.5	0.017	10.07	11.73	21.05	50.50	0.5	3.25	-413.9	1.028

WELL CAPACITY (Gallons Per Foot): **0.75"** = 0.02; **1"** = 0.04; **1.25"** = 0.06; **2"** = 0.16; **3"** = 0.37; **4"** = 0.65; **5"** = 1.02; **6"** = 1.47; **12"** = 5.88
TUBING INSIDE DIA. CAPACITY (Gal./Ft.): **1/8"** = 0.0006; **3/16"** = 0.0014; **1/4"** = 0.0026; **5/16"** = 0.004; **3/8"** = 0.006; **1/2"** = 0.010; **5/8"** = 0.016
BTOC = Below top of casing – feet below top of casing which includes above grade riser

PURGING EQUIPMENT CODES: **B** = Bailer; **BP** = Bladder Pump; **ESP** = Electric Submersible Pump; **PP =** Peristaltic Pump; **O** = Other (Specify)

SAMPLING DATA

SAMPLED BY (PRINT) / AFFILIATION: Christine Jaynes/Parsons	SAMPLER(S) SIGNATURE(S): CJaynes	SAMPLING INITIATED AT: **1330**	SAMPLING ENDED AT: **1405**
PUMP OR TUBING DEPTH IN WELL (feet): **44.25**	TUBING MATERIAL CODE: **Teflon-lined PE**	FIELD-FILTERED: Yes/**SM 4500 Sulfide** FILTER SIZE: 0.45 µm Filtration Equipment Type: **In-line filter**	
FIELD DECONTAMINATION: PUMP Y **No**	TUBING Y **No (replaced)**	DUPLICATE: **No**	

SAMPLE CONTAINER SPECIFICATION				SAMPLE PRESERVATION			INTENDED ANALYSIS AND/OR METHOD	SAMPLING EQUIPMENT CODE	Additional Comments
SAMPLE ID CODE	# CONTAINERS	MATERIAL CODE	VOLUME	PRESERVATIVE USED	TOTAL VOL ADDED IN FIELD (mL)	FINAL pH			
MW-115C	1	PE	250mL	HNO3	--	--	6010B TAL Metals/7470A Hg	APP	
MW-115C	1	PE	125mL	--	--		3500 FE/ 9040B pH	APP	
MW-115C	1	PE	250mL	--	--	--	6010B Dissolved Silica	APP	
MW-115C	1	PE	125mL	--	--	--	9056A_28D Chloride & Sulfate	APP	
MW-115C	1	AG	125mL	--	--	--	SM 5310 DOC	APP	
MW-115C	2	PE	250mL	NaOH Zinc Acetate	--	--	SM4500 Sulfide	APP	**Field-Filtered**
MW-115C	1	PE	500mL	--	--	--	2540C TDS	APP	
MW-115C	1	PE	250mL	--	--	--	2320B Alkalinity	APP	
MW-115C	1	AG	125mL	HCl	--	--	SM5310 TOC	APP	

REMARKS: Purge paused with 0.5 gallons purged at 1034; purge continued at 1144. Difficulty stabilizing the water level due in part to the pump RPM slowing down. The pump was switched out after the 1252 reading. Per SOP, parameters stable for three readings prior to sample collection. Tubing–in-Screen-Interval purge method utilized. The turbidity reading of 248 NTU is believed to be the result of a precipitate noted in the sample cell.

MATERIAL CODES: **AG** = Amber Glass; **CG** = Clear Glass; **PE** = Polyethylene; **PP** = Polypropylene; **S** = Silicone; **T** = Teflon; **O** = Other (Specify)

SAMPLING EQUIPMENT CODES: **APP** = After Peristaltic Pump; **B** = Bailer; **BP** = Bladder Pump; **ESP** = Electric Submersible Pump; **RFPP** = Reverse Flow Peristaltic Pump; **SM** = Straw Method (Tubing Gravity Drain); **O** = Other (Specify)

NOTES: Stabilization Criteria for Range of Variation of Last Three Consecutive Readings:-**pH:** ± 0.1 unit **Specific Conductance:** ± 5% **Dissolved Oxygen:** all readings ≤ 10% saturation; optionally, ± 0.2 mg/L **Turbidity:** all readings ≤ 10 NTU; or ± 10%

