Florida Onsite Sewage Nitrogen Reduction Strategies Study

Task C.14

Soils & Hydrogeologic Characterization and Monitoring Plan

Progress Report

March 2015

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Florida Onsite Sewage Nitrogen Reduction Strategies Study

TASK C.14
PROGRESS REPORT

Soils & Hydrogeologic Characterization and Monitoring Plan

Prepared for:

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Soils and Hydrogeologic Characterization and Monitoring Plan for the Test Facility Site

1.0 Background

Task C of the Florida Onsite Sewage Nitrogen Reduction Strategies (FOSNRS) Study includes the characterization of soils and hydrogeologic properties to aid in development of the soil and groundwater (S&GW) test facility monitoring plan and an accurate conceptual model of the Gulf Coast Research and Education Center (GCREC) site. The site characterization data was also developed to aid in the interpretation of Task C results obtained at the GCREC facilities. Characterization included soils analyses, aquifer testing, tracer testing and piezometer installation.

2.0 Characterization

The GCREC is located in southwest Hillsborough county Florida. The surrounding area is characterized by a relatively flat topography with a southwesterly dip towards Tampa Bay. Regional groundwater flow is southwest towards Carlton Branch, a small creek that drains into the Little Manatee River. The predominate land use around the GCREC is agriculture, with intermittent tree cover. There are no high-density housing developments in the vicinity of the GCREC with the exception of a small dormitory complex located in the northwest area of the GCREC property.

Two test facilities constructed as part of Task C are located at the GCREC: the GCREC mound, and the S&GW test facility. Construction details, instrumentation, operation, and monitoring are presented in previous Task C deliverables (Task C.10, C.11, C.12, C.20, C.21, and C.22). The GCREC mound is the onsite wastewater treatment system (OWTS) that serves the facilities on the property. The facility OWTS has been in service since 2004 and is assumed to be under steady state operating conditions. The six pilot scale systems were constructed for the purposes of this project and have been in operation since May 2012.

The local hydraulic gradient of the surficial aquifer is in a northeast to southwest direction. Directly north of the field site is a drainage ditch that borders the entire northern portion of the field site. To the south and west of the site are two additional irrigation ditches that appear to be used to control the groundwater level for adjacent agricultural fields. Both of

these ditches contained standing water during the summer of 2013, which appeared to be at the elevation of the water table in adjacent monitoring wells. Although the irrigation ditches are in close proximity to the field site, they do not appear to control the hydraulic gradient. Interpolated groundwater contours from field measurements seem to indicate that the water in the irrigation ditches is where the water table intersects the land surface rather than a constant head boundary, see Appendix A for details. The adjacent fields were not under cultivation during the study period which may explain the apparently uncontrolled water level in the drainage ditches. During cultivation, the irrigation ditches may be used to control the water table in the adjacent field which would have a profound effect on the hydraulic gradient within the field site. The drainage ditch to the north of the field site may serve as a recharge point for groundwater during large rain events.

3.0 Soil Characteristics

Soil characteristics at the GCREC were evaluated: 1) in 2009 prior to selection of the FOSNRS test facility site, 2) in June 2010 during instrumentation of the GCREC mound 3) in May 2012 during instrumentation of the S&GW test areas, and 4) in October 2013 during instrumentation of additional wells prior to the third tracer test conducted in the S&GW Test Area 3 (TA3).

Results from the soil survey conducted in 2009 indicated the predominant soil types in the area of interest as Zolfo fine sand, Seffner fine sand, and Myakka fine sand. A memorandum describing the results was submitted in May 2009 (Appendix B). A prominent spodic layer was identified.

Additional soil characterization was conducted during the instrumentation of the GCREC mound site. Soil cores were collected to the spodic layer at four grid locations (CD6.5, E9, F4, and west side of the mound [near A9]), and at one location (G10) a continuous soil core was collected down to the confining Hawthorn clay layer which separates the surficial aquifer from the Floridan aquifer below. This deep core provides a general idea of the soil properties within the surficial aquifer. The remaining cores were collected through the extent of the vadose zone and will be used to determine valid parameter values for the groundwater model of the area.

During the instrumentation of the S&GW test facility, two additional continuous soil cores were collected at locations MM (located between TA2 and TA5) and TT (north of the tracer test No. 2 area). In addition, a soil pit was dug at the southeast corner of the field site six feet below grade, approximately to the level of the spodic layer that was located during

the installation of monitoring wells (Figure 1). The spodic layer is the darkly colored layer which underlies the lightly colored layer. The soil profile is characterized by a darkly colored top layer referred to as the A horizon. This layer contains organic matter in varying stages of decomposition and is also the primary rooting zone for plant life, though larger plants and trees may access layers below the A horizon as well. The following lightly colored layer below the A horizon is the zone of elluviation known as the E horizon. Organic acids and infiltrating rain leach organic matter and minerals from this layer creating a distinctly lighter colored layer (Huang et al, 2012).

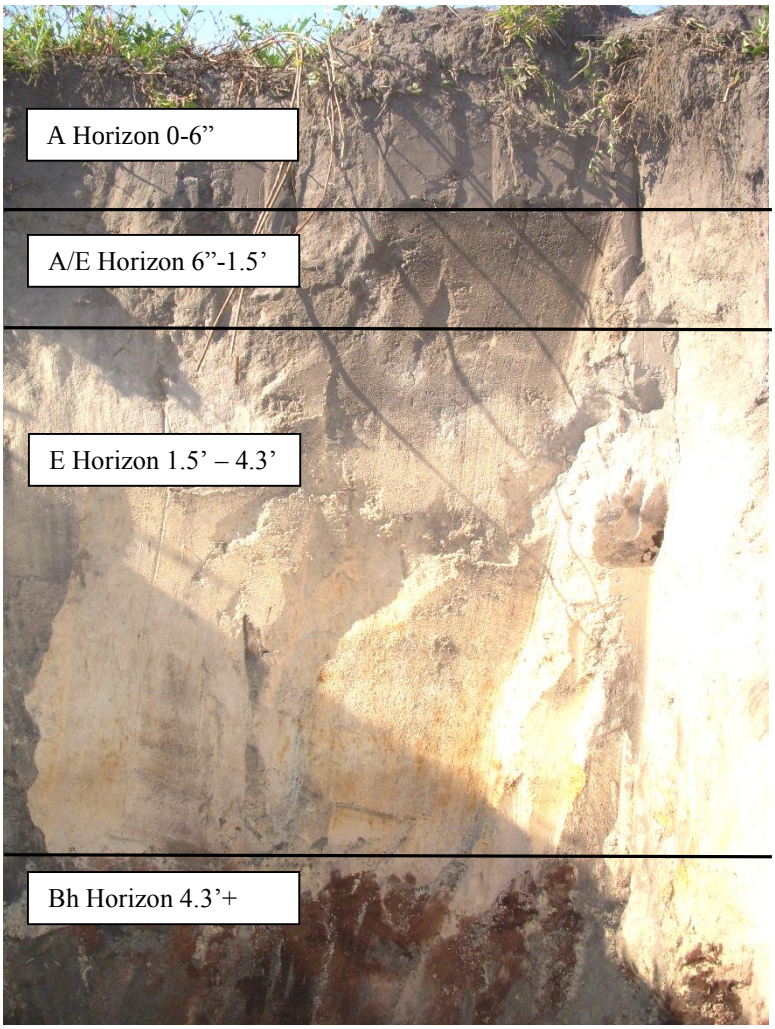

Figure 1
Soil pit which shows the soil profile morphology that characterizes the field site.

The layer below the E horizon is a layer of soil in the intermediate stages of development. This layer is known as the B horizon and is also the zone of illuviation where material leached from the overlying layers accumulates. Soil in this layer is predominantly mineral with lesser amounts of organic matter though in the case of Florida soils the darkly colored spodic layer may contain significant amounts of organic acids (Florida, 2012; Huang et al, 2012). The spodic layer is contained within the B horizon and forms as minerals dissolved by the action of organic acids and infiltration precipitate coating soil grains. Precipitation of soluble minerals within the B horizon may occur because of the changing redox conditions encountered at the water table interface or because of microbial degradation of organic chelates of mineral's (Huang et al, 2012). The soil pit and soil cores extracted during the installation of monitoring wells confirm the presence of the spodic layer throughout the field site.

The spodic layer has unique chemical and hydrologic properties that differentiate it from the rest of the soil profile. The spodic layer is an illuvial zone where soluble material from overlying horizon precipitates. The spodic layer within the area of the field site also has distinct physical features that differentiate it from the surrounding soil. The minerals that precipitate, coating the soil particles, cause this layer to have a well sorted characteristic. The space between sand grains in the spodic layer is partially filled by the minerals that precipitate, coating the sand grains, which gives this layer the well sorted characteristic. Because of this feature, it is expected that the spodic layer may have a hydraulic conductivity much less than the surrounding aquifer. Chemical and physical attributes of this layer do not appear to control the migration of nitrate within the surficial aquifer.

Two additional continuous soil cores were collected during the instrumentation of additional wells surrounding Test Area 3 for the third tracer test. The continuous soil cores were collected from the natural ground surface to 15 ft bgs to determine general soil properties (lithology, soil features, organic matter content, grain size, etc) at two locations: within the mini-mound through the north observation port at grid location C2 and southwest of the TA3 at grid location P5. The soil samples collected during the various stages of characterization were submitted to the University of Florida IFAS Analytical Services Laboratories and University of Florida SWS Mineralogy Core Laboratory for analysis. The complete soil data set is included in Appendix C.

4.0 Aquifer Testing

The aquifer system around west central Florida is characterized by a surficial aquifer separated from the lower Floridan aquifer by a confining unit (Schiffer et al, 1998). The confining unit, known as the Hawthorn group, is present throughout most of the state extending into southern Georgia and Alabama. The Hawthorn group is comprised of marine and land sediments deposited about 25 million years ago. The lower layers of the group are predominantly marine derived while the upper layers are sediments derived from land. The upper layers of this group are comprised mainly of clay that is impervious to water and thus forms a confining unit separating the surficial aquifer from the Floridan aquifer system. The Hawthorn group overlays a limestone bed rock though in some areas this layer is absent exposing the limestone below. This absence occurs along the Ocala Platform, north of Tampa Bay parallel to I-75 and the Sanford High, northeast of Orlando. The Hawthorn group is between 200 and 300 feet thick in the southeast corner of Hillsborough county where the GCREC facility is located (Scott, 1988).

The main geochemical feature of the Hawthorn group is the abundance of phosphate minerals. The occurrence of phosphate within the Hawthorn sediments is well known and has been exploited for some time. In 2001, Florida supplied 25 percent of the world's phosphate needs and 75 percent of the United States' needs (Hodges & Mulkey, 2003). Arsenic also occurs with phosphate in these sediments and has been implicate as the cause of high arsenic content in drinking water in some areas of Florida (Lazareva & Pichler, 2007). While the occurrence of these minerals can alter the chemistry of groundwater in the surficial aquifer there is no evidence of this occurring within the vicinity of the field site.

4.1 Measurement of Aquifer Parameters

Aquifer parameters are values that are used to describe the movement of groundwater within a model that represents the physical aquifer. Aquifer parameters may be physical characteristics that are visible with the eye and may be directly measured such as the hydraulic gradient, or intrinsic characteristics that are measured indirectly such as hydraulic conductivity.

Groundwater elevations were measured during several occasions to establish the temporal variation in hydraulic gradient and the direction of flow within the field site. The general direction of groundwater flow at GCREC is in a northeast to southwest direction (Appendix A). As previously discussed, the irrigation ditches that border the field site to the south and west may control the hydraulic gradient within the field site during cultivation of the adjacent field but did not appear to be controlling groundwater flow during the study period. The direction of groundwater flow seems to indicate that it is flowing in the direction

of Carlton Branch a small stream that drains to the Little Manatee River emptying into Tampa Bay.

Twenty four standpipe piezometers ranging in size from ¾-inch to 2-inch and screen lengths between 1-foot and 5-feet were installed downgradient of the GCREC mound for groundwater sampling purposes and to determine hydraulic conductivity of the aquifer. The piezometers vary in depth, some of which end at the confining Hawthorn layer. The hydraulic conductivity for the field site was primarily determined via slug tests.

4.2 Slug Test Analysis

Aquifer parameters obtained by means of slug tests should be considered carefully; because these tests are only capable of sampling aquifer properties in the immediate vicinity of the wells where the tests are being conducted, often this area is much smaller than that of pump tests (Fetter, 2001). Also, the assumptions that are inherent to any analytical solution for groundwater flow will affect the values obtained for aquifer parameters.

Hydraulic conductivity for the saturated zone beneath the GCREC mound and directly downgradient from it was inferred using the Bouwer and Rice method. Calculations were double checked using the Hvorslev method as quality control. The Bouwer and Rice and the Hvorslev method should be in relative agreement provided assumptions inherent to both analysis are correct. The hydraulic conductivity measurements obtained from these two methods was compared to literature values reported for aquifers with similar soil properties.

4.2.1 Hvorslev Slug-Test Analysis

The Hvorslev method is appropriate for wells that do not fully penetrate the aquifer, meaning the screen length is less than the aquifer thickness. This method is appropriate for either addition or withdrawal of water from the well. It is important prior to testing to know the well geometry and how it was installed. If the ratio of the screen length to the screen radius is greater the 8 then the governing equation given by Equation 1 applies (Hvorslev, 1951).

$$K = \frac{r^2 \ln\left(\frac{L_e}{R}\right)}{2L_e t_{37}} \tag{1}$$

where
K (cm/d) = hydraulic conductivity
r (cm) = radius of the well casing

L_e (cm) = length of the well screen
R (cm) = radius of the well screen
t_{37} (s) = time for water level to fall to 37% of the initial change.

The water level in the well is monitored before, during and after the displacement, either by addition or withdrawal, of some volume of water. The displacement at time t is divided by the initial maximum (H_t/H_o), and the continuous change in displacement is plotted with time until the water level in the well returns to its equilibrium level after the initial displacement.

The resultant plot should look similar to Figure 2 when plotted on a semi log plot. The value t_{37} is selected by reading the x axis when the ratio H_t/H_o equals 0.37. Equation 1 can then be solved for hydraulic conductivity. For the slug test data collected at the test facility site, it was assumed that the radius of the well screen was the radius of the tubing used for the well and the length of the well screen was the length of the slotted portion of the tubing. In situations where the well is installed in a low permeable material and a higher permeable material such as gravel is used to fill between the well screen and the bore wall, the screen length (L_e) becomes the length of the gravel pack and the radius of the well screen (R) becomes the radius of the bore hole (Fetter 2001). The wells at the test facility field site were installed using fine sand as backfill between the well casing and the bore wall. Because the backfill material is very similar to the native aquifer material, it was assumed that the radius of the well screen was the radius of the well casing and the length of the well screen was the length of the slotted portion of the well casing. Results from both the Hvorslev and Bouwer and Rice analysis are provided in Table 1.

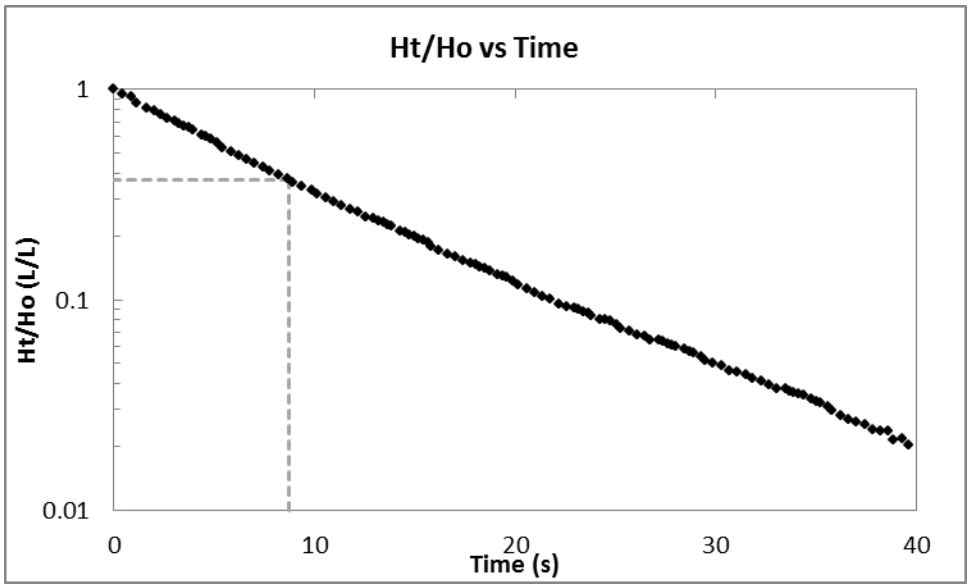

Figure 2
The figure used for the Hvorslev method to analyze slug test data. This figure represents the results from one slug test of well PZ19.

4.2.2 Bouwer and Rice Slug-Test Analysis

The Bouwer and Rice method provides an alternative analysis for slug tests which is useful for comparison with the Hvorslev method. It is anticipated that both methods will give values that are in relative agreement with each other. The Bouwer and Rice method uses a subset of the H_t/H_o vs Time data rather than a point value as the Hvorslev method does, which can help eliminate effects of the borehole fill. Equation 2 gives the hydraulic conductivity for wells that penetrate an unconfined aquifer (Bouwer & Rice, 1976).

$$K = \frac{r_c^2 \ln\left(\frac{R_e}{R}\right)}{2L_e} \cdot \frac{1}{t} \cdot \ln\left(\frac{H_o}{H_t}\right) \qquad (2)$$

where
K (cm/d) = hydraulic conductivity
r_c (cm) = radius of the well casing
R (cm) = Radius of the gravel envelop

R_e (cm) = radial distance over which the head is dissipated
L_e (cm) = length of the well screen
H_o (cm) = initial displacement of the water table at time t = 0
H_t (cm) = the displacement of the water table at time t = t
t (s) = time since H = H_o

Where $\ln\left(\frac{R_e}{R}\right)$ is given by Equation 3 for wells that are not screened over the entire length of the aquifer and by Equation 4 for wells that are screened over the entire length of the aquifer.

$$\ln\left(\frac{R_e}{R}\right) = \left[\frac{1.1}{\ln\left(\frac{L_w}{R}\right)} + \frac{A+B*\ln\left(\frac{h-L_w}{R}\right)}{\frac{L_e}{R}}\right]^{-1} \tag{3}$$

$$\ln\left(\frac{R_e}{R}\right) = \left[\frac{1.1}{\ln\left(\frac{L_w}{R}\right)} + \frac{C}{\frac{L_e}{R}}\right]^{-1} \tag{4}$$

Where A, B, and C are dimensionless numbers that were empirically derived and are given by the following equations (DeBisschop).

$$A = 1.638445671 + 0.166908063 * Log\left(\frac{L_e}{R}\right) + 0.000740459 * e^{\left(6.17105281*Log\left(\frac{L_e}{R}\right) - 1.054747686*\left(Log\left(\frac{L_e}{R}\right)\right)^2\right)} \quad (5)$$

$$B = 0.174811819 + 0.060056188 * Log\left(\frac{L_e}{R}\right) + 0.007965502 * e^{\left(2.053376868*Log\left(\frac{L_e}{R}\right) - 0.007790328*\left(Log\left(\frac{L_e}{R}\right)\right)^2\right)} \quad (6)$$

$$C = 0.074711376 + 1.083958569 * Log\left(\frac{L_e}{R}\right) + 0.00557352 * e^{2.929493814*Log\left(\frac{L_e}{R}\right) - 0.001028433*\left(Log\left(\frac{L_e}{R}\right)\right)^2} \quad (7)$$

Similar to the Hvorslev method, the Bower and Rice slug test analysis observes the time required for the water level in the well to return to its equilibrium level after the initial disturbance. The ratio of the displacement at time t to the initial (maximum) displacement is plotted versus time on a semi log plot. The plot will resemble that of Figure 3 if the hydraulic conductivity of the borehole fill is the same as the native aquifer material. The exponential rate constant used in Equation 1 given by the trendline fitted to the data gives the value of:

$$\frac{1}{t} \cdot \ln\left(\frac{H_o}{H_t}\right).$$

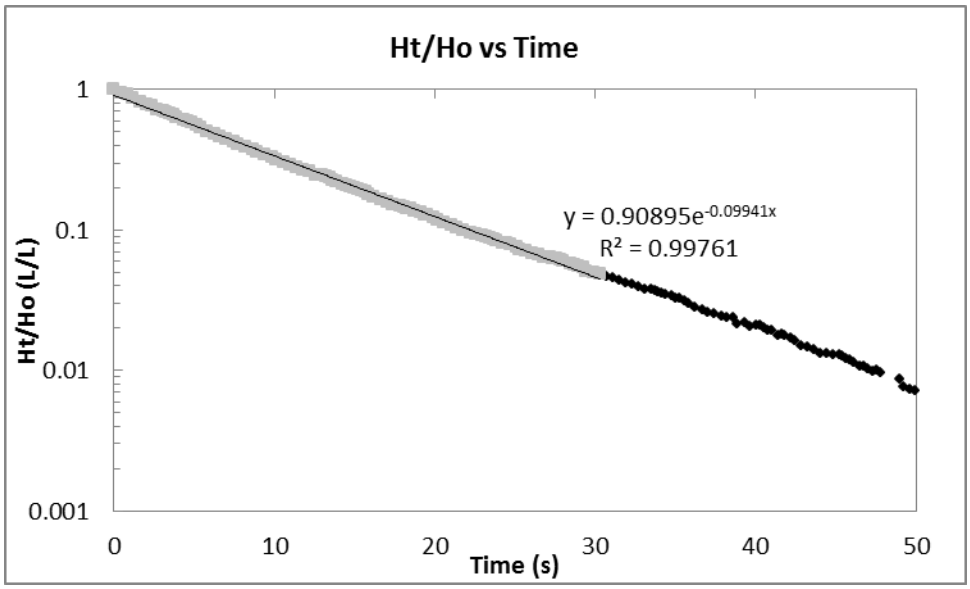

Figure 3
The figure used for the Bouwer and Rice method to analyze slug test data.
This figure represents the results from one slug test of well PZ19. The best fit curve to the linear portion of the data on the H_t/H_o vs Time plot gives the exponential rate constant used in Equation 2.