GROUNDWATER SAMPLING LOG

SITE NAME: **LCP Chemical Site**		SITE LOCATION: **Brunswick, GA**
WELL NO: **MW-519B**	SAMPLE ID: **MW-519B-MID**	DATE: **2/5/2013**

PURGING DATA

WELL DIAMETER (inches): **2**	TUBING DIAMETER (inches): **1/4**	WELL SCREEN INTERVAL DEPTH (feet btoc): **42.55 to 47.55**	STATIC DEPTH TO WATER (feet btoc): **9.15**	PURGE PUMP TYPE OR BAILER: **PP**

EQUIPMENT VOLUME PURGE: 1 EQUIPMENT VOL. = (TUBING CAPACITY X TUBING LENGTH) + FLOW CELL VOLUME
= (0.0026 gallons/foot X 48.55 feet) + 0.13 gallons = **0.26 gallons**

INITIAL PUMP OR TUBING DEPTH IN WELL (feet btoc): **45.05**	FINAL PUMP OR TUBING DEPTH IN WELL (feet btoc): **45.05**	PURGING INITIATED AT: **1428**	PURGING ENDED AT: **15.57**	TOTAL VOLUME PURGED (gallons): **1.2**

TIME	VOLUME PURGED (gallons)	CUMUL. VOLUME PURGED (gallons)	PURGE RATE (gpm)	DEPTH TO WATER (feet btoc)	pH (standard units)	TEMP. (^{O}C)	SP COND. (mS/cm)	DISSOLVED OXYGEN (% saturation)	TURBIDITY (NTUs)	ORP (mV)	SP Gravity (sg)
1520	0.7	0.7	0.013	11.77	8.70	22.26	63.70	0.9	11.1	-385.4	
1528	0.1	0.8	0.125	11.85	8.73	21.87	63.17	0.8	10.4	-388.1	
1535	0.1	0.9	0.014	11.93	8.65	21.90	62.90	0.8	10.1	-379.1	
1542	0.1	1.0	0.014	11.95	8.69	21.38	62.73	0.6	9.26	-375.9	
1549	0.1	1.1	0.014	11.97	8.67	21.36	62.61	0.5	9.81	-378.3	
1555	0.1	1.2	0.016	11.99	8.67	21.38	62.53	0.5	8.41	-381.6	1.037

WELL CAPACITY (Gallons Per Foot): **0.75"** = 0.02; **1"** = 0.04; **1.25"** = 0.06; **2"** = 0.16; **3"** = 0.37; **4"** = 0.65; **5"** = 1.02; **6"** = 1.47; **12"** = 5.88
TUBING INSIDE DIA. CAPACITY (Gal./Ft.): **1/8"** = 0.0006; **3/16"** = 0.0014; **1/4"** = 0.0026; **5/16"** = 0.004; **3/8"** = 0.006; **1/2"** = 0.010; **5/8"** = 0.016
BTOC = Below top of casing – feet below top of casing which includes above grade riser

PURGING EQUIPMENT CODES: **B** = Bailer; **BP** = Bladder Pump; **ESP** = Electric Submersible Pump; **PP =** Peristaltic Pump; **O** = Other (Specify)

SAMPLING DATA

SAMPLED BY (PRINT) / AFFILIATION: Christine Jaynes/Parsons	SAMPLER(S) SIGNATURE(S):	SAMPLING INITIATED AT: **1601**	SAMPLING ENDED AT: **Not Recorded**

PUMP OR TUBING DEPTH IN WELL (feet): **45.05**	TUBING MATERIAL CODE: **Teflon-lined PE**	FIELD-FILTERED: **Yes/SM 4500 Sulfide** FILTER SIZE: **0.45** µm Filtration Equipment Type: **In-line filter**

FIELD DECONTAMINATION: PUMP Y **No** TUBING Y **No (replaced)** DUPLICATE: **No**