Wells may exhibit two distinct linear portions on the H_t/H_o vs Time plot due to a difference in hydraulic conductivity of the borehole fill. In this case, the second linear portion of the data should be used to determine the exponential rate constant used in Equation 2. It is also important to understand where the top of the well screen is in relation to the water table. During the analysis of the slug test data from the test facility site, it was noted that several wells had screens that were located at the water table or a little above the water table. Because the screen is not below the water table, a portion of the slug that is added to the well will flow into the unsaturated zone potentially distorting the hydraulic conductivity measurement.

4.2.3 Slug-Test Results

A total of 12 standpipe piezometers were tested, four 2-inch wells were initially tested in 2011 and an additional 8 wells ranging in size from ¾-inch to 2-inch were tested in 2013. The wells are located upgradient and downgradient and to the northwest of the GCREC mound. The hydraulic conductivity measured in this area ranges from a high of 83 ft/d at PZ24 to a low of 0.07 ft/d at PZ15. Table 1 summarizes all of the hydraulic conductivity

values calculated for the slug tests in 2011 and 2013. There is a notable discrepancy between the Bouwer & Rice value and the Hvorslev value for PZ03, PZ07, PZ08 and PZ15.

Figure 4 shows the Bouwer & Rice data used for analysis which has two distinct linear areas. It appears that the borehole fill has a relatively higher hydraulic conductivity than the aquifer material. After the slug is added, the water moves rapidly into the borehole fill, and as this area fills, the rate of decline in water level slows. The second linear portion of the graph represents the hydraulic properties of the aquifer rather than the borehole fill. The Hvorslev method assumes that aquifer properties can accurately be determined when the displacement of water level in the well reaches 37% of the initial displacement. Unfortunately, this value is reached in the first linear portion of H_t/H_o vs Time which represents the hydraulic conductivity of the borehole fill rather than the aquifer. Therefore, the hydraulic conductivity calculated using the Hvorslev method is incorrect. The wells at the field site were installed by hand, Geoprobe™ or a drill rig. Wells that were installed by hand are affected by the difference in hydraulic conductivity of the borehole fill whereas wells installed by either the Geoprobe™ or drill rig do not display this phenomenon.

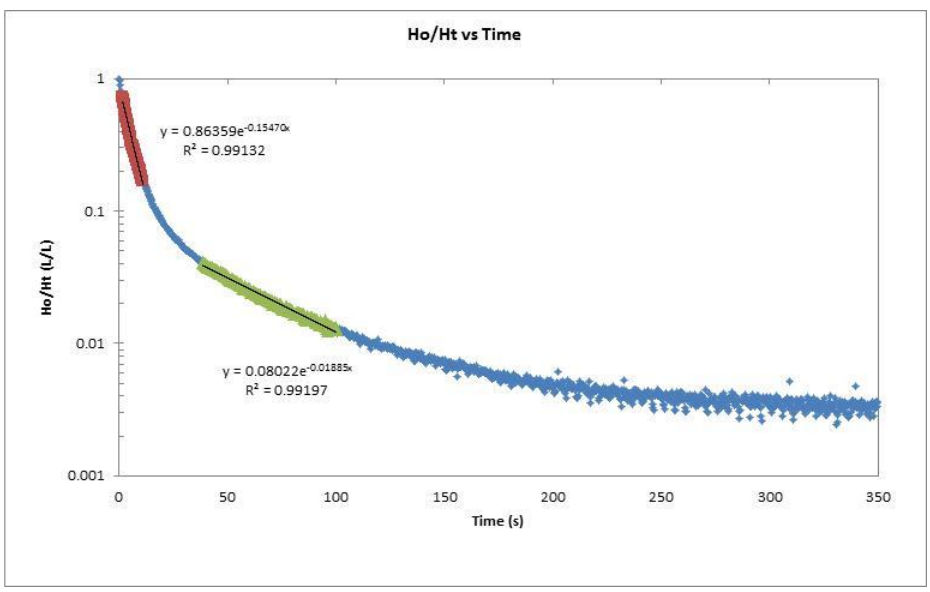

Figure 4
Bouwer & Rice slug test data for PZ08 displays the effect that the borehole fill can have on the calculated hydraulic conductivity. The lower portion of the curve is the correct portion to use to determine aquifer properties.

Wells PZ19, PZ21, PZ23 and PZ24 were tested multiple times giving a range of values for hydraulic conductivity. The remaining wells were tested only once due to time constraints and weather. The data from the wells that were tested multiple times illustrate the variability in the computed hydraulic conductivities at a single location. Table 2 gives the hydraulic conductivity values calculated from the replicate slug tests at the four wells. The difference between the mean and median, for the four wells, indicates that the actual hydraulic conductivity is likely not the average that was calculated. The difference between the mean and median for PZ21 and PZ23 is small enough that it can reasonably be assumed that that the actual hydraulic conductivity is very close to the calculated average. An increase in hydraulic conductivity increases the uncertainty in the calculated value. PZ24 has the largest calculated values of hydraulic conductivity, the largest standard deviation, and the largest difference between the median and average. This is due in part to difficulties with adding the slug to the well in an instantaneous manner. Because of the high hydraulic conductivity of PZ24, the water level in the well did not reach a well-defined peak as it should have. The rate at which the slug was added to the well was too low, due to the diameter of the well, to create the instantaneous peak that was needed. The remaining wells that were tested only once, all had low relative hydraulic conductivities that allowed for nearly instantaneous addition of the slug to the well. The true hydraulic conductivity for these wells is thus reasonably represented by the one value.

Figure 5 is one of the many possible hydraulic conductivity fields that control flow through and beyond the STU of the facility OWTS. Hydraulic conductivity values were assigned to areas that were not tested by interpolating measured values via kriging. The process of interpolation assumes that the values at a particular location are more closely related to surrounding locations then distant locations. There are several interpolation functions that can be used but kriging is generally accepted as common practice for geologic properties. The correlation between values at two points and their distance apart is calculated then plotted, the resultant plot is known as a semi variogram. There are several semi variogram models that may fit the plotted data but two of the most common models that accurately fit geologic data are the spherical and exponential variograms. The kriging algorithm assigns values to new locations using the semi variogram model that was chosen by minimizing the variance of the kriged values (Goovaerts, 1997). The hydraulic conductivity field for the field site was created with a spherical semi variogram using the method described above. There are many equally possible fields that can be produced using the spherical semi variogram that all have an equally low variance. While the hydraulic conductivity field in Figure 5 is not unique, it does give some idea of the flow regime within the field site.

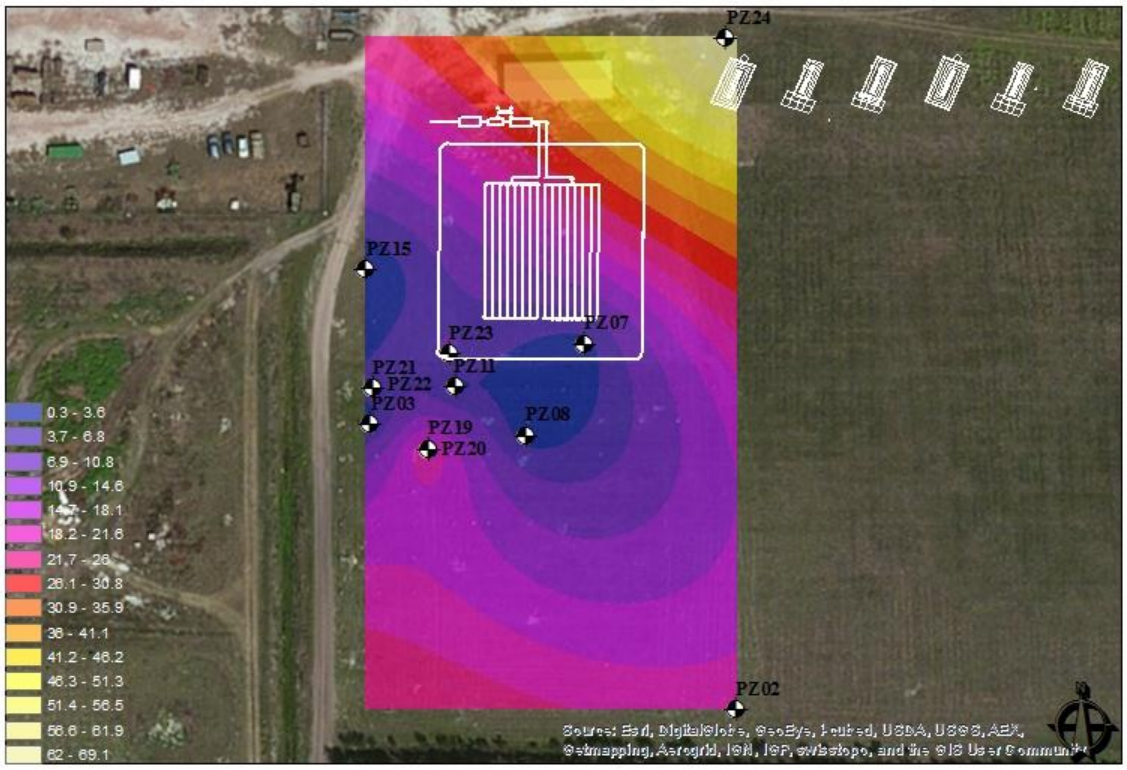

Figure 5
One of many possible hydraulic conductivity fields computed using the Kriging interpolation method with a spherical semi variogram model. Values in ft/day.

Table 1
Calculated hydraulic conductivities at test facility

ID	Test#	Date	BouwerRice[1] (ft/d)	Hvorslev[1] (ft/d)
PZ08	1	7/12/2013	2.02	33.60
PZ11	1	7/12/2013	2.78	4.13
PZ15	1	7/12/2013	0.28	3.67
PZ15	2	7/12/2013	0.07	8.72
PZ19	2	10/20/2011	25.90	32.32
PZ19	4	10/20/2011	25.79	27.76
PZ19	1	10/20/2011	25.12	26.76
PZ19	3	10/20/2011	24.21	28.24
PZ19	1	10/14/2011	23.84	27.30
PZ19	4	10/14/2011	22.74	26.27
PZ19	3	10/14/2011	21.06	29.78
PZ19	4	10/12/2011	21.00	21.84
PZ19	3	10/12/2011	19.42	16.65
PZ19	2	10/12/2011	18.44	18.20
PZ19	2	10/14/2011	18.10	27.92
PZ19	1	10/12/2011	12.47	28.90
PZ20	1	7/12/2013	2.33	3.14
PZ21	4	10/19/2011	5.25	5.78
PZ21	3	10/19/2011	5.25	5.71
PZ21	1	10/19/2011	5.18	5.37
PZ21	2	10/14/2011	5.13	5.48
PZ21	3	10/14/2011	4.95	5.29
PZ21	2	10/19/2011	4.93	5.85
PZ21	1	10/14/2011	4.82	5.11
PZ21	2	10/12/2011	4.43	3.39
PZ21	3	10/12/2011	4.23	3.37
PZ21	4	10/12/2011	4.21	3.61
PZ21	1	10/12/2011	3.85	2.95
PZ02	1	7/12/2013	20.49	36.18
PZ03	1	7/12/2013	2.12	30.47
PZ07	1	7/12/2013	2.32	28.25
PZ22	1	7/12/2013	5.81	6.47
PZ23	6	7/12/2013	10.46	11.47

Table 1 (continued)
Calculated hydraulic conductivities at test facility

ID	Test#	Date	BouwerRice[1] (ft/d)	Hvorslev[1] (ft/d)
PZ23	4	10/14/2011	8.39	9.24
PZ23	2	10/20/2011	8.19	9.80
PZ23	1	10/14/2011	7.80	9.90
PZ23	3	10/14/2011	7.71	9.39
PZ23	1	10/20/2011	7.67	9.95
PZ23	1	10/12/2011	7.59	9.54
PZ23	4	10/12/2011	7.51	9.00
PZ23	5	10/12/2011	7.49	8.95
PZ23	3	10/12/2011	7.47	9.14
PZ23	4	10/20/2011	7.27	9.19
PZ23	2	10/12/2011	7.15	9.33
PZ23	3	10/20/2011	7.13	9.88
PZ23	2	10/14/2011	6.39	9.88
PZ24	2	10/20/2011	82.98	98.77
PZ24	2	10/13/2011	82.34	27.60
PZ24	4	10/13/2011	81.69	32.40
PZ24	3	10/20/2011	79.16	54.63
PZ24	4	10/20/2011	77.63	70.69
PZ24	1	10/20/2011	74.05	69.41
PZ24	5	7/11/2013	69.23	58.05
PZ24	6	7/11/2013	64.94	43.41
PZ24	1	10/13/2011	54.03	44.67
PZ24	3	10/13/2011	25.71	65.51

[1]*The large discrepancy between the Bouwer & Rice and Hvorslev hydraulic conductivities is due to the difference in hydraulic conductivity of the borehole fill for wells installed by hand. The Bouwer & Rice calculated hydraulic conductivities are the best representative values for this aquifer.*

Table 2
Hydraulic conductivities from replicate slug tests at four wells

	PZ19	PZ21	PZ23	PZ24[1]
ft/day	ft/day	ft/day	ft/day	ft/day
Day 1	25.12	5.18	7.80	74.05
	23.84	4.82	7.67	54.03
	12.47	3.85	7.59	-
Day 2	25.90	5.13	8.19	82.98
	18.44	4.93	7.15	82.34
	18.10	4.43	6.39	-
Day 3	24.21	5.25	7.71	79.16
	21.06	4.95	7.47	25.71
	19.42	4.23	7.13	-
Day 4	25.79	5.25	8.39	81.69
	22.74	4.21	7.51	77.63
	21.00	-	7.27	-
Day 5	-	-	7.49	69.23
	-	-	10.46	64.94
Mean	21.51	4.75	7.73	69.17
Median	21.90	4.93	7.55	75.84
std dev	3.96	0.49	0.92	17.80

[1]*The large hydraulic conductivity values lead to larger standard deviations and PZ24 values are likely affected by the inability of adding the slug quickly enough.*

4.3 Tracer Test Analysis

Tracer testing is a means for characterizing expected travel direction, times and uniformity of flow by injecting a chemical compound into the subsurface. It is an indirect method as aquifer properties are inferred from an observed behavior that is compared with a mathematical model. It follows that the test results are not unique, i.e. different aquifer descriptions can result in a given tracer test result. The most direct method for groundwater velocity determination was used which consisted of introducing a tracer at one point in the flow field and observing its arrival at other points.

Three separate tracer tests were conducted at GCREC in April 2011, November 2011 and February 2014. The tracer tests were conducted at three separate locations: southeast of the GCREC mound, adjacent to the GCREC S&GW test facility, and lastly within the

S&GW test facility Test Area 3 (TA3). Tracer test summaries were presented previously in Task C.15 documents, and a summary is presented here.

Various analytical methods are available for calculating the average interstitial velocity of groundwater flow. One approach in calculating the horizontal velocity is the empirical method where the distance is divided by the time of peak concentration occurrence. The saturated hydraulic conductivity, K_{sat}, can also be estimated from the tracer results using Darcy's law as follows:

$$v = \frac{K_{sat} * gradient}{n_e}, \text{ solving for } K_{sat} \quad (8)$$

$$K_{sat} = \frac{v * n_e}{gradient} \quad (9)$$

where:

v = groundwater velocity

K_{sat} = saturated hydraulic conductivity

n_e = effective porosity.

4.3.1 Tracer Test No. 1 Analysis

The first tracer test was conducted by delivering tracer solution to an open-air trench that was positioned perpendicular to the groundwater flow in soils representative of the area where the existing GCREC mound nitrogen plume is located. The trench was 5 feet long (perpendicular to flow) and 1 foot wide. Drive point samplers were installed beneath the trench and in several rows downgradient of the trench at 1-foot, 2-feet, 4-feet and 5-feet from the edge of the trench (see Figure 6). Significant rain during the beginning of the tracer test and a significant drop in groundwater elevation towards the end of the test contributed to varying shapes in breakthrough curves for the monitoring locations. Mound tracer test breakthrough curves are provided for three locations at the 2-foot row (T-2-1), 4-foot row (T-4-2.5) and 5-foot row (T-5-4) of drive points (Figure 7). An additional deeper drive point (T-4-2) adjacent to the 4-foot row (T-4-2.5) drive point was installed to allow continuation of sample collection following the drop in groundwater elevation to below the T-4-2.5 drive point elevation.

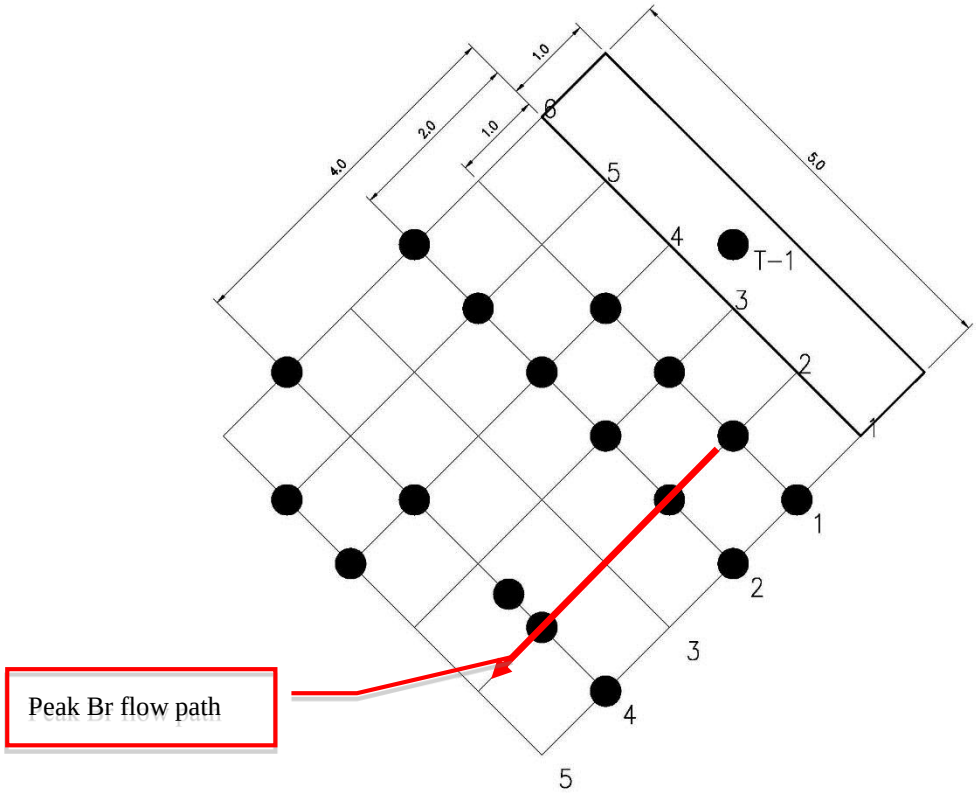

Figure 6
Tracer Test No. 1 GCREC Mound tracer test area. The black dots depict the locations of the drive points.

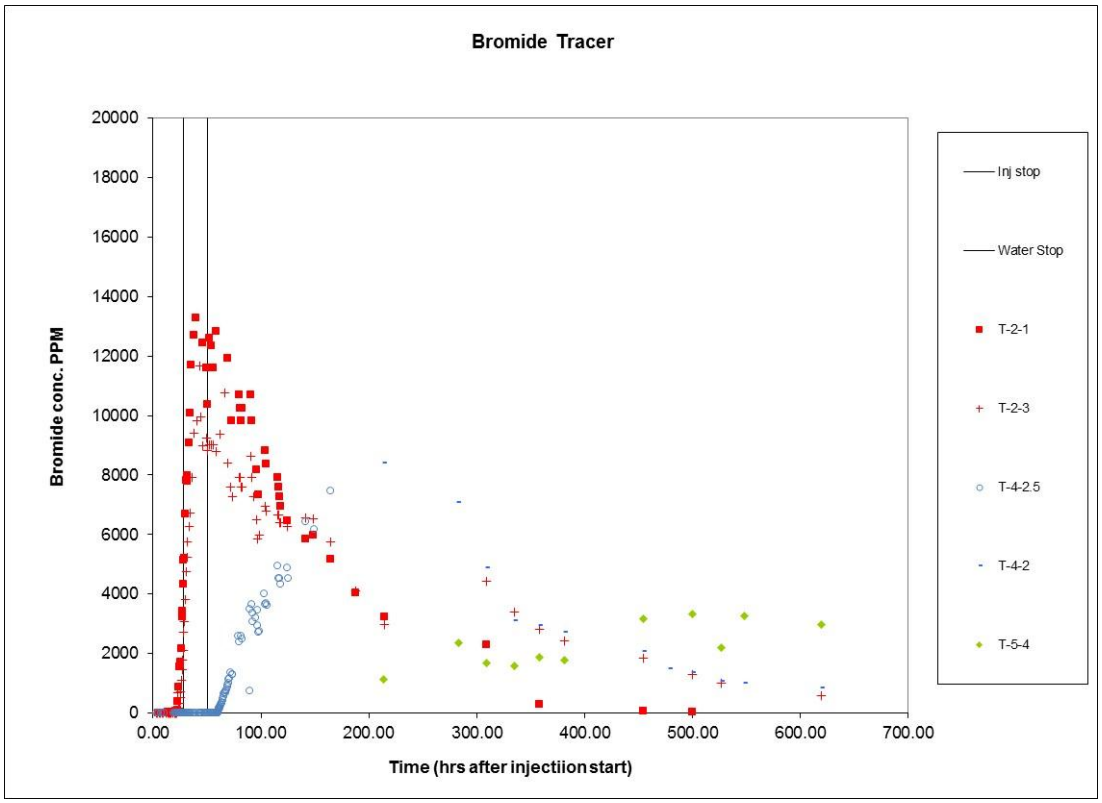

Figure 7
Tracer Test No. 1 GCREC Mound
Breakthrough curves

The groundwater velocity calculated by the empirical method using the peak breakthrough curves from location T-2-1 to T-4-2 was 0.28 ft per day during the first tracer test. Using the groundwater velocity determined from the breakthrough curve data, the average hydraulic gradient across the tracer test area (0.0079) at the start of the test, and an estimated effective porosity of 33%; the estimated saturated hydraulic conductivity is 11.5 ft per day. Table 3 summarizes the first tracer test calculated velocity and hydraulic conductivity (Ksat).

Table 3
Tracer Test No. 1 Groundwater Velocity using Empirical Method

Peak to Peak Ids	X, distance (ft)	Peak concentration occurred (days between peaks)	Velocity m/day [ft/day]	Ksat m/day [ft/day]
T-2-1 → T-4-2	2	7.25	0.0841 [0.2760]	3.496 [11.469]

4.3.2 Tracer Test No. 2 Analysis

The second tracer test was conducted adjacent to the S&GW test facility in soils representative of the S&GW test facility research area, but in an area that would not interfere with monitoring of the S&GW test area plumes. The tracer solution was delivered to a drip irrigation bed oriented roughly parallel to the groundwater flow. The tracer dose area was equivalent in size to one-third of the infiltrative area of the S&GW pilot-scale test areas (20-ft by 2-ft). The dose area was therefore approximately 6.67 ft long (parallel to flow) and 2 ft wide (perpendicular to flow). Four pressure compensating drip tubing lines were placed directly on the natural ground surface. The drip lines were covered with approximately a 4-in layer of sand. The drip lines were arranged with 8-in spacing between the lines and a 2-ft interval between drip emitters. A 1 ft by 1 ft sampling grid for groundwater screening was developed downgradient of the tracer dose area (Figure 8). Transect lines Row 0 through Row 12 are parallel to the southern edge of the area and increase (higher number identification) moving southward from the dose area. Transect lines A through P (from east to west) are perpendicular to the southern edge of the dose area.

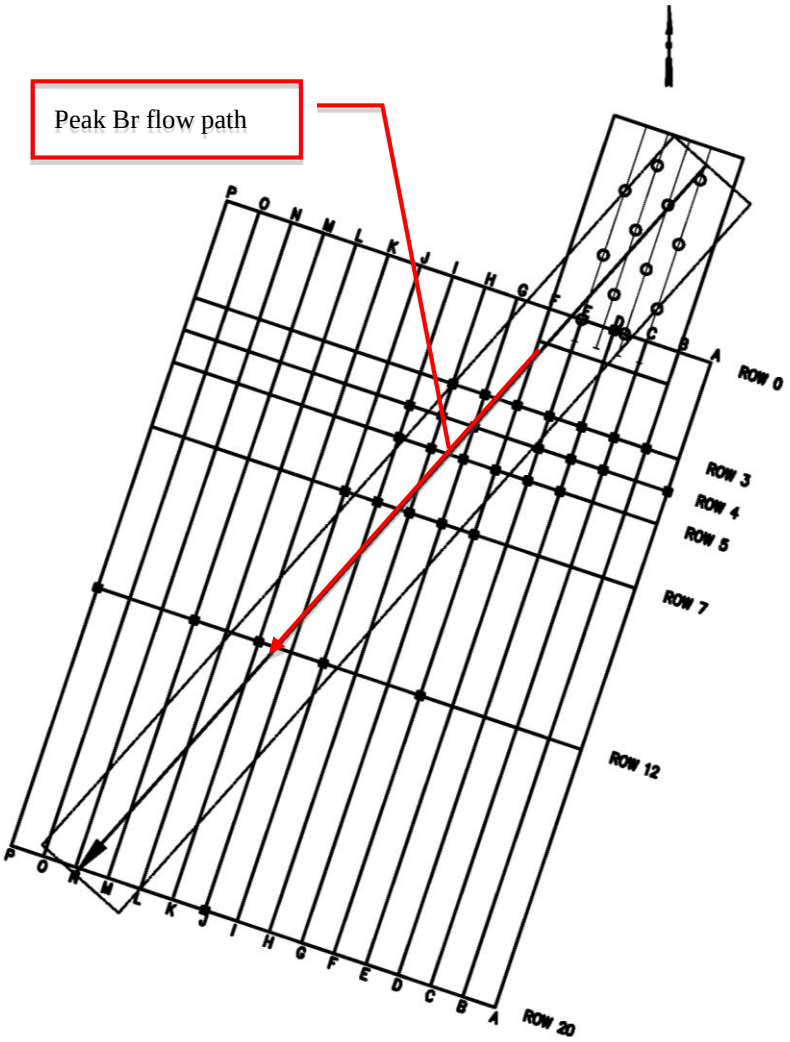

Figure 8
Tracer Test No. 2 S&GW Test Facility tracer test area. The black dots depict the locations of the monitoring wells.

Similar to the first tracer test, breakthrough curves were generated for downgradient monitoring points. However for the second test, standpipe piezometers (groundwater wells)

were installed rather than drive points to accommodate a submersible water quality sensor datalogger (AquiStar TempHion smart sensor). Three submersible sensors were installed within various wells to continuously record the bromide concentration which provided better breakthrough curves as compared to the first test.

Breakthrough curves were generated for both the unsaturated and saturated zone transport. An analysis of the initial bromide datalogger data at location 0D provides an opportunity to evaluate the unsaturated zone travel time since this monitoring point was directly below an emitter. Figure 9 is the breakthrough curve generated for this location (0D). The bromide tracer breakthrough (103 ppm Br) started approximately 180 hours after the initial tracer dose. The peak bromide concentration (1,192 ppm Br) occurred 308 hours after the tracer dosing (Figure 9). At the start of the test, the groundwater elevation was approximately five feet below the natural grade. Therefore, the unsaturated zone travel time was approximately 0.4 to 0.7 ft per day under the hydraulic loading conditions studied.

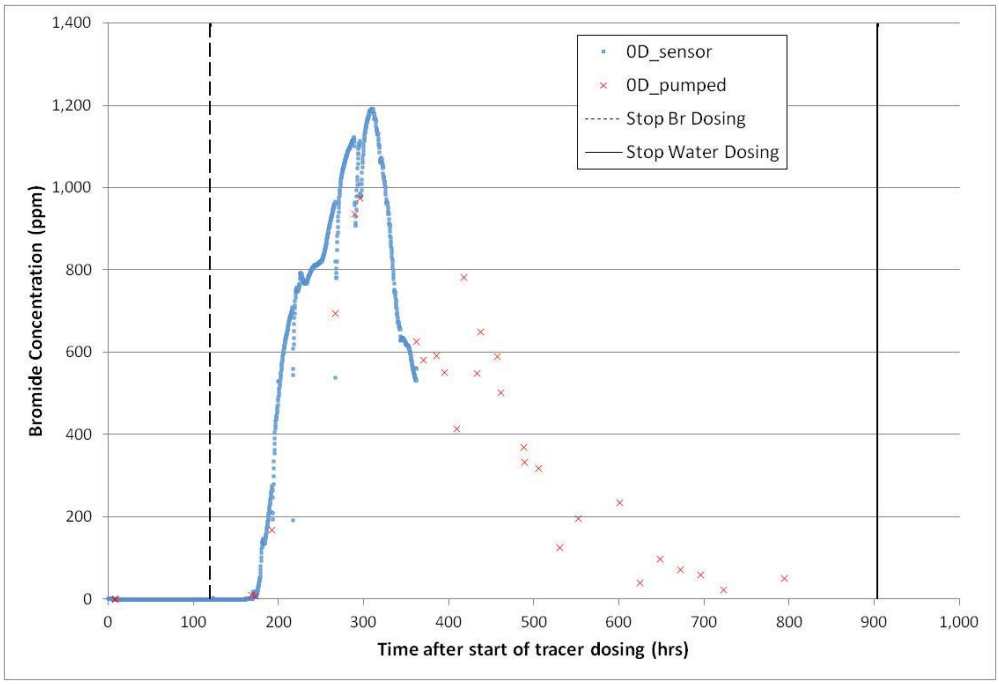

Figure 9
Tracer Test No. 2 S&GW Test Facility
Breakthrough curve for unsaturated zone

Tracer test breakthrough curves are provided in Figure 10 for five additional downgradient locations at the 5-foot row (5H), 7-foot row (7I) and 12-foot row (12I,12K and 12M). During the 62-day period of bromide monitoring, the bromide plume moved horizontally away from the dosing area a distance of over 15 ft. The velocity ranged from 0.21 to 0.31 ft per day with a median value of 0.258 ft per day as summarized in Table 4. The velocity data showed that the groundwater flow was faster near the source during dosing of tracer solution and water which is most likely attributed to a slightly increased gradient during dosing. Therefore, the further downgradient values are likely most representative of natural groundwater flow conditions at the time of the tracer test.

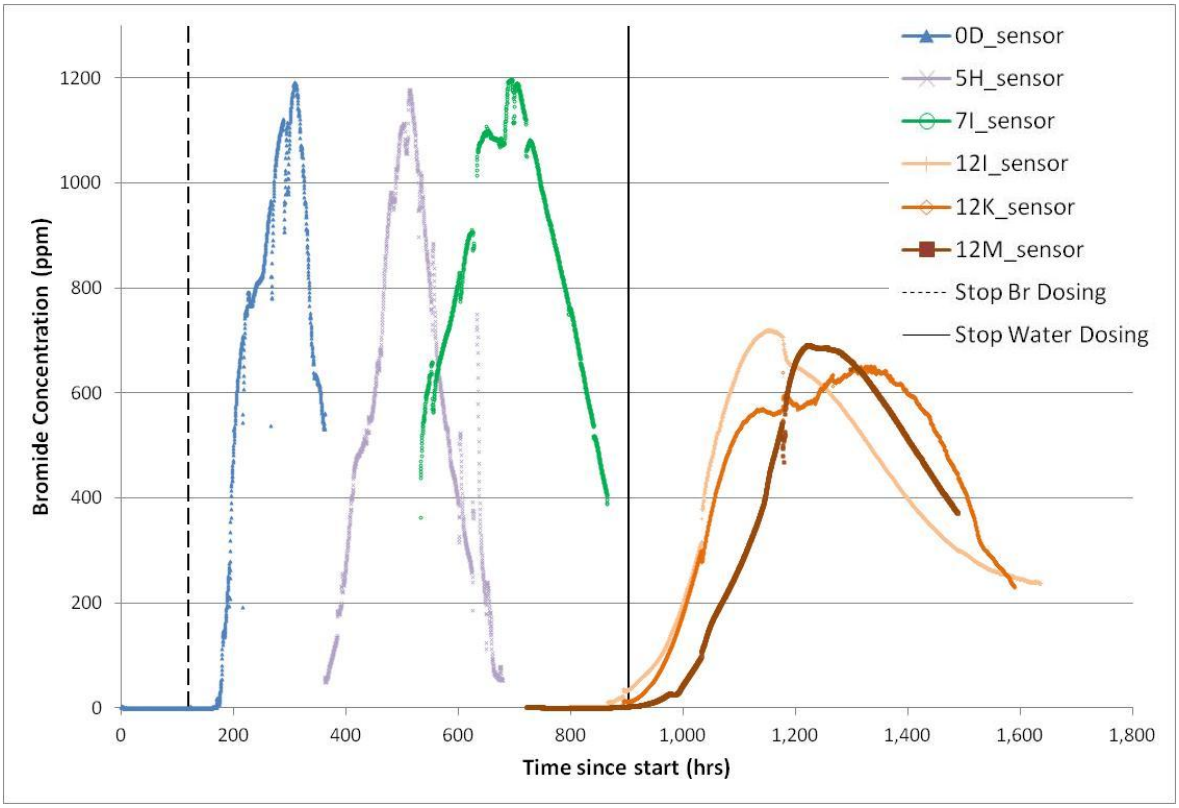

Figure 10
Tracer Test No. 2 S&GW Test Facility
Breakthrough curves for the saturated zone

Table 4
Tracer Test No. 2 Groundwater Velocity using Empirical Method

Peak to Peak Well Ids	X, distance (ft)	Peak concentration occurred (days between peaks)	Velocity m/day [ft/day]	Ksat m/day [ft/day]
0D→12K	13.06	42.00	0.0948 [0.3110]	4.167 [13.671]
5H→7I	2.17	7.52	0.0880 [0.2887]	3.869 [12.694]
5H→12K	7.61	33.48	0.0693 [0.2273]	3.046 [9.993]
7I→12K	5.44	25.97	0.0639 [0.2095]	2.807 [9.211]
Median			0.0786 [0.2580]	3.458 [11.344]
Range			0.06-0.095 [0.21 – 0.31]	2.81-4.17 [9.2-13.7]

[1]Peak flow path generally follows 5H → 7I→ 12K

4.3.3 Tracer Test No. 3 Analysis

The third tracer test was conducted within Test Area 3 of the S&GW test facility. After 650 experimental days of operation, the tracer solution was prepared in the STE dose tank, and the dose pump that was used throughout the S&GW test facility study period was used to deliver the tracer solution to the three STE test areas (TA1, TA3, and TA5). All three test areas were dosed tracer solution to ensure that the hydraulic loading was consistent with the study period; however only TA3 was monitored and results reported.

Breakthrough curves were generated for both the unsaturated and saturated zone transport. Soil moisture samples from the three TA3 southern suction lysimeters LY12S, LY24S, and LY42S provided an opportunity to evaluate the unsaturated zone travel time (Figure 11). Figure 12 depicts the breakthrough curves generated for these three locations. The shallowest lysimeter (LY12S) is located at the mound sand and native soil interface which is 0.3 m (12 in) below the infiltrative surface. The maximum or peak concentration of bromide in LY12S (580 ppm Br) occurred 5.8 days (138 hours) after initial input of bromide. The lysimeter located 0.3 m (12 in) into the native soil (LY24S) peak bromide concentration (590 ppm Br) occurred 162 hours after initial input of bromide. The deepest lysimeter 0.76 m (30 in) into the native soil (LY42S) peak bromide concentration (395 ppm Br) occurred 257 hours after initial input of bromide. Using the median peak

bromide unsaturated zone travel time obtained during this test, the estimated unsaturated zone flow rate was 0.090 m/day (0.296 ft/day) as summarized in Table 5.

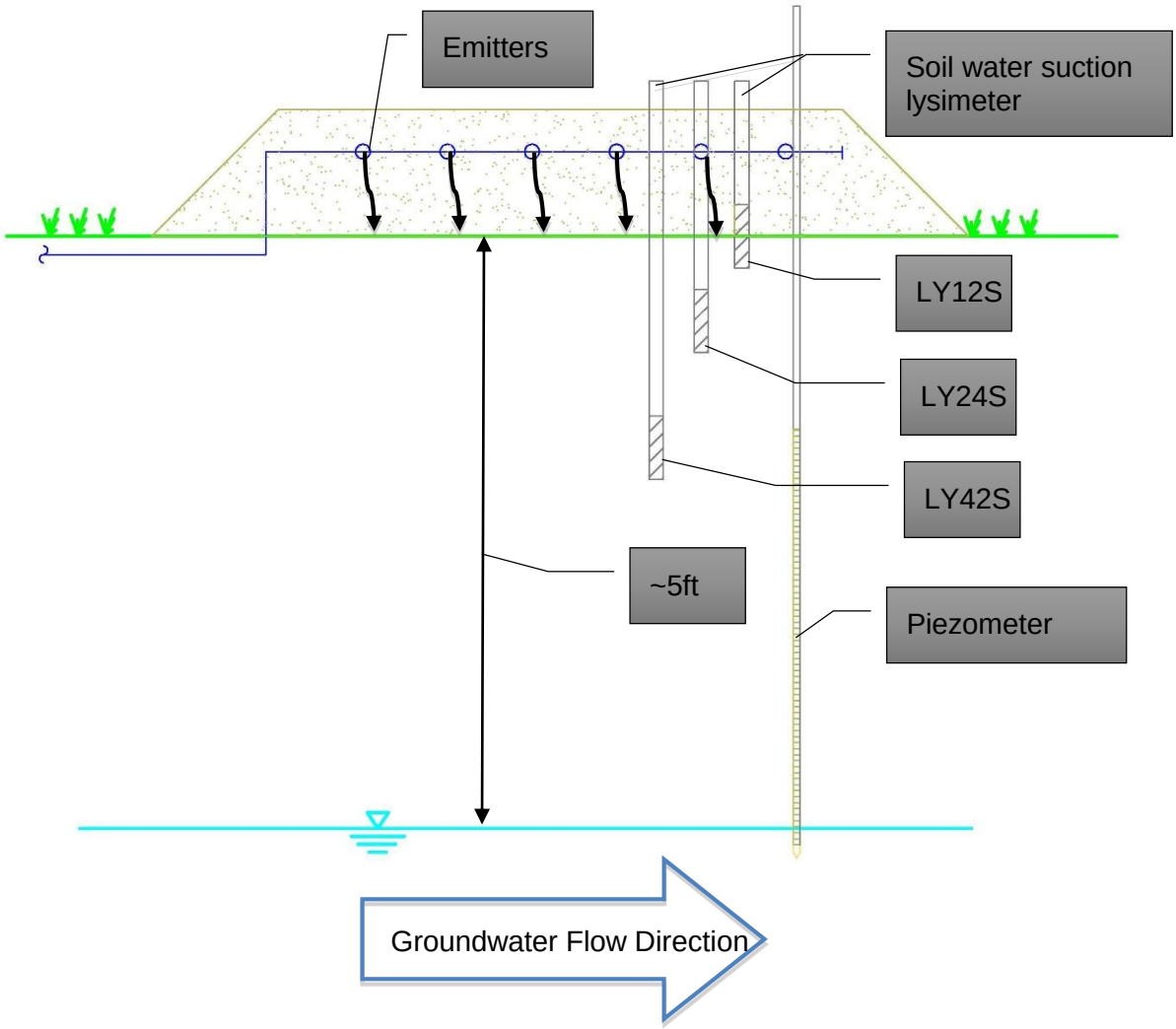

Figure 11
Test Area 3 Cross Section

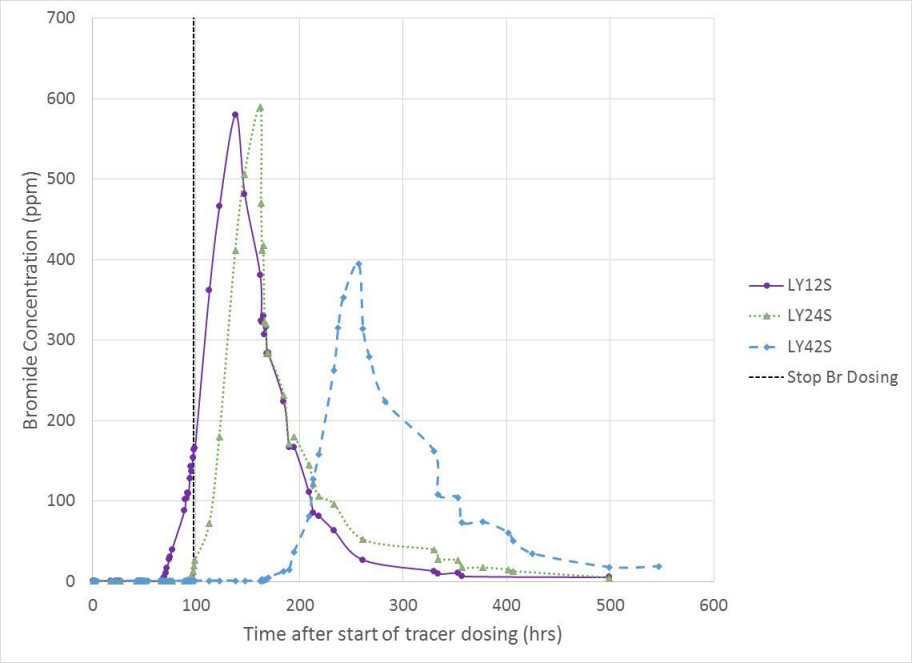

Figure 12
Tracer Test No. 3 TA3, S&GW Test Facility
Breakthrough curves for the unsaturated zone

Table 5
Tracer Test No. 3 Unsaturated Zone Travel Time

	Distance (L)	Time since start (t)		Br- conc	Velocity (Va)	Velocity (Va)
	m	hours	days	ppm	m/day	ft/day
LY12S	0.3	138.3	5.8	580.0	0.053	0.174
LY24S	0.6	162.0	6.8	590.0	0.090	0.296
LY42S	1.07	257.2	10.7	394.7	0.100	0.327
Range					0.05-0.10	0.17-0.33
Median					0.090	0.296

A 2 ft by 2 ft sampling grid for groundwater screening was developed downgradient of TA3 (Figure 13). Transect lines A through T are parallel to the northern edge of the mound and increase (higher letter identification) moving southward from the mound. Transect lines 4' through 16 (numbered from east to west) are perpendicular to the northern edge of the mound. Similar to the second tracer test, six submersible bromide sensors were installed within various downgradient groundwater wells to continuously record the bromide concentration which provided better breakthrough curves as compared to the first test. Breakthrough curves were generated for each of the wells where a datalogging sensor was installed. However, the tracer did not travel in the downgradient direction that was expected, it traveled in a more westerly direction. Some of the groundwater elevation measurements over the course of the study indicated that this direction was possible, but the vast majority of elevation data showed a more southwest flow direction. Because of the unexpected flow direction, bromide data was limited to fewer of the wells available for monitoring.

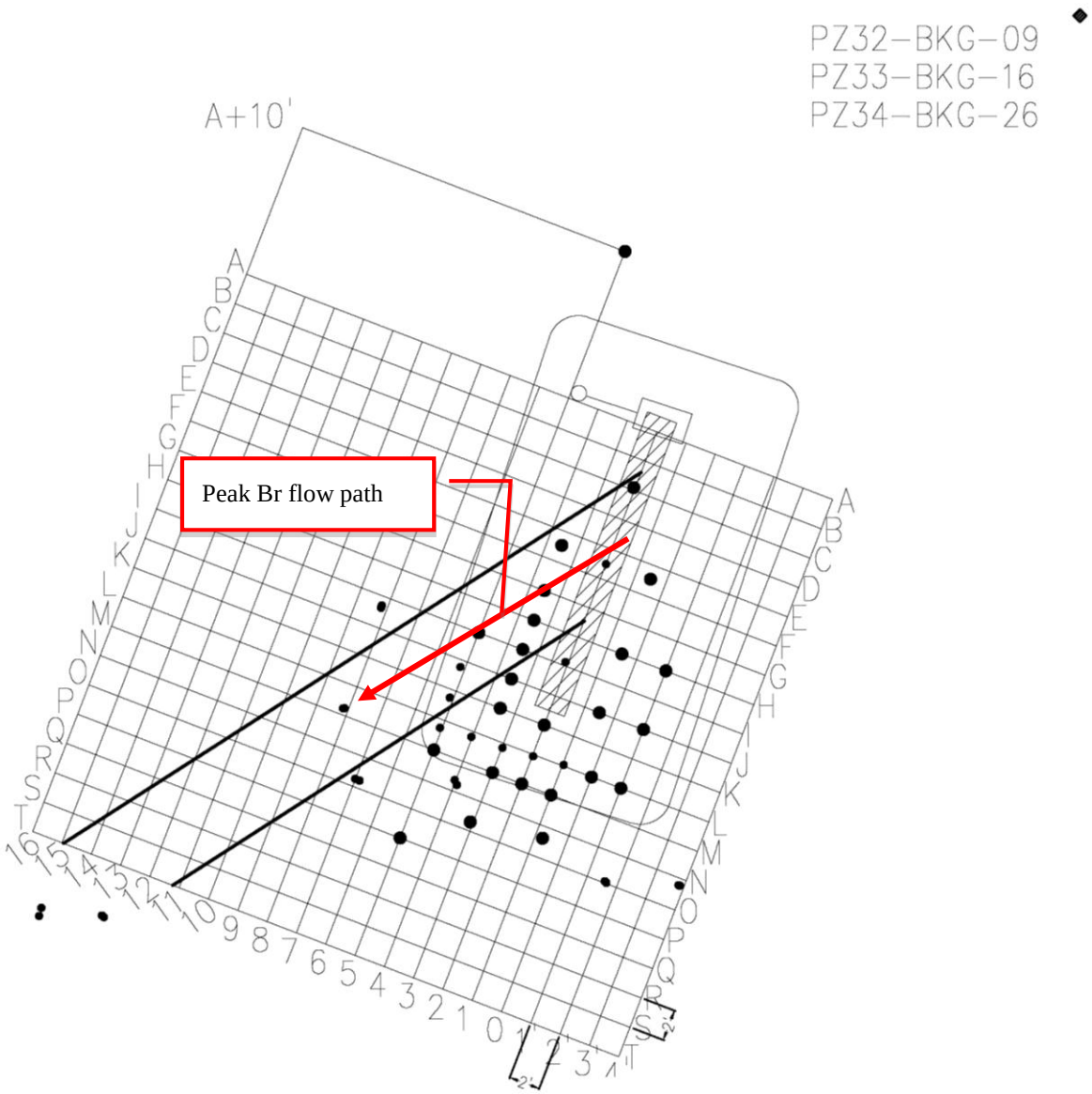

Figure 13
Tracer Test No. 3 S&GW Test Facility Test Area 3. The black dots depict the locations of the monitoring wells.

Figure 14 illustrates the curves at the two downgradient locations approximately 1.52 m (5 ft) apart (G3.5 and I5) where the peak bromide concentration was measured. During the 112-day period of bromide monitoring, the bromide plume moved horizontally away from the dosing area a distance of over 3 m (10 ft). The average groundwater seepage velocity immediately downgradient of the infiltrative surface was 1.5 m (4.96 ft) in 24.562 days, or approximately 0.0616 m/day (0.2019 ft/day) as summarized in Table 6.

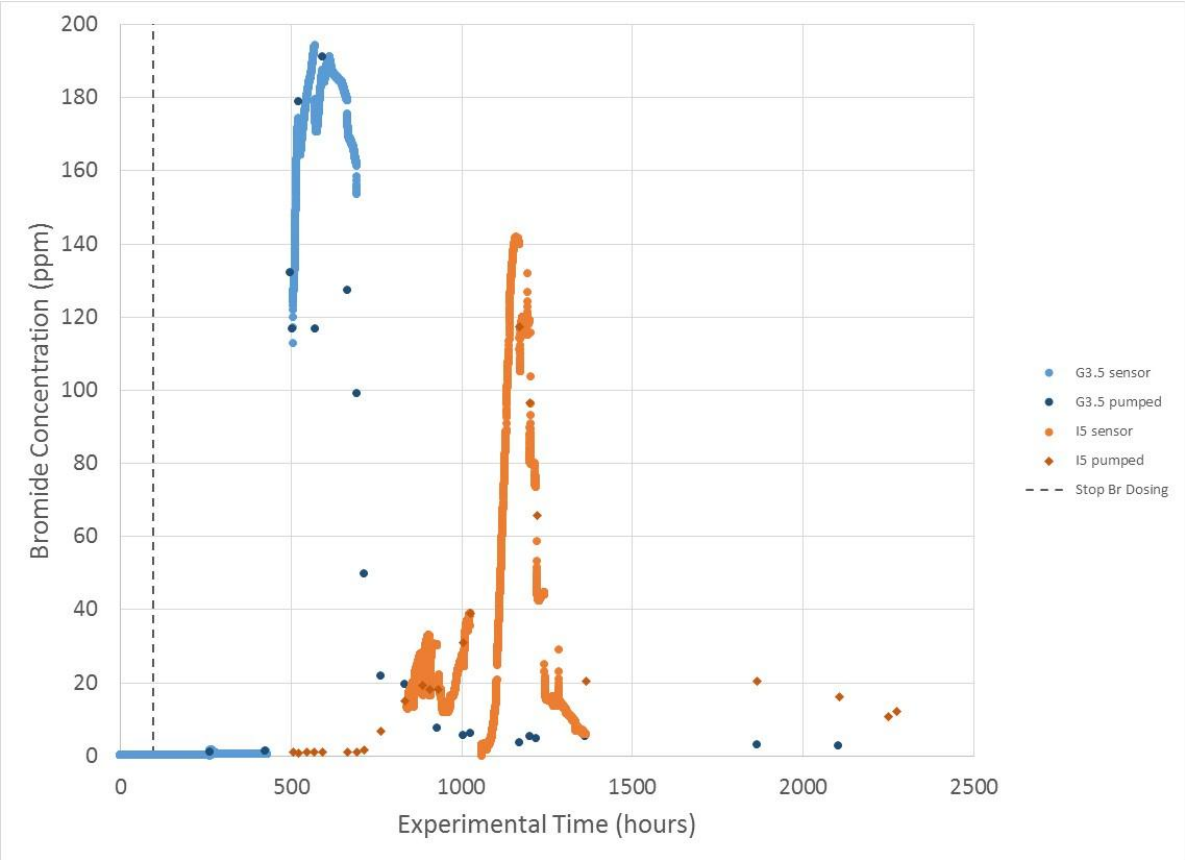

Figure 14
Tracer Test No. 3 TA3, S&GW Test Facility
Breakthrough curves for the saturated zone

Table 6
Tracer Test No. 3 Groundwater Velocity using Empirical Method

Peak to Peak Well Ids	X, distance (ft)	Peak concentration occurred (days between peaks)	Velocity m/day [ft/day]	Ksat m/day [ft/day]
G3.5→I5	4.96	24.56	0.0615 [0.2019]	1.296 [4.251]

4.3.4 Tracer Test Results

The results from the three tracer tests are summarized in Table 7.

Table 7
Tracer Test Results

	Velocity Range		Median Velocity		Median Ksat	
	m/d	ft/d	m/d	ft/d	m/d	ft/d
Unsaturated Zone						
Tracer Test No. 2	0.119-0.204	0.39-0.67				
Tracer Test No. 3	0.053-0.100	0.17-0.33	0.090	0.296		
Saturated Zone						
Tracer Test No. 1			0.084	0.2760	3.496	11.469
Tracer Test No. 2	0.064-0.095	0.21-0.31	0.078	0.2580	3.458	11.344
Tracer Test No. 3			0.062	0.2019	1.296	4.251

Results from the first tracer test indicate a relatively high velocity and associated high saturated hydraulic conductivity. Significant rain during the beginning of the tracer test and a significant drop in groundwater elevation towards the end of the test contributed to varying shapes in breakthrough curves for the monitoring locations. The second test provided better groundwater breakthrough curves which was largely attributed to the use of submersible sensors installed within downgradient groundwater wells to continuously record the bromide. An unsaturated zone velocity was estimated during the second tracer test using the data obtained from one well installed directly below an emitter. The third tracer test provided better unsaturated breakthrough curves by monitoring the suction lysimeters installed at three depths. However, the tracer did not travel in the anticipated downgradient groundwater direction which limited the amount of groundwater bromide data collected.

5.0 Monitoring Plan

A monitoring network was developed for each of the S&GW Test Facility test areas as depicted in Figures 15 and 16. Transect lines A through U are parallel to the northern edge of the mound and increase (higher letter identification) moving southward from the mound. Transect lines 0 through 21 (numbered from east to west) are perpendicular to the northern edge of the mound. Groundwater monitoring points were installed in November 2011, March 2012, May 2012, October 2012, and October 2013. Standpipe piezometers were installed using either hand or drilling methods. Standpipe piezometers consist of either ¾-in., 1-in., or 2-in. diameter PVC with 1-ft, 2.5-ft, 5-ft, or 10-ft long 0.010 slot PVC screens and PVC riser extending to the ground surface (refer to the Task C QAPP and Task C.10/C.11/C.12 Progress Report for additional detail). A complete list of all installed monitoring devices is included in Appendix D.

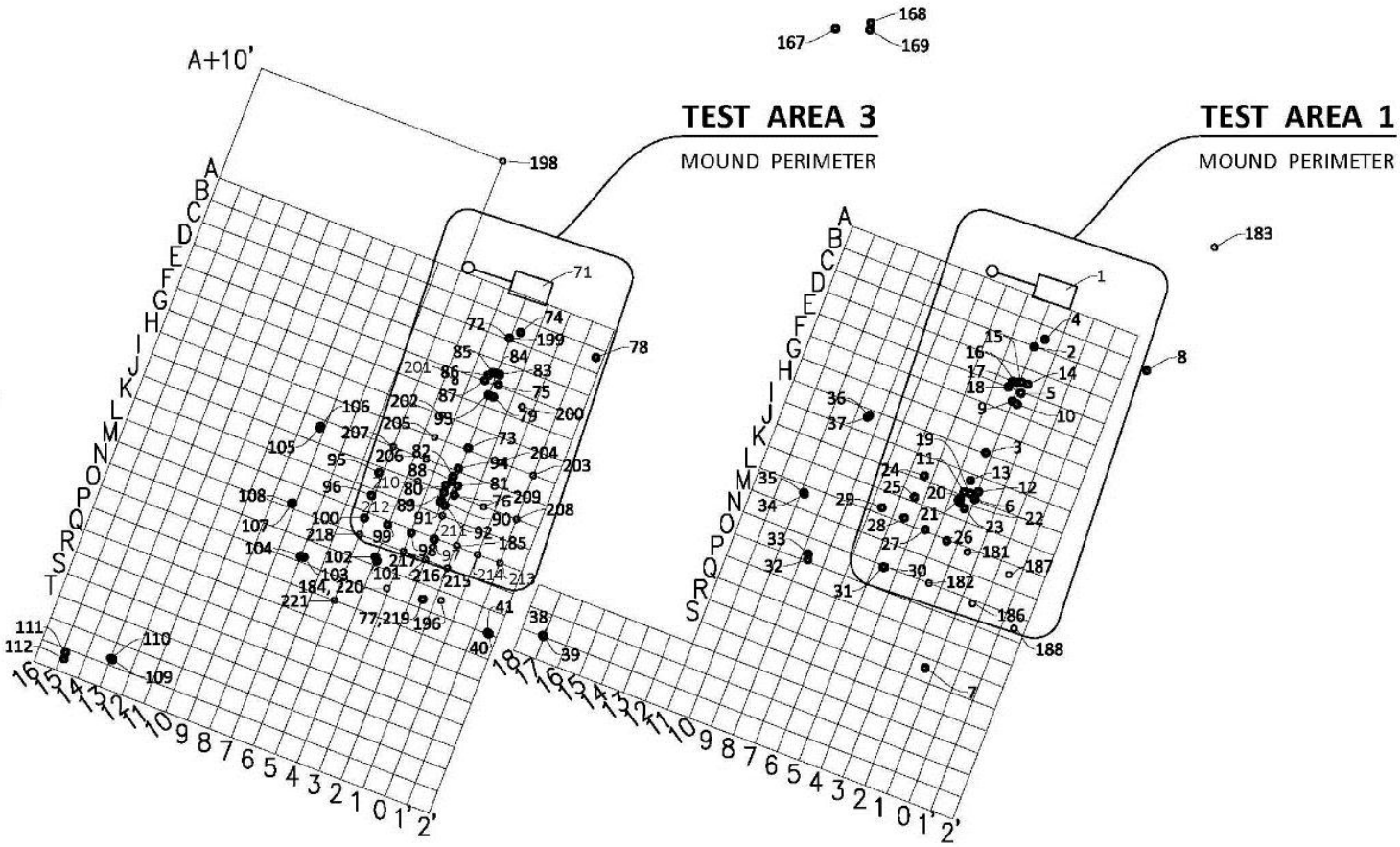

Figure 15
S&GW Test Facility System Monitoring Schematic of TA1 and TA3 (STE System)
[1]Location identification corresponds to Table D.1 ID #

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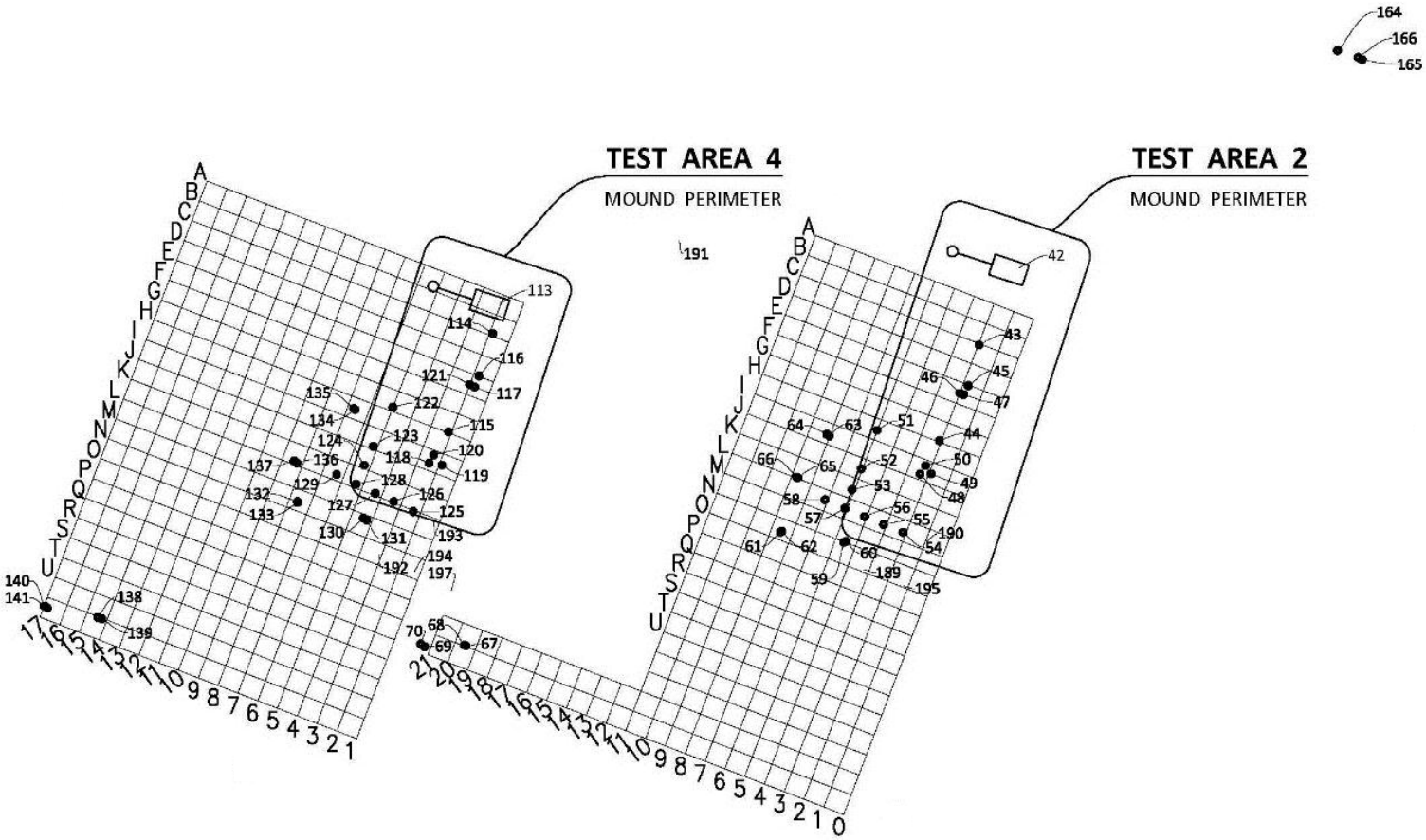

Figure 16
S&GW Test Facility System Monitoring Schematic of TA2 and TA4 (ATU System)
[1]Location identification corresponds to Table D.1 ID #

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6.0 References

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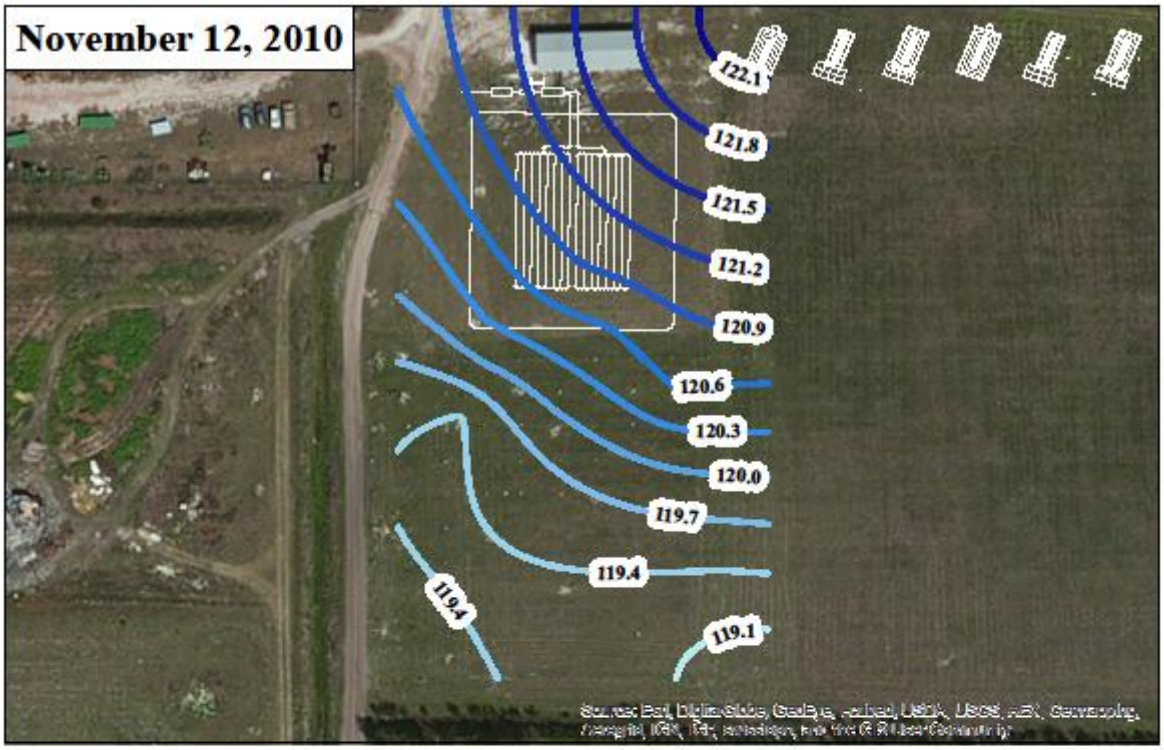
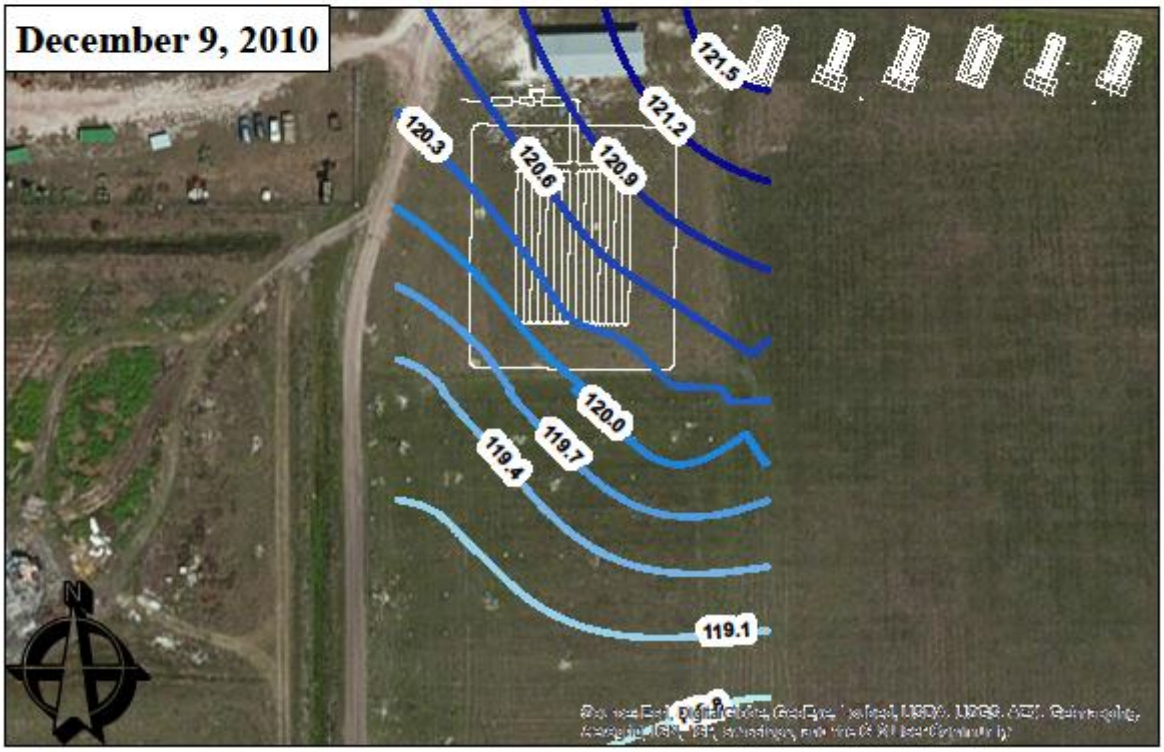
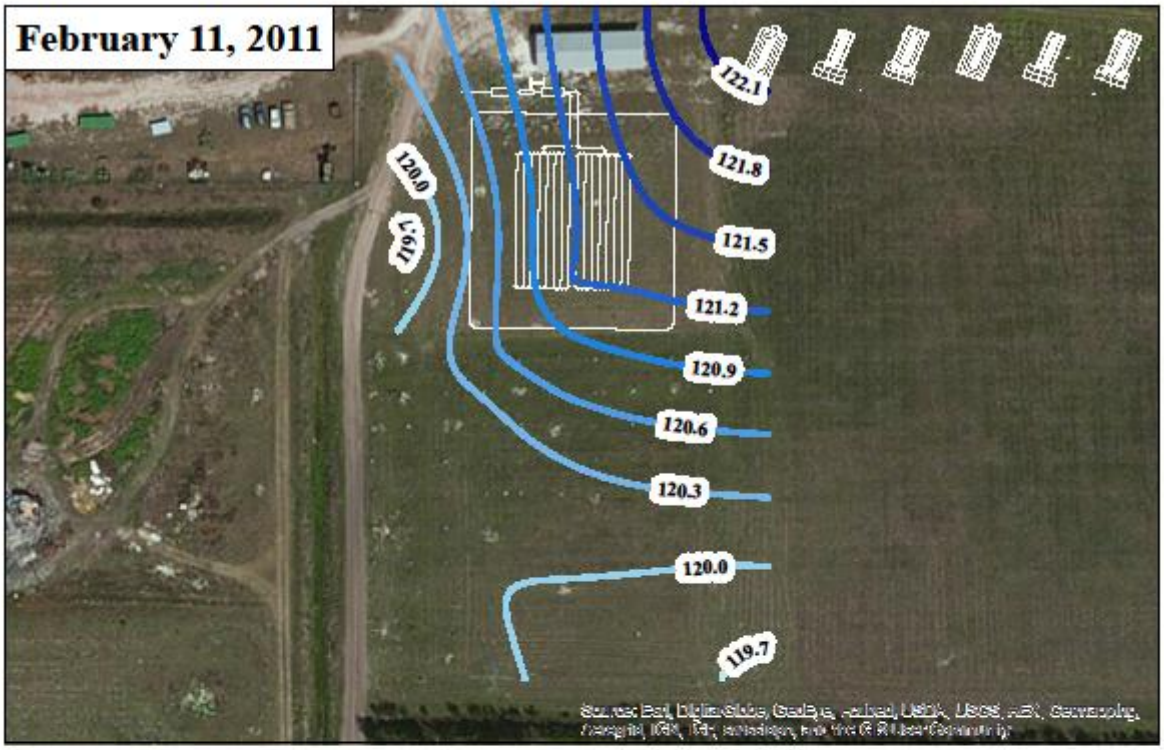
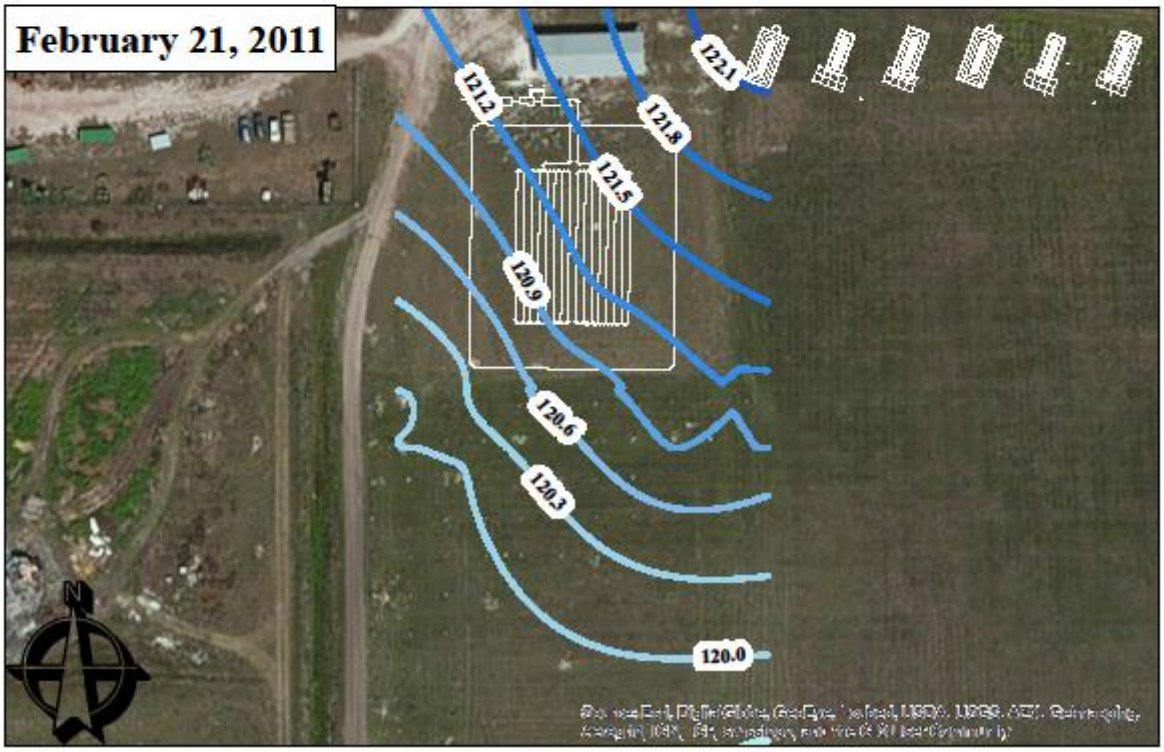
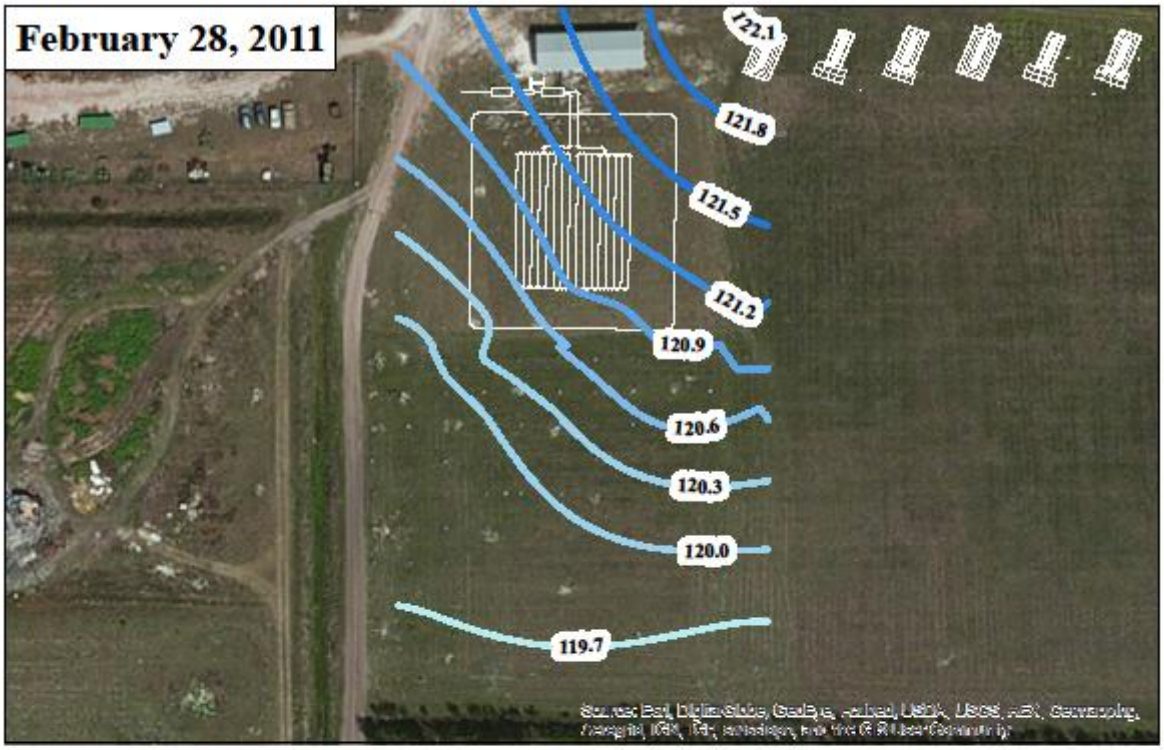
Appendix A: Interpolated Groundwater Contours

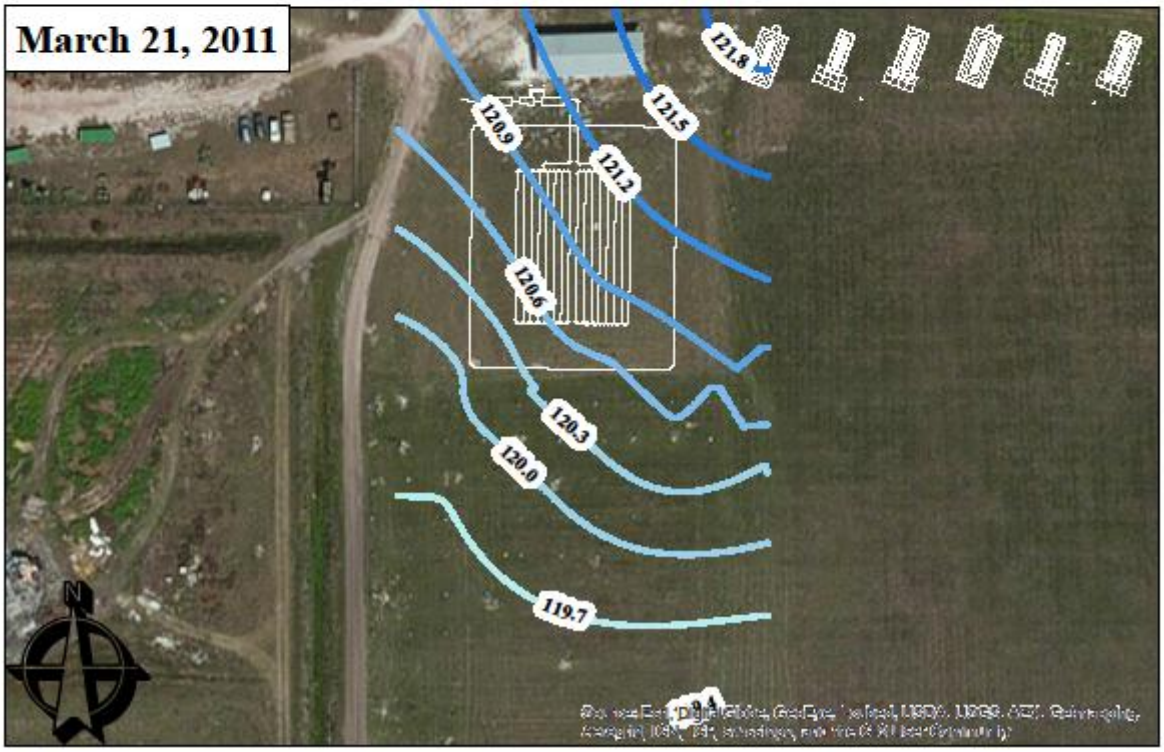


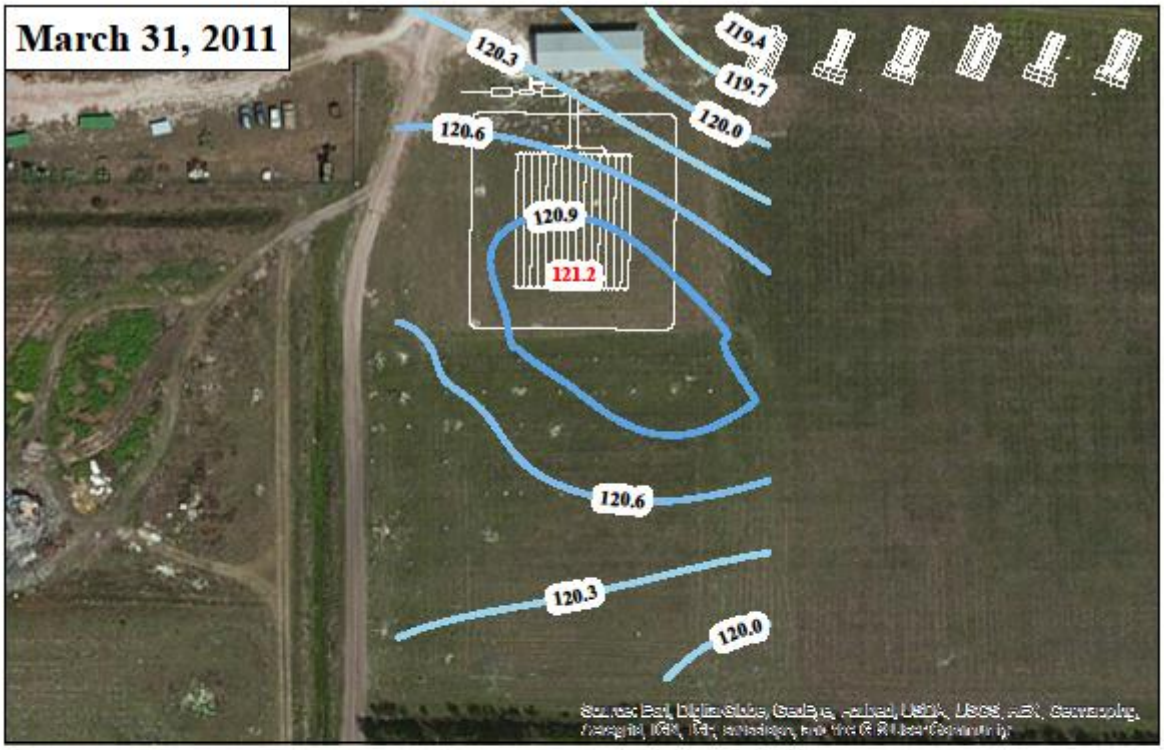


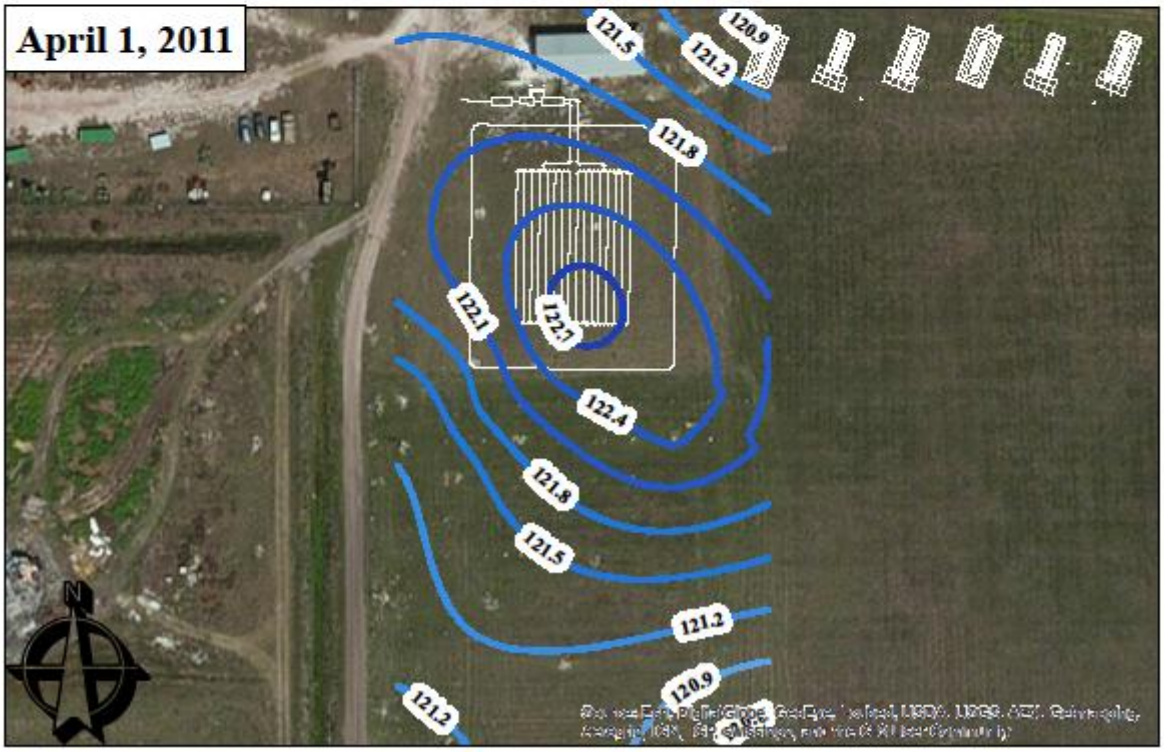


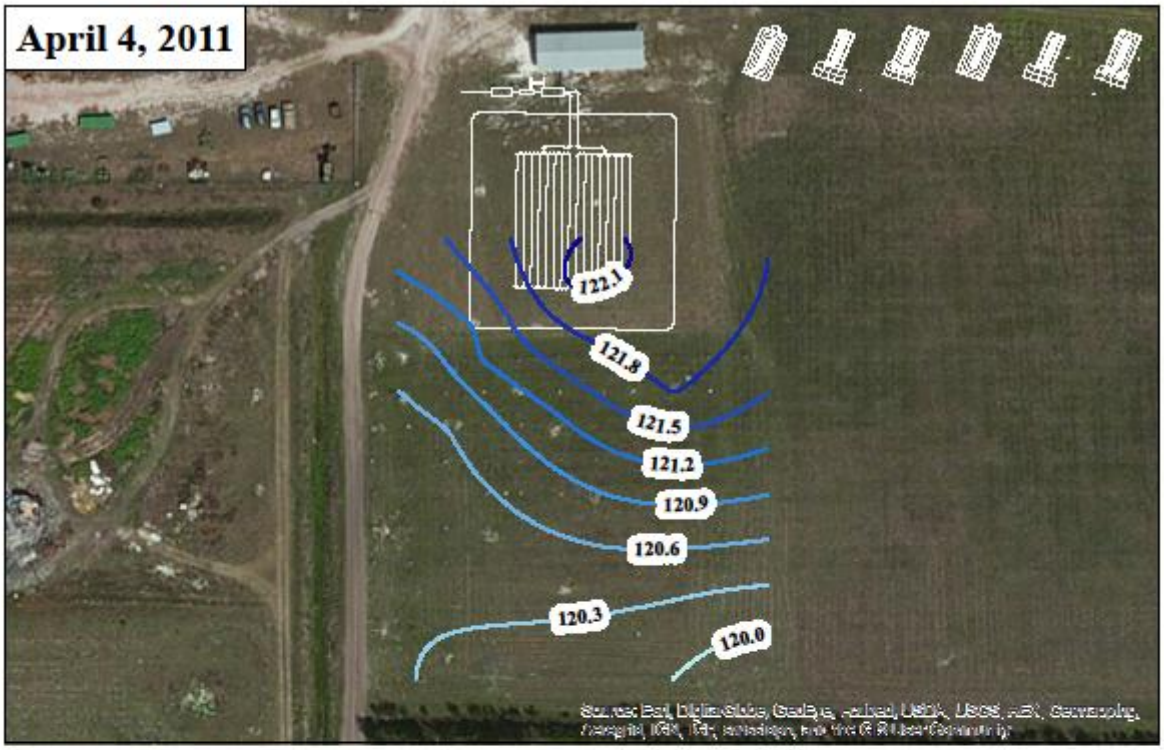








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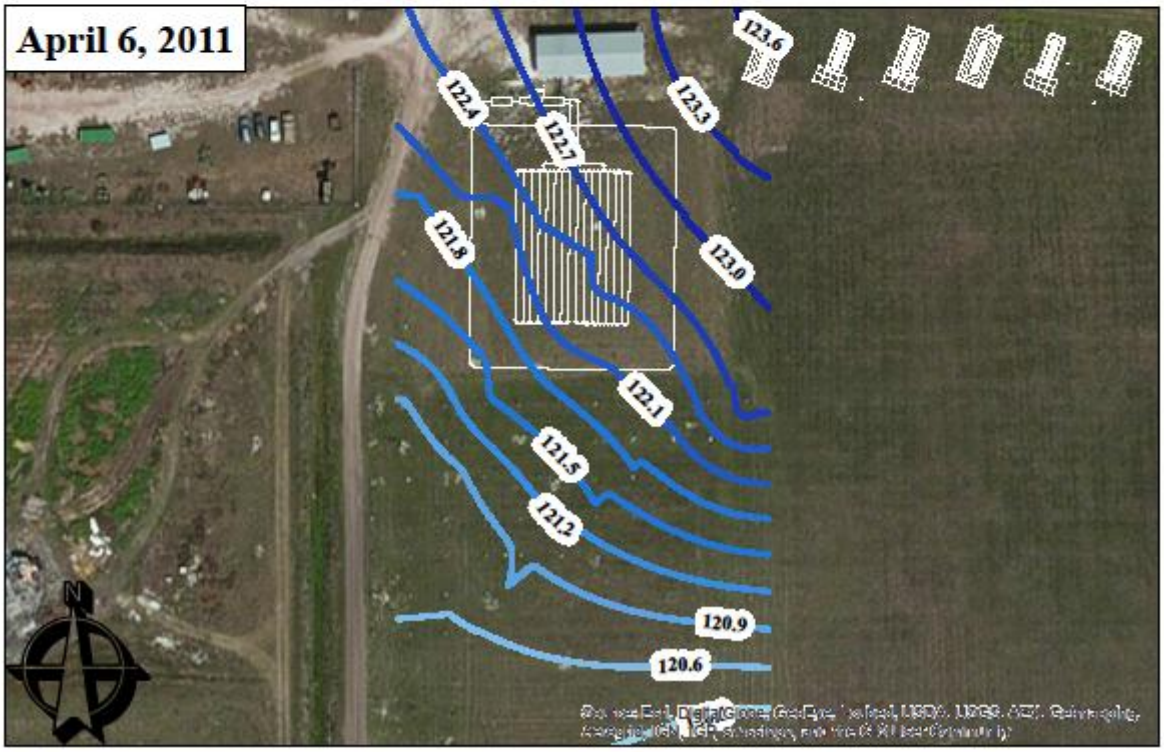
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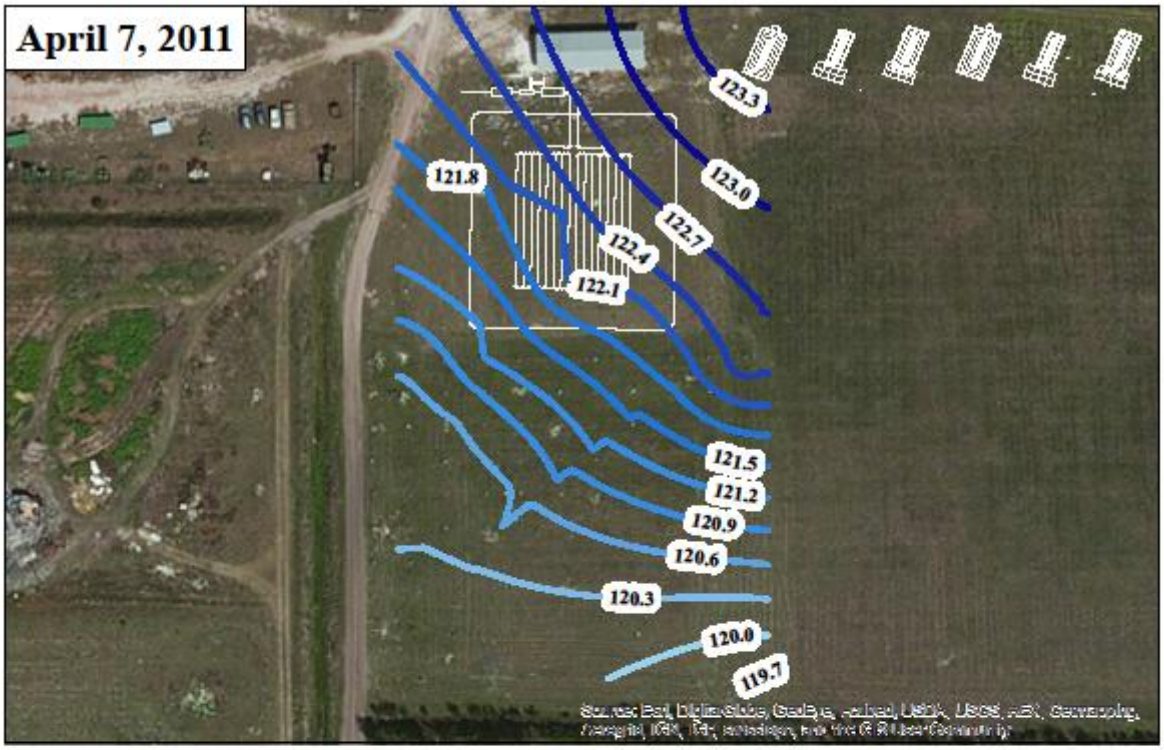

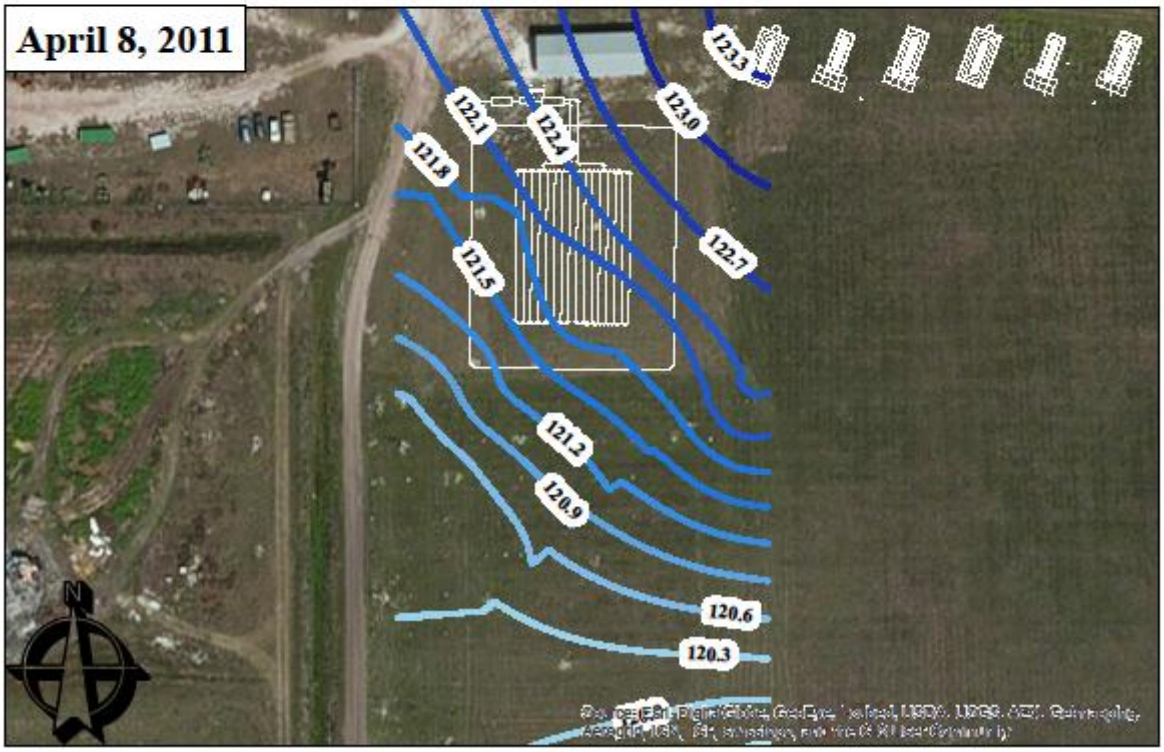

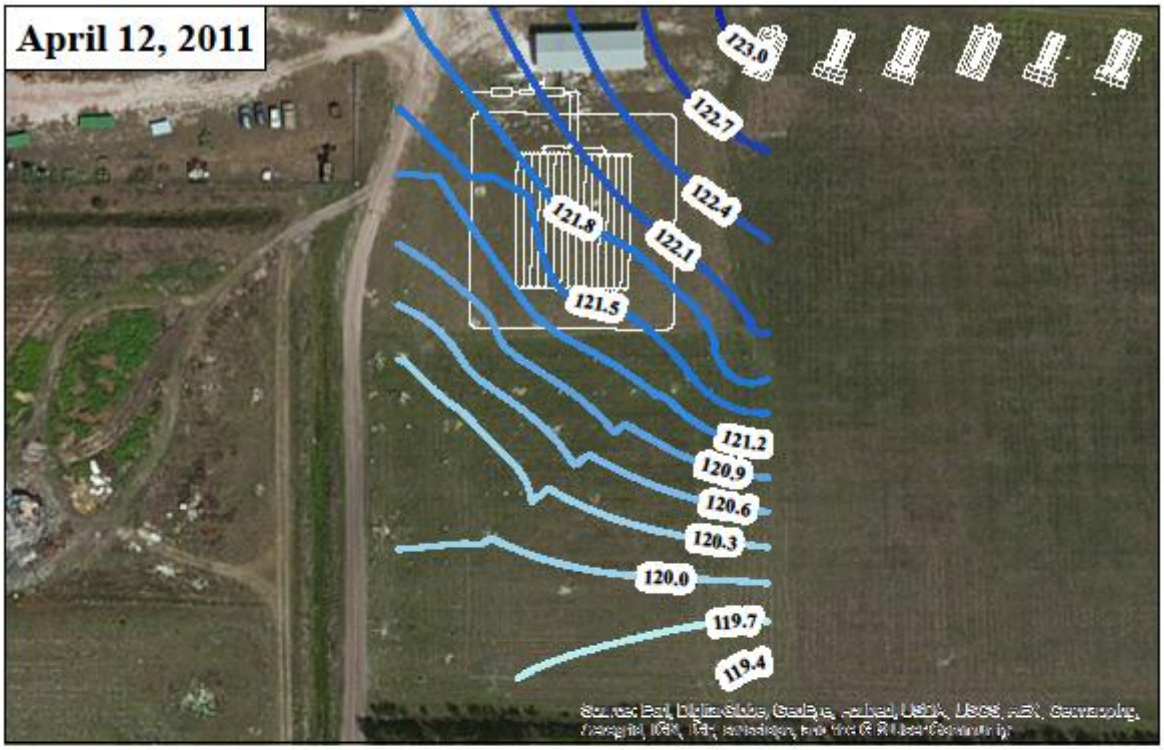

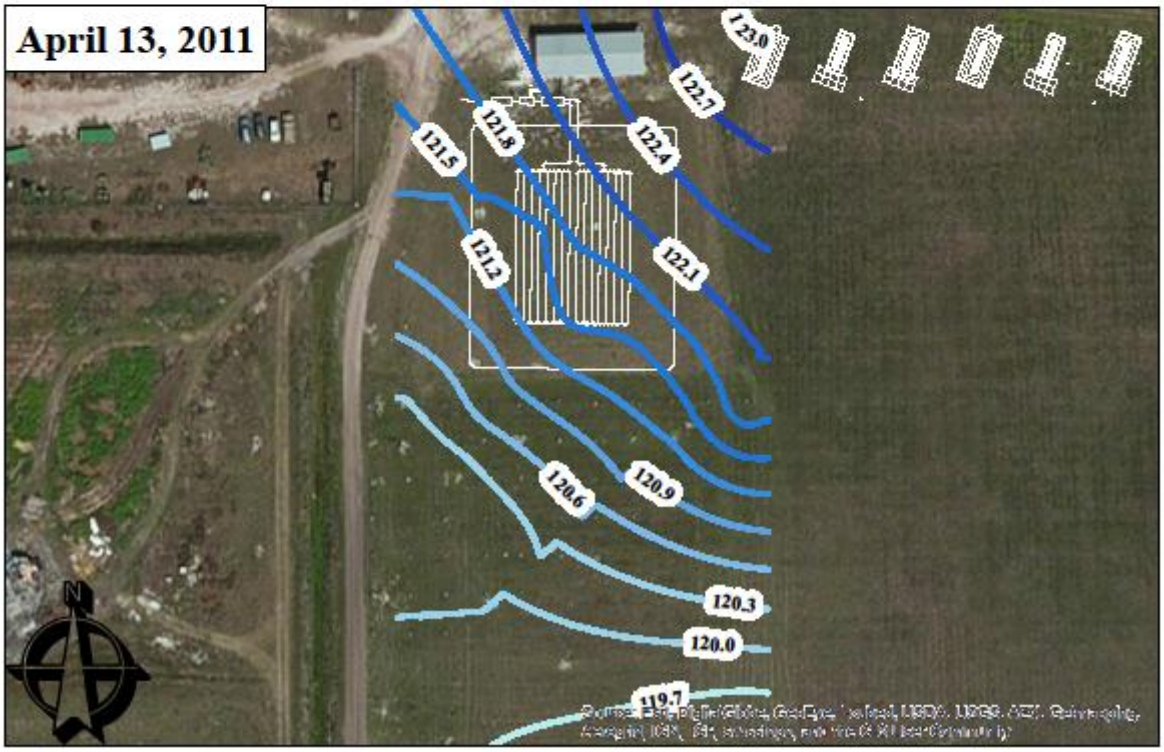

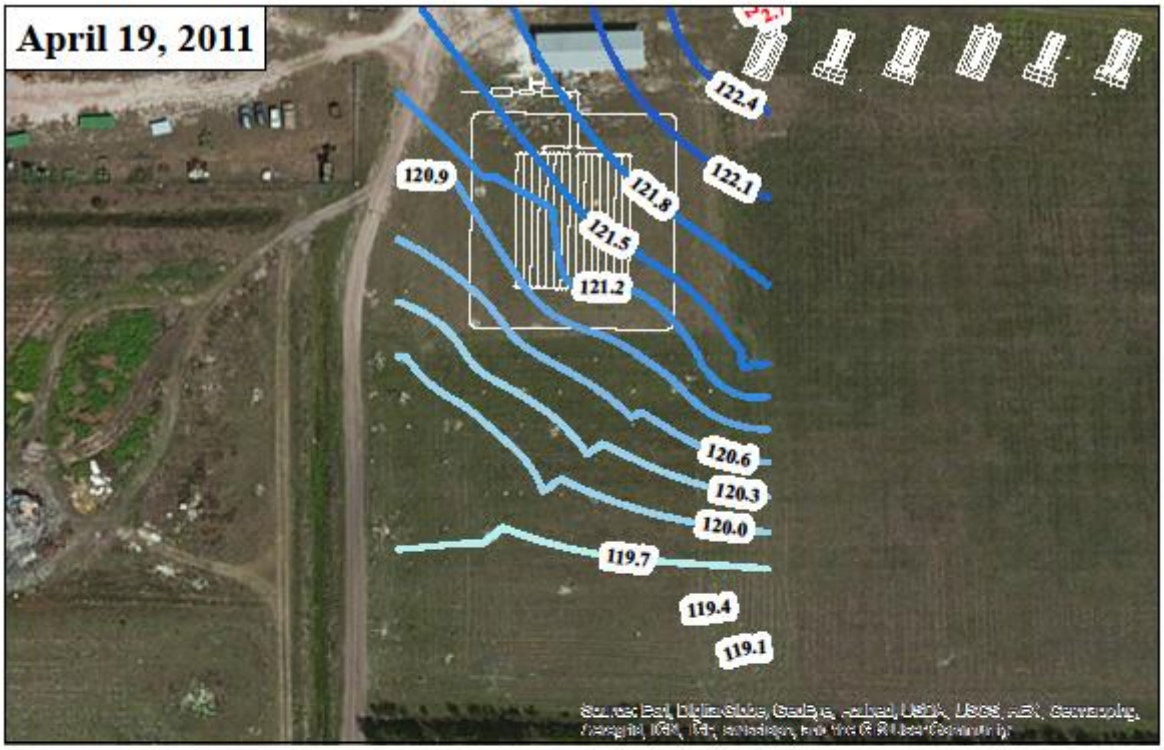

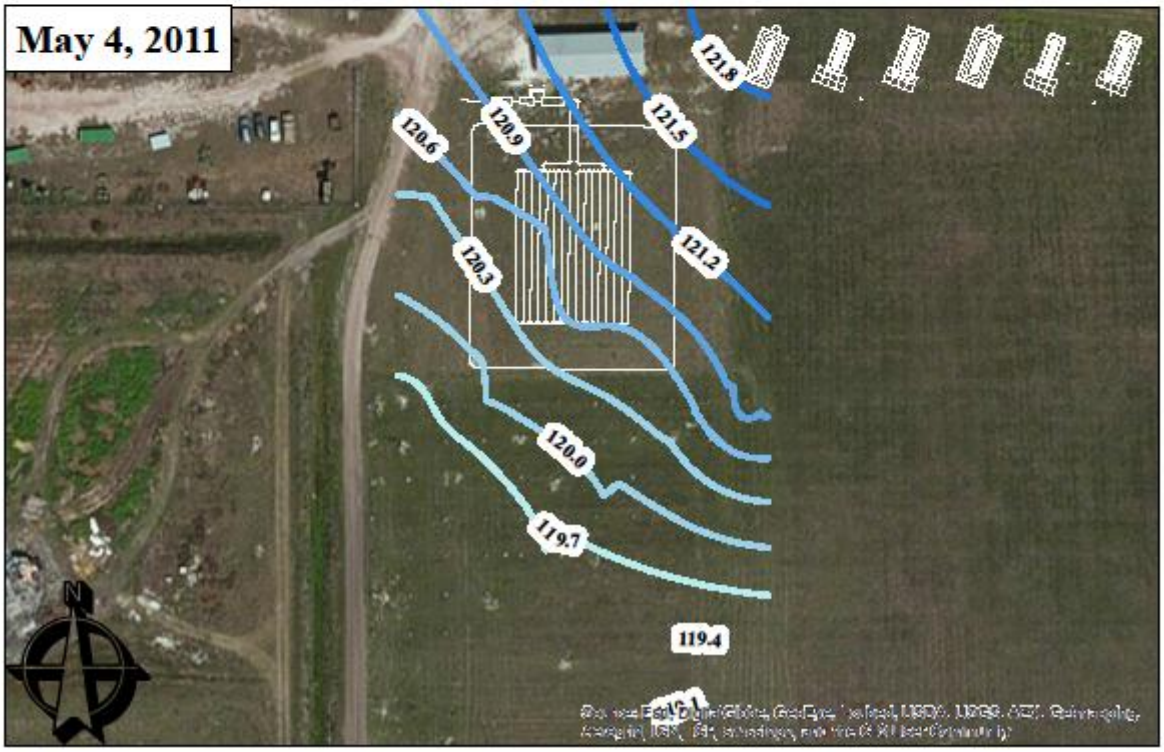

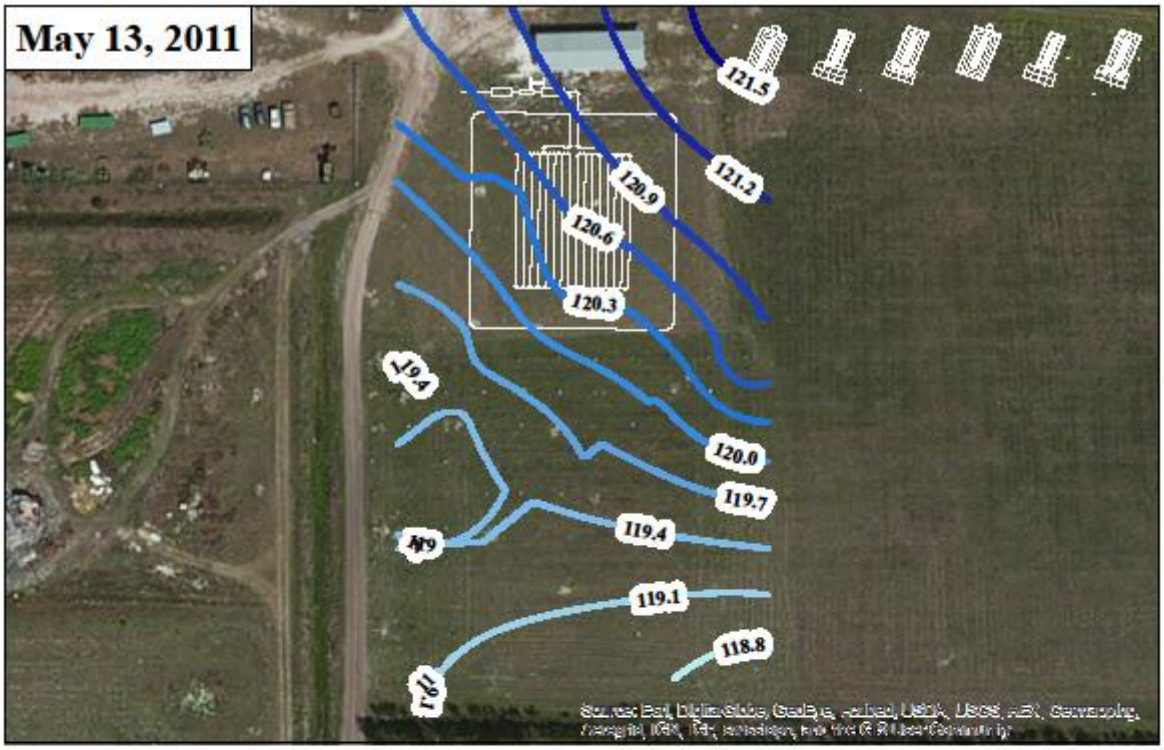
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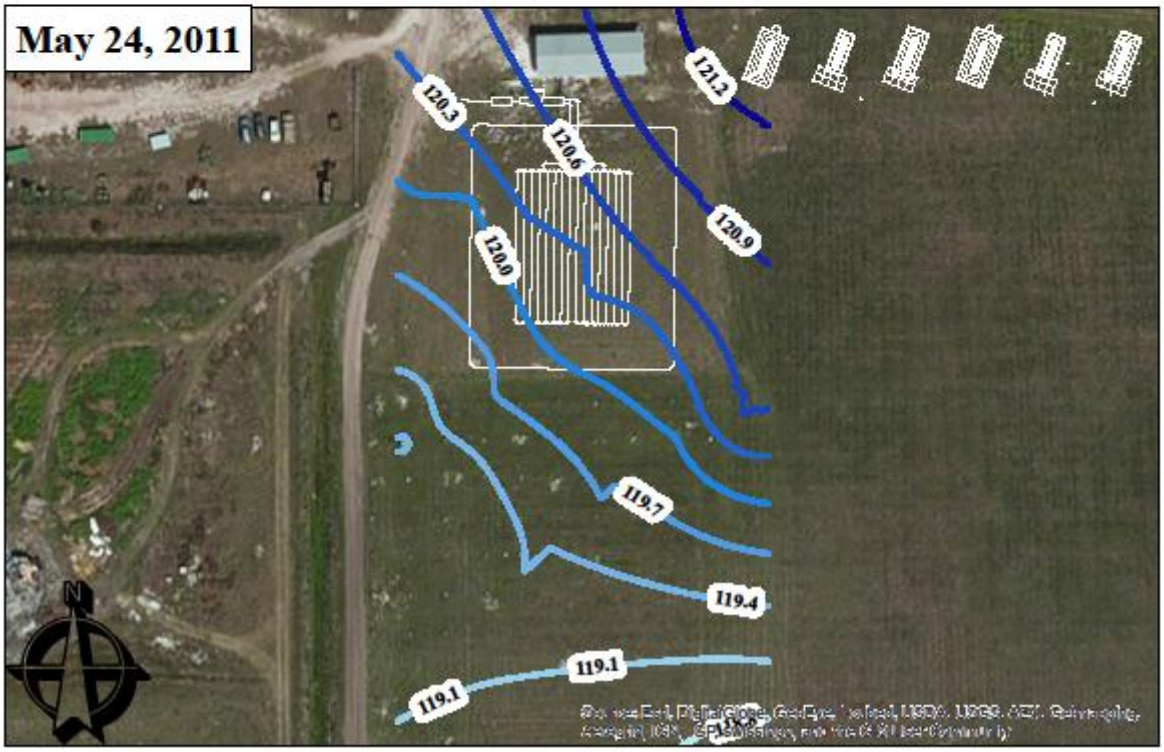
May 24, 2011
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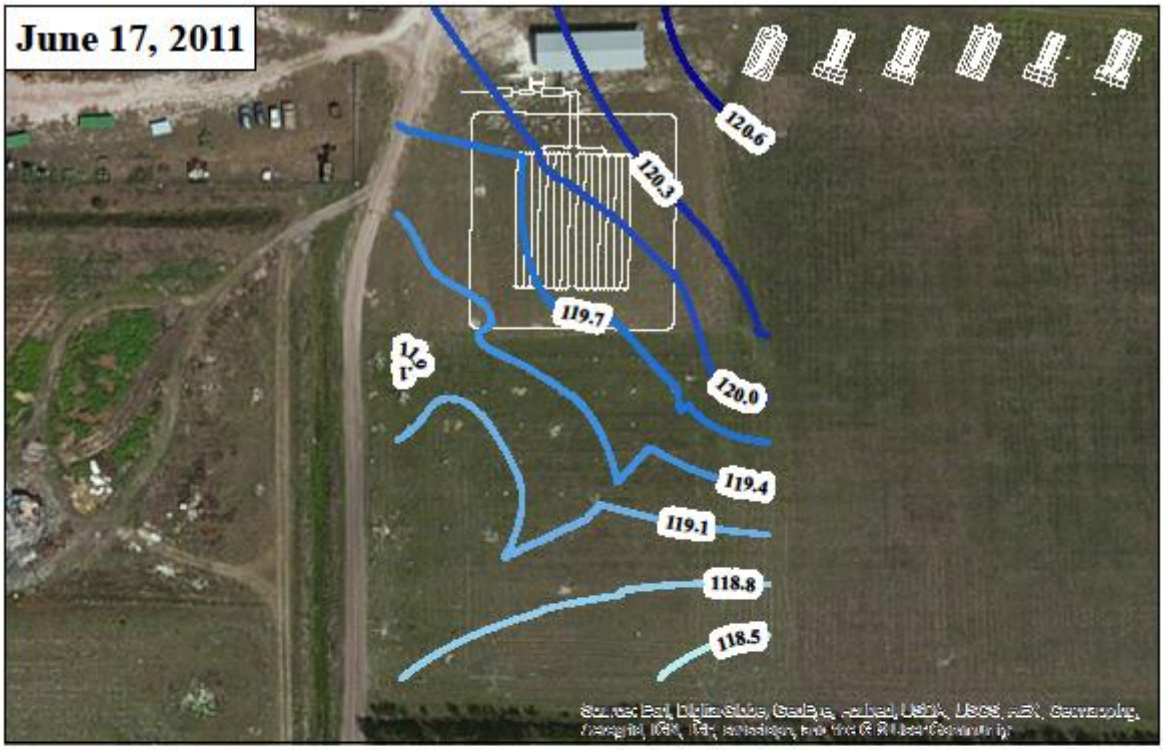
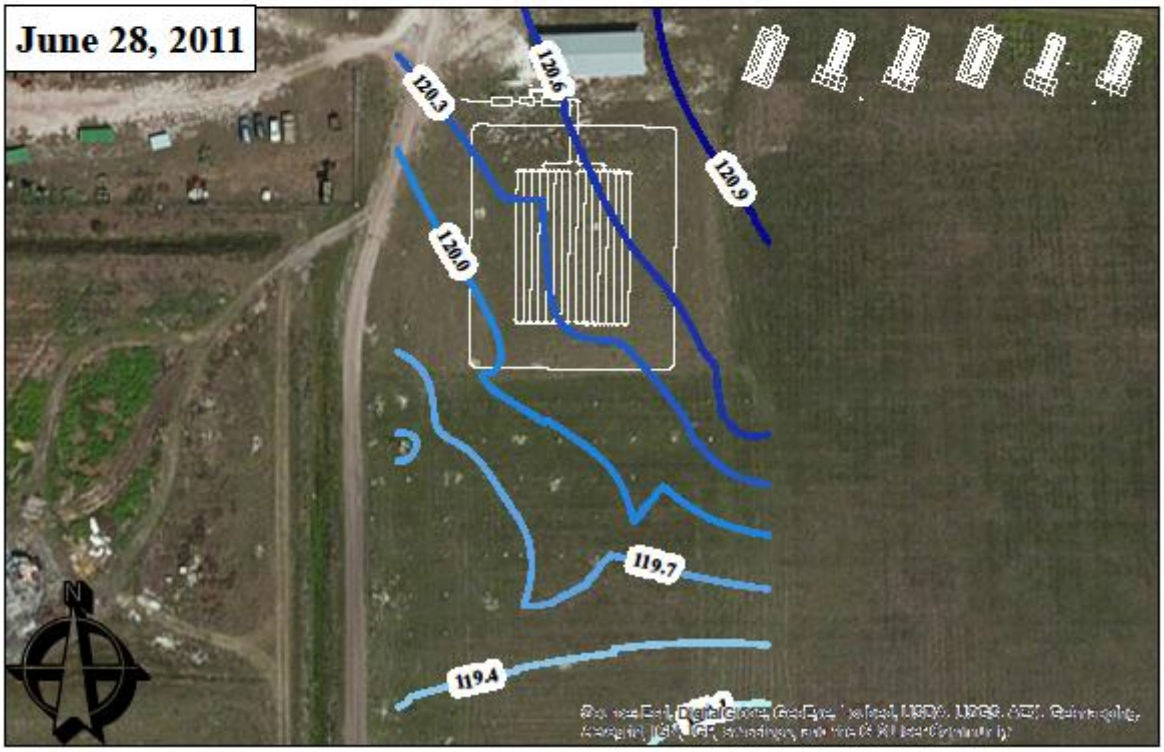
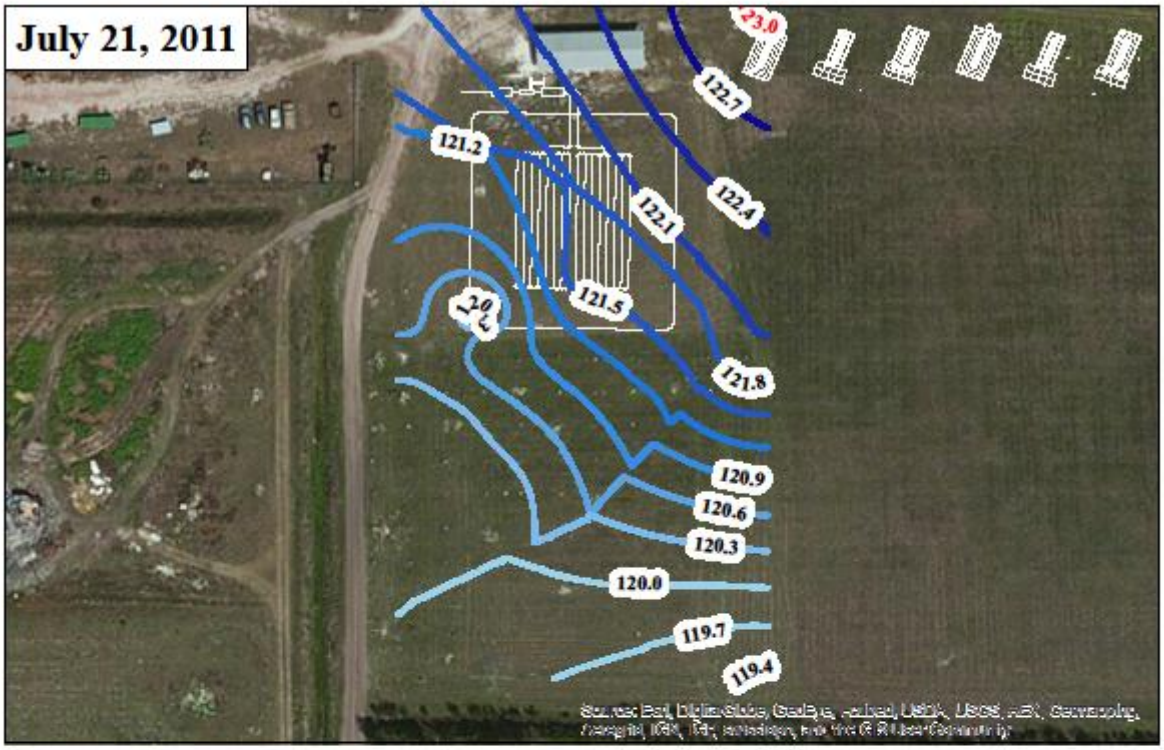
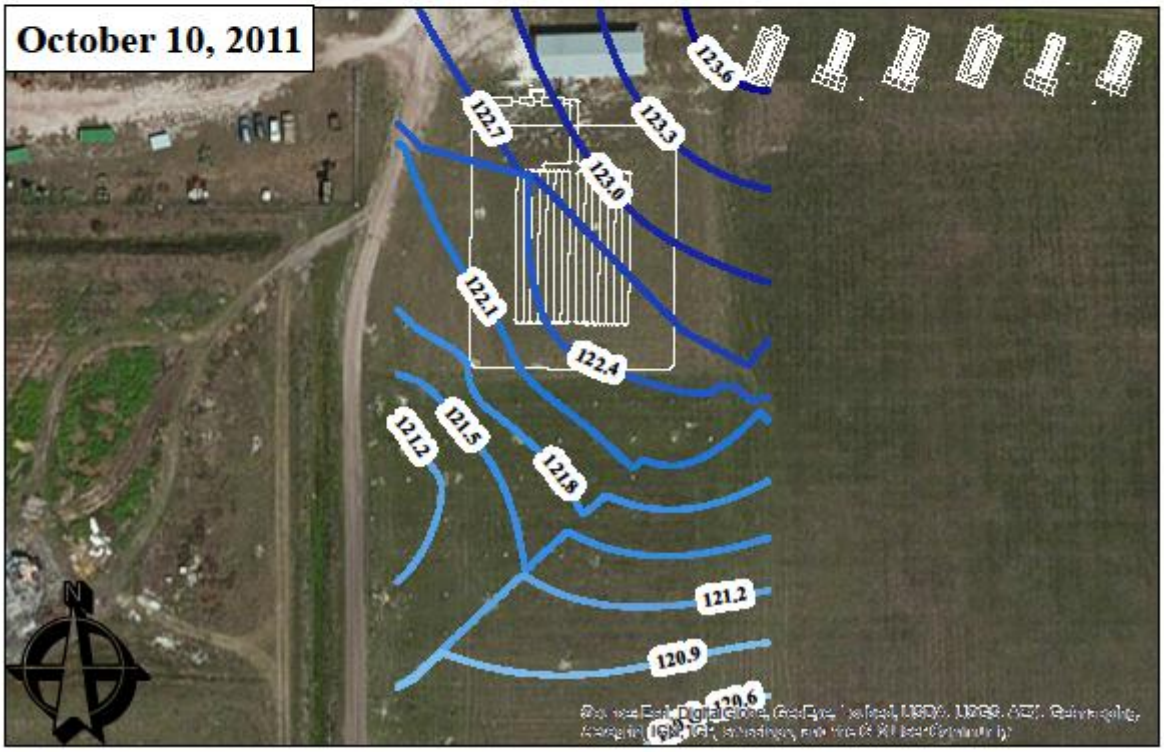
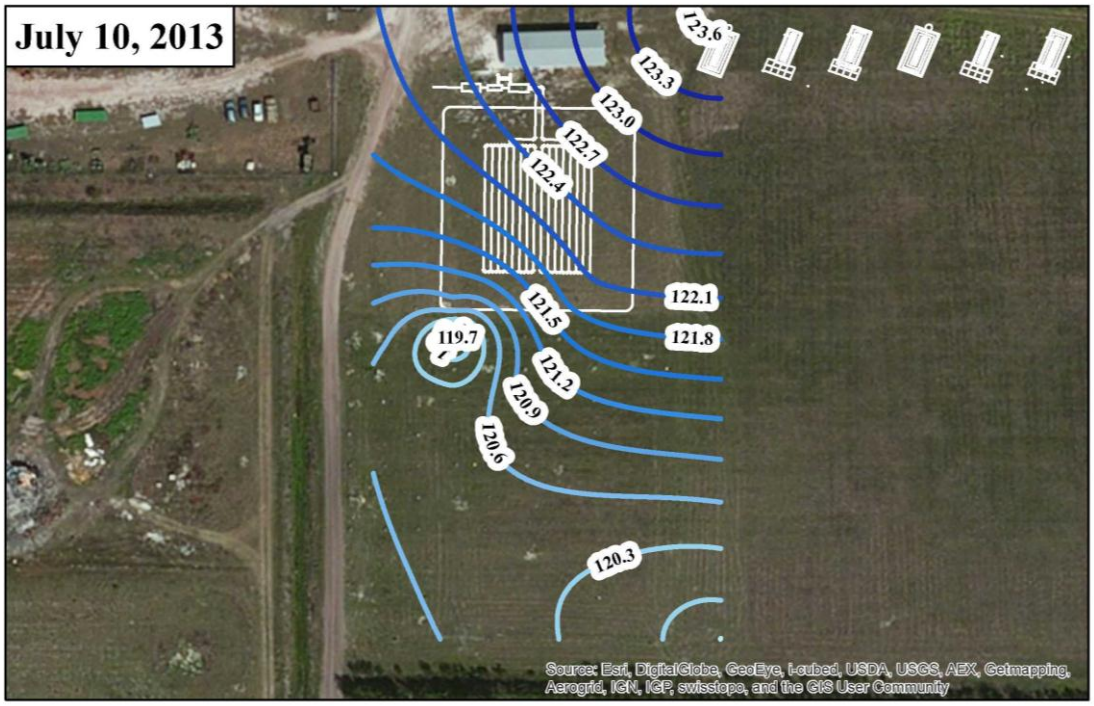
120.3
120.6
120.9
120.0
119.7
119.4
119.1
N











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Appendix B: GCREC Memorandum

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HAZEN AND SAWYER
Environmental Engineers & Scientists

Hazen and Sawyer, P.C.
10002 Princess Palm Avenue
Registry One Building, Suite 200
Tampa, Florida 33619
(813) 630-4498
Fax: (813) 630-1967

M E M O R A N D U M DATE: May 18, 2009

FOR: Elke Ursin, Florida Department of Health

FROM: Damann L. Anderson, P.E.

SUBJECT: Evaluation of Test Facility Site

Hazen and Sawyer is conducting the Florida Onsite Sewage Nitrogen Reduction Strategies (FOSNRS) Study under contract CORCL with the Florida Department of Health. Under Task A of this project, we are in the process of identifying test facility sites where multiple assessments of onsite nitrogen reduction technologies and groundwater quality can be conducted in subsequent phases of the study. Two potential sites identified in the response to the ITN were the University of South Florida Lysimeter Facility property and the University of Florida's Gulf Coast Research and Education Center (GCREC) near Wimauma, FL. Salient issues include space availability, site access, wastewater source of sufficient quantity and quality, subsurface hydrology, power supply and security.

After a preliminary assessment of the USF Lysimeter Facility, we feel that the cost of rehabilitating this facility will be beyond the budget allocated for that effort. Also, since space is limited at the USF facility and it is not conducive for groundwater quality assessments, we have concluded that it would be more cost effective to have only one test facility, where the controlled testing portion of the project could be conducted. It is our recommendation that the GCREC be selected as the test facility site. This memorandum summarizes the characteristics of the GCREC facility, as related to establishment of this test facility.

The GCREC facility is located at 14625 County Road 672, Wimauma, Florida. The facility is situated on 475 acres of land that were donated by Hillsborough County government. The facility contains research trials for vegetables, small fruit and ornamental plants. In addition, 16 laboratories are housed onsite, one being a water quality laboratory which is available and can provide many of the analyses of interest for the FOSNRS project. One of the active programmatic areas is soil and water science. A preliminary agreement to participate has been obtained, and the key personnel at the facility are interested in the FOSNRS study. A suitable area for the proposed work has been identified at the facility as depicted in Figure 1.

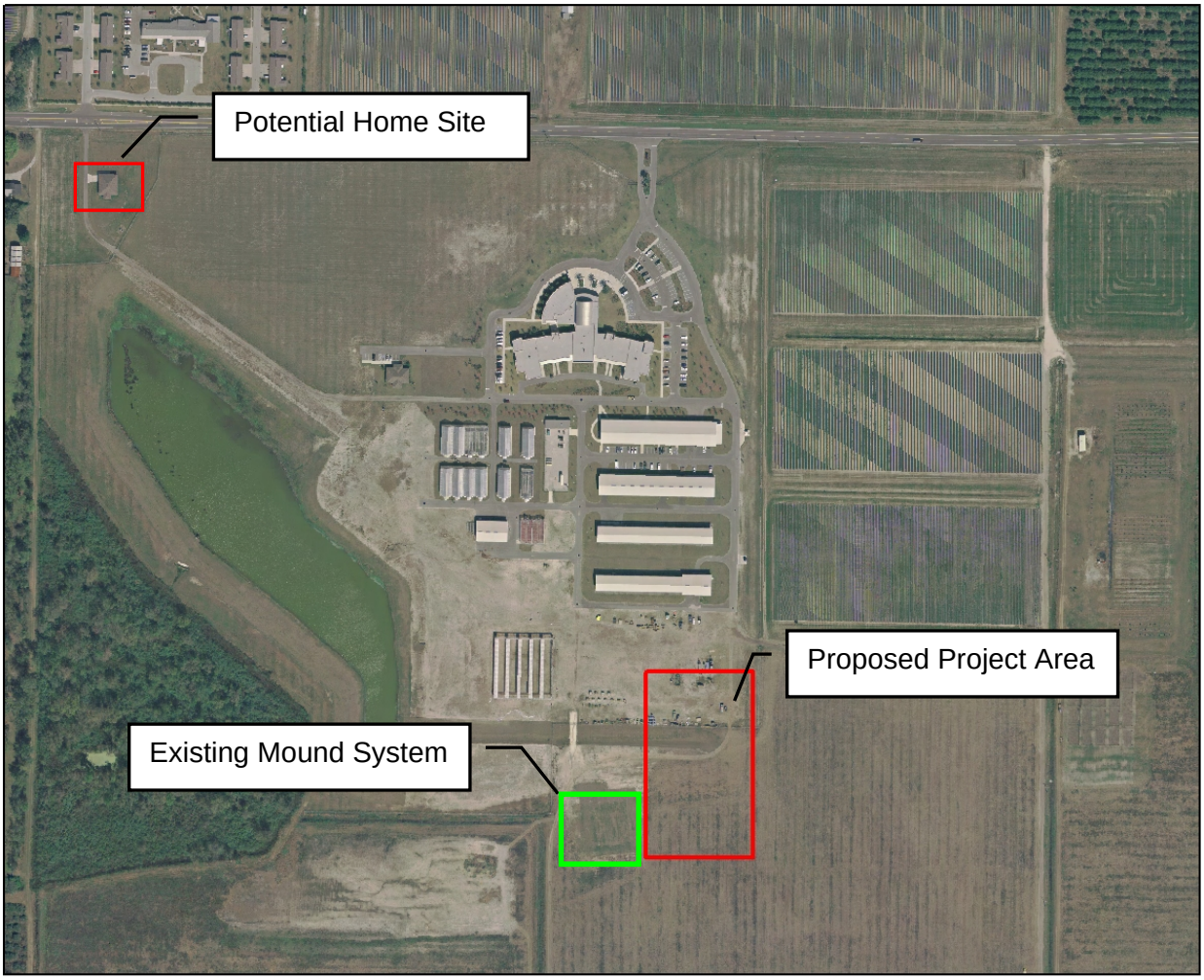

Figure 1. GCREC Facility and Proposed Project Area

Figure 2 is the web soil survey for the project area produced by the National Cooperative Soil Survey operated by the United States Department of Agriculture (USDA) Natural Resources Conservation Service (NRCS). As shown, the primary classification of soils on the site are Zolfo and Seffner fine sands.

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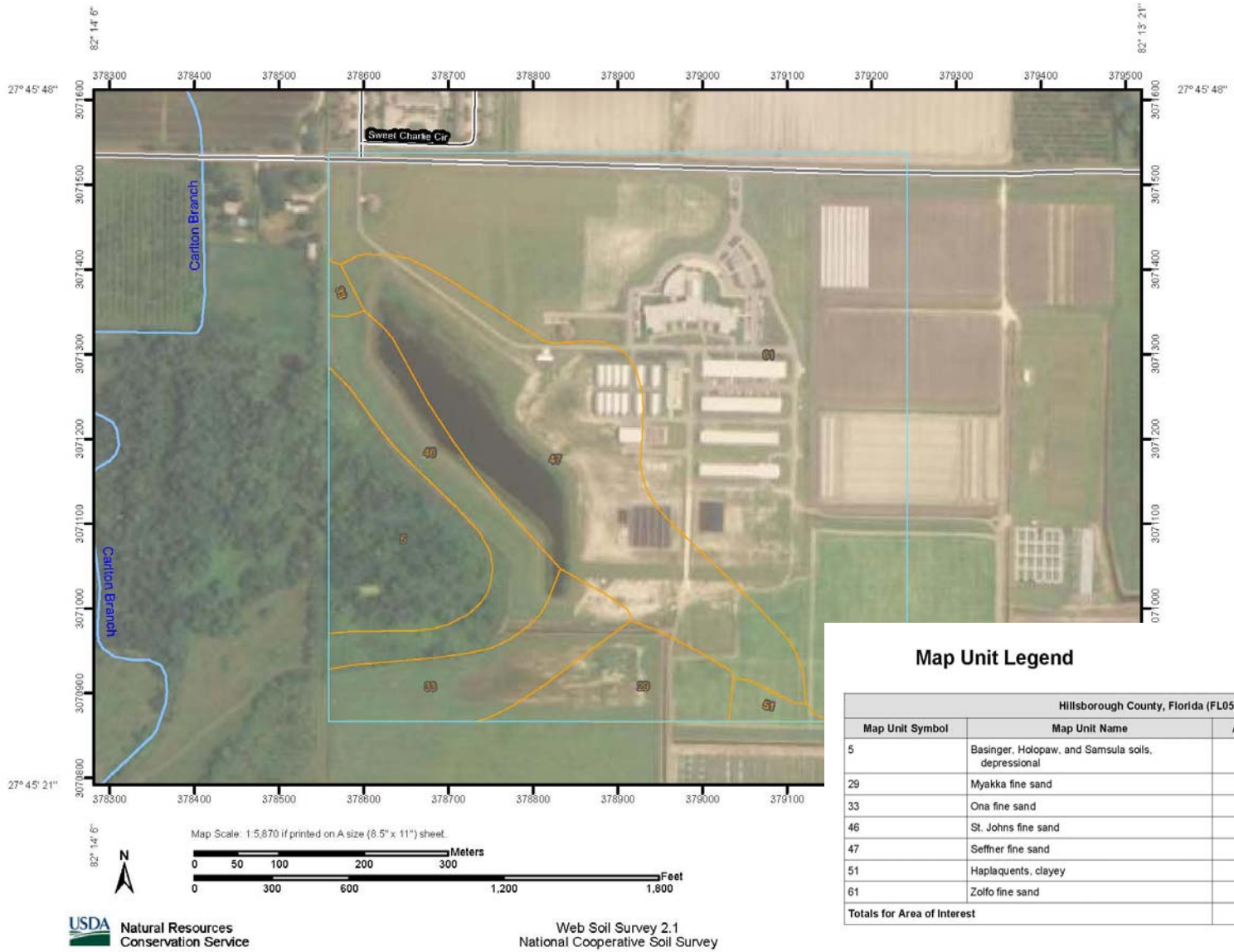
Soil Map—Hillsborough County, Florida



USDA Natural Resources Conservation Service

Web Soil Survey 2.1
National Cooperative Soil Survey

Map Unit Legend

Hillsborough County, Florida (FL057)			
Map Unit Symbol	Map Unit Name	Acres in AOI	Percent of AOI
5	Basinger, Holopaw, and Samsula soils, depressional	9.4	8.2%
29	Myakka fine sand	5.1	4.5%
33	Ona fine sand	7.1	6.3%
46	St. Johns fine sand	8.5	7.5%
47	Seffner fine sand	22.6	19.9%
51	Haplaquents, clayey	0.9	0.8%
61	Zolfo fine sand	59.9	52.8%
Totals for Area of Interest		**113.4**	**100.0%**

Figure 2

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Richard Ford, a Resource Soil Scientist with the NRCS, conducted a preliminary soils assessment of the GCREC project area on March 26, 2009. The objective of the soils assessment was to confirm the soil characteristics on the site, obtain soil profile descriptions and morphology, and obtain an estimate of the depth to seasonal high water table at the site. The mapped soils in this area are primarily Seffner fine sand (47) and Zolfo fine sand (61), with a limited area of Myakka fine sand (29). These are soils of the Florida flatwoods land resource area. Seffner and Zolfo fine sands are classified as somewhat poorly drained and Myakka fine sand is classified as poorly drained. A letter from Mr. Ford describing his assessment is included with this memo as an attachment.

Figure 3 indicates the approximate locations where five soil borings were augered on site to a depth of eighty inches.

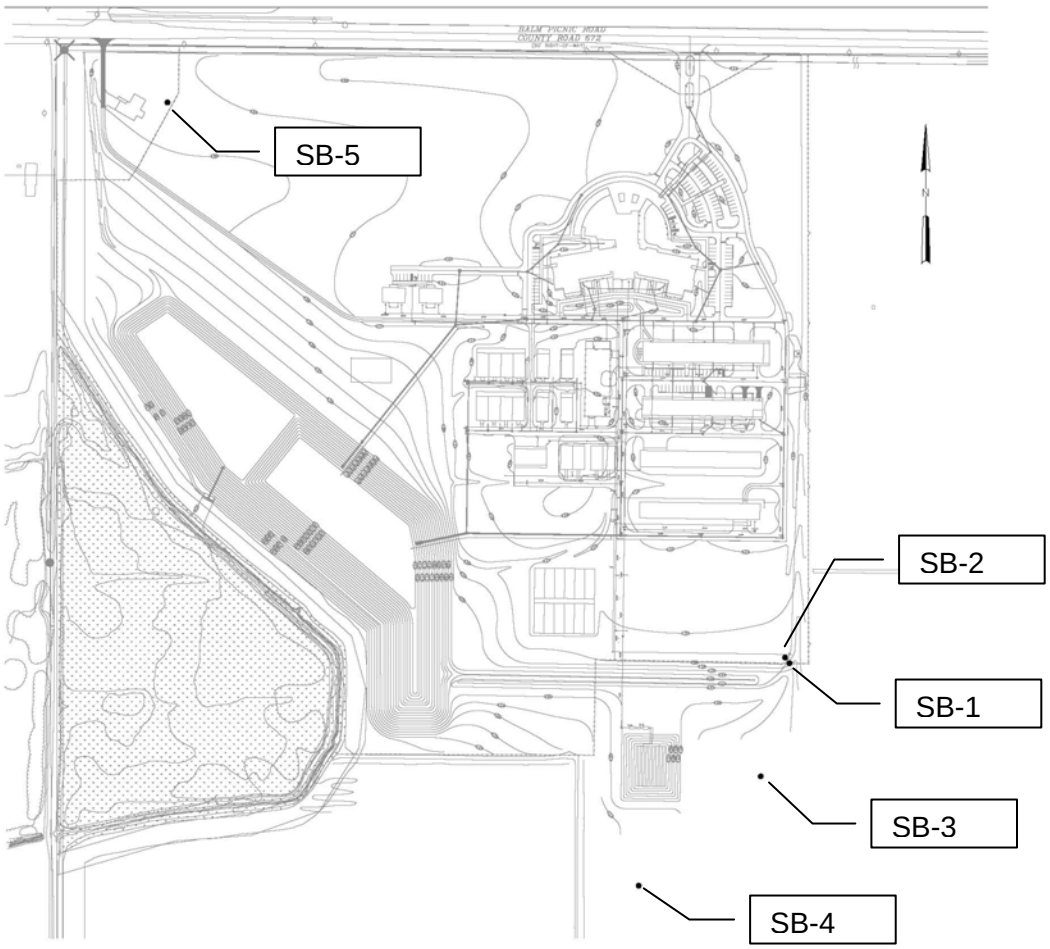

Figure 3. Approximate Soil Boring Locations

Soil boring 1 was identified as Zolfo fine sand. This profile had a well developed spodic horizon at about 58 inches. There was also evidence of some sand fill noted at the surface. It was estimated at approximately 10 inches thick. The soil profile at SB-2 was also identified as Zolfo fine sand. The well developed spodic horizon was at approximately 54 inches. There was about 10 inches of fill on the surface. The seasonal high water table was determined to be 30 inches plus or minus 6 inches. Soil boring 3 was mapped and identified in the field as Zolfo fine sand. The seasonal high water table indicators were found between 24 and 39 inches. The location of SB-4 is in or near an area mapped as Myakka fine sand based on the Soil Survey of Hillsborough County, Florida. However, the soil identified on site more closely resembled Seffner fine sand. This soil differs from Myakka fine sand by being somewhat poorly drained rather than poorly drained. The seasonal high water table was determined to be 30 inches plus or minus 6 inches. Soil boring 5 was identified as Zolfo fine sand. The seasonal high water table was also determined to be 30 inches plus or minus 6 inches. Seffner and Zolfo fine sands are both deep, somewhat poorly drained soils formed in sandy marine sediment. They are found on low-lying ridges on the flatwoods.

Based on the soils found on site, the soil mapping is representative. Water table depths determined on site were within the range of the mapped soils with only one exception. This occurred at soil boring 4 where Seffner fine sand was identified rather than Myakka fine sand. In addition, the area identified as Haplaquents in the Soil Survey of Hillsborough County was not encountered in the area investigated. If present, this area must exist south of the drainage ditch that forms the southern boundary of the study area, which was not investigated.

Another salient issue regarding the project site is a wastewater source of sufficient quantity and representative quality. The existing onsite wastewater treatment system consists of a pressure dosed mound system designed for 2,850 gallons per day. The septic tank receives flow from the research facility offices and approximately 11 graduate students that live in onsite dormitories. The laboratory liquid waste flow is not sent to the onsite wastewater system. Table 1 provides a summary of the system based on design drawings located at the GCREC.

Table 1. GCREC Onsite Wastewater Treatment System Summary

Primary Treatment – two precast septic tanks in series	-One 2,500 gallon precast septic tank-Category 4 without baffle -One 1,250 gallon precast septic tank-Category 4 with outlet screen
Dosing Tank	3,000 gallon precast pump/dosing tank-Category 4
Mound System Drainfield	4,351 ft2 infiltrative area (0.65 gpd/ft2)

A grab sample was collected at the outlet of the second septic tank on March 26, 2009. Results of laboratory analyses of this sample are summarized in Table 2.

Table 2. Septic Tank Effluent Field & Laboratory Analyses

pH (measured in field)	6.51
Temperature (^{o}C, in field)	25.4
Dissolved Oxygen (mg/L, in field)	0.13
Alkalinity (mg/L)	220
TKN (mg/L)	52
Ammonia (mg/L)	39
Nitrate (mg/L)	0.24
Nitrite (mg/L)	0.022
$CBOD_5$ (mg/L)	300
COD (mg/L)	680
Fecal Coliform (Col/100 mL)	10E6
Phosphorus (Total) (mg/L)	8.5
Total Dissolved Solids (mg/L)	590
Total Suspended Solids (mg/L)	80

Six piezometers were installed at the facility on March 17, 2009 to determine subsurface hydrology. Figure 3 depicts the approximate piezometer locations and the water table elevations measured on March 26, 2009.

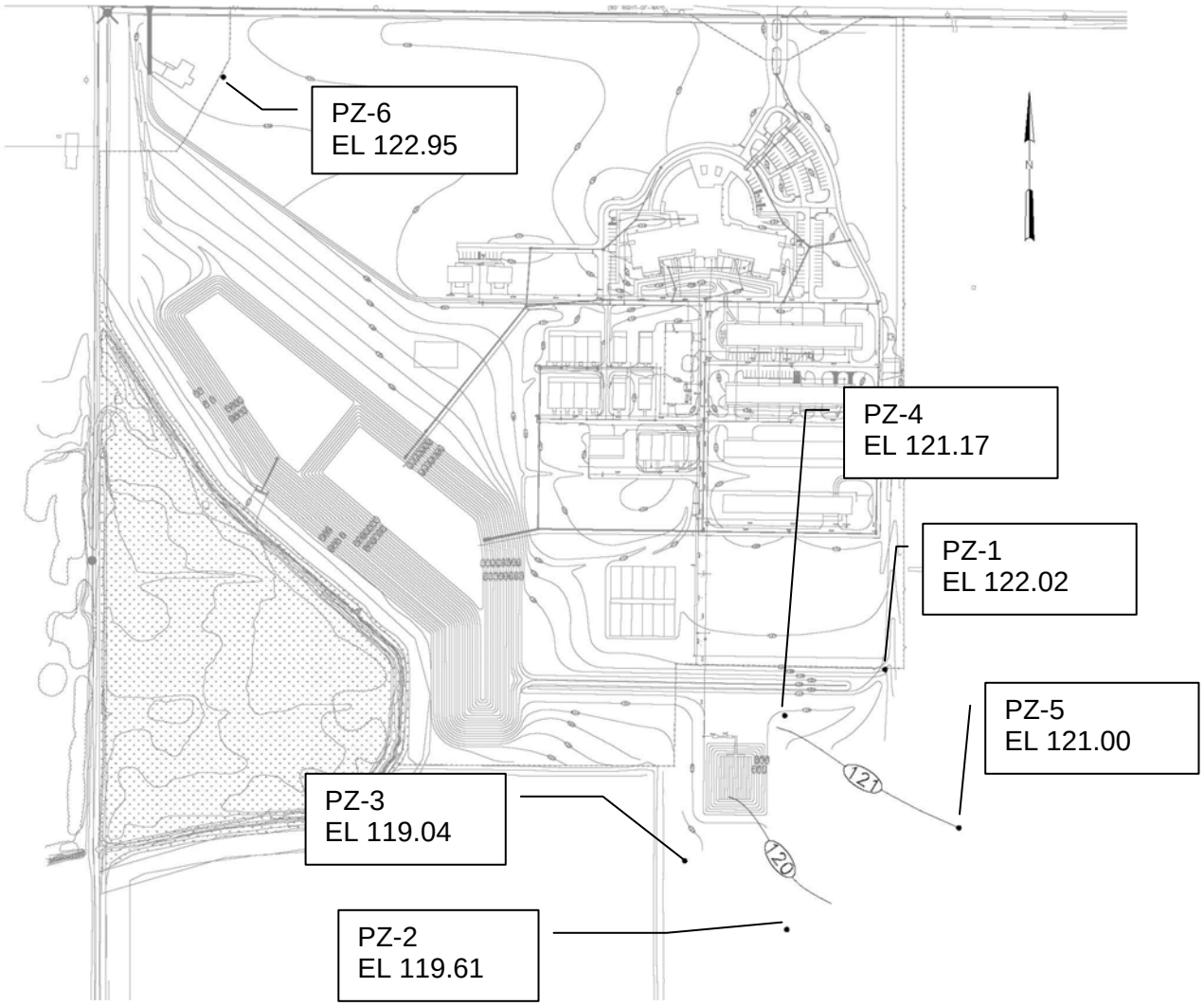

Figure 3. Piezometer Locations and Water Table Elevations on March 26, 2009

Summary

Based on the cost and time associated with rehabilitating the USF facility, it has become apparent that proceeding with construction of two test facility sites will be costly and time consuming. The current budget in the FOSNRS contract for construction of a test facility at USF does not appear to be sufficient for both the rehabilitation work and the testing facility construction. In addition, the USF Lysimeter station can only be used for pilot tests of treatment technologies and unsaturated zone work, since the water table is extremely deep at the site (>25 ft.) and sufficient area for plume delineation and monitoring is not available. Management of two facilities once operational will also be more difficult and expensive in future phases of the project.

The preliminary soils assessment, wastewater (STE) quality, and preliminary GW assessment appear to be conducive to performing the proposed work. While the flatwoods type soils at the site have a shallow groundwater that may be more likely to support *in-situ* denitrification, the soils of the Florida flatwoods land resource area make up approximately 55% of the area of the state, over 60% if the Everglades land resource area is excluded. In contrast, soils of the central Florida ridge land resource area make up approximately 17% of the area of the state (Ayres Associates, 1987). Also, a site conducive to *in-situ* denitrification is desirable from a groundwater modeling perspective. To include denitrification in the models developed in Task D, a study site where denitrification can be measured will be more likely to provide the needed inputs and calibration data for model development. If the mechanisms of *in-situ* denitrification can be identified at the site, then the models developed should be able to predict whether such denitrification is likely to occur at any given site. Additionally, the individual home field sites for Task C will be chosen to include soils of different types, including well drained fine sands typical of the central Florida ridge recharge areas, and the models developed will be tested at these sites.

Treatment technology pilot testing and both the saturated & unsaturated zone investigations could be performed at the GCREC. Therefore, the Project Team recommendation is to conduct all test facility work at the GCREC. This recommendation would include shifting the funds for test facility design and construction in Task A to the design and construction of the test facility for Task C, or vice versa. We would like to proceed with the GCREC site as the only FOSNRS Study testing facility, and request FDOH direction in this regard.

enc: NRCS letter

c: E. Roeder
P. Booher

File 44237-001

NRCS Natural Resources Conservation Service

1700 U.S. Hwy. 17 So., Suite 2 Bartow