SAMPLE CONTAINER SPECIFICATION				SAMPLE PRESERVATION			INTENDED ANALYSIS AND/OR METHOD	SAMPLING EQUIPMENT CODE	Additional Comments
SAMPLE ID CODE	# CONTAINERS	MATERIAL CODE	VOLUME	PRESERVATIVE USED	TOTAL VOL ADDED IN FIELD (mL)	FINAL pH			
MW-519B-MID	1	PE	250mL	HNO3	--	--	6010B TAL Metals/7470A Hg	APP	
MW-519B-MID	1	PE	125mL	--	--		3500 FE/ 9040B pH	APP	
MW-519B-MID	1	PE	250mL	--	--	--	6010B Dissolved Silica	APP	
MW-519B-MID	1	PE	125mL	--	--	--	9056A_28D Chloride & Sulfate	APP	
MW-519B-MID	1	AG	125mL	--	--	--	SM 5310 DOC	APP	
MW-519B-MID	2	PE	250mL	NaOH Zinc Acetate	--	--	SM4500 Sulfide	APP	**Field-Filtered**
MW-519B-MID	1	PE	500mL	--	--	--	2540C TDS	APP	
MW-519B-MID	1	PE	250mL	--	--	--	2320B Alkalinity	APP	
MW-519B-MID	1	AG	125mL	HCl	--	--	SM5310 TOC	APP	

REMARKS: Per SOP, parameters stable for three readings prior to sample collection. Tubing–in-Screen Interval purge method utilized. Water level stabilized prior to collecting parameters. Purge water clear brown, sulfur-like odor.

MATERIAL CODES: **AG** = Amber Glass; **CG** = Clear Glass; **PE** = Polyethylene; **PP** = Polypropylene; **S** = Silicone; **T** = Teflon; **O** = Other (Specify)

SAMPLING EQUIPMENT CODES: **APP** = After Peristaltic Pump; **B** = Bailer; **BP** = Bladder Pump; **ESP** = Electric Submersible Pump; **RFPP** = Reverse Flow Peristaltic Pump; **SM** = Straw Method (Tubing Gravity Drain); **O** = Other (Specify)

NOTES: Stabilization Criteria for Range of Variation of Last Three Consecutive Readings:-**pH:** ± 0.1 unit **Specific Conductance:** ± 5% **Dissolved Oxygen:** all readings ≤ 10% saturation; optionally, ± 0.2 mg/L **Turbidity:** all readings ≤ 10 NTU; or ± 10%

GROUNDWATER SAMPLING LOG

SITE NAME: **LCP Chemical Site**	SITE LOCATION: **Brunswick, GA**

WELL NO: **SW-1**	SAMPLE ID: **SW-1**	DATE: **2/5/2013**

PURGING DATA

WELL DIAMETER (inches): **4**	TUBING DIAMETER (inches): **1/4**	WELL SCREEN INTERVAL DEPTH(ft btoc): **43 to 48**	STATIC DEPTH TO WATER (ft btoc): **9.52**	PURGE PUMP TYPE OR BAILER: **PP**

EQUIPMENT VOLUME PURGE: 1 EQUIPMENT VOL. = (TUBING CAPACITY X TUBING LENGTH) + FLOW CELL VOLUME
= (0.0026 gallons/foot X 49 feet) + 0.13 gallons = **0.26 gallons**

INITIAL PUMP OR TUBING DEPTH IN WELL (feet btoc): **45.5**	FINAL PUMP OR TUBING DEPTH IN WELL (feet btoc): **45.5**	PURGING INITIATED AT: **0731**	PURGING ENDED AT: **0840**	TOTAL VOLUME PURGED (gallons): **1.5**

TIME	VOLUME PURGED (gallons)	CUMUL. VOLUME PURGED (gallons)	PURGE RATE (gpm)	DEPTH TO WATER (feet btoc)	pH (standard units)	TEMP. (^{O}C)	SP COND. (mS/cm)	DISSOLVED OXYGEN (% saturation)	TURBIDITY (NTUs)	ORP (mV)	SP Gravity (sg)
0758	0.5	0.5	0.02	9.58	6.71	16.42	28.45	20.1	5.36	-120.3	
0808	0.25	0.75	0.03	9.59	6.73	17.22	28.62	8.1	2.96	-150.5	
0817	0.25	1.0	0.03	9.60	6.72	17.74	28.48	6.1	2.36	-167.8	
0827	0.25	1.25	0.03	9.60	6.72	18.14	28.35	5.1	4.02	-180.6	
0836	0.25	1.5	0.03	9.60	6.72	18.15	28.35	4.4	1.40	-185.8	1.015

WELL CAPACITY (Gallons Per Foot): **0.75"** = 0.02; **1"** = 0.04; **1.25"** = 0.06; **2"** = 0.16; **3"** = 0.37; **4"** = 0.65; **5"** = 1.02; **6"** = 1.47; **12"** = 5.88
TUBING INSIDE DIA. CAPACITY (Gal./Ft.): **1/8"** = 0.0006; **3/16"** = 0.0014; **1/4"** = 0.0026; **5/16"** = 0.004; **3/8"** = 0.006; **1/2"** = 0.010; **5/8"** = 0.016
BTOC = Below top of casing – feet below top of casing which includes above grade riser

PURGING EQUIPMENT CODES: **B** = Bailer; **BP** = Bladder Pump; **ESP** = Electric Submersible Pump; **PP =** Peristaltic Pump; **O** = Other (Specify)

SAMPLING DATA

SAMPLED BY (PRINT) / AFFILIATION: Christine Jaynes/Parsons	SAMPLER(S) SIGNATURE(S): CJaynes	SAMPLING INITIATED AT: **0851**	SAMPLING ENDED AT: **0922**

PUMP OR TUBING DEPTH IN WELL (feet): **45.5**	TUBING MATERIAL CODE: **Teflon-lined PE**	FIELD-FILTERED: Yes/**SM 4500 Sulfide** FILTER SIZE: <u>0.45</u> μm Filtration Equipment Type: **In-line filter**

FIELD DECONTAMINATION: PUMP Y **No** TUBING Y **No (replaced)**	DUPLICATE: **No**

SAMPLE CONTAINER SPECIFICATION				SAMPLE PRESERVATION			INTENDED ANALYSIS AND/OR METHOD	SAMPLING EQUIPMENT CODE	Additional Comments
SAMPLE ID CODE	# CONTAINERS	MATERIAL CODE	VOLUME	PRESERVATIVE USED	TOTAL VOL ADDED IN FIELD (mL)	FINAL pH			
SW-1	1	PE	250mL	HNO3	--	--	6010B TAL Metals/7470A Hg	APP	
SW-1	1	PE	125mL	--	--		3500 FE/ 9040B pH	APP	
SW-1	1	PE	250mL	--	--	--	6010B Dissolved Silica	APP	
SW-1	1	PE	125mL	--	--	--	9056A_28D Chloride & Sulfate	APP	
SW-1	1	AG	125mL	--	--	--	SM 5310 DOC	APP	
SW-1	2	PE	250mL	NaOH Zinc Acetate	--	--	SM4500 Sulfide	APP	**Field-Filtered**
SW-1	1	PE	500mL	--	--	--	2540C TDS	APP	
SW-1	1	PE	250mL	--	--	--	2320B Alkalinity	APP	
SW-1	1	AG	125mL	HCl	--	--	SM5310 TOC	APP	

REMARKS: Per SOP, parameters stable for three readings before sampling. Tubing–in-Screen-Interval purge method utilized. Purge water clear, light brown and became less brown as purge continued, odor noted.

MATERIAL CODES: **AG** = Amber Glass; **CG** = Clear Glass; **PE** = Polyethylene; **PP** = Polypropylene; **S** = Silicone; **T** = Teflon; **O** = Other (Specify)

SAMPLING EQUIPMENT CODES: **APP** = After Peristaltic Pump; **B** = Bailer; **BP** = Bladder Pump; **ESP** = Electric Submersible Pump; **RFPP** = Reverse Flow Peristaltic Pump; **SM** = Straw Method (Tubing Gravity Drain); **O** = Other (Specify)

NOTES: Stabilization Criteria for Range of Variation of Last Three Consecutive Readings:-**pH:** $\pm$ 0.1 unit **Specific Conductance:** $\pm$ 5% **Dissolved Oxygen:** all readings $\leq$ 10% saturation; optionally, $\pm$ 0.2 mg/L **Turbidity:** all readings $\leq$ 10 NTU; or $\pm$ 10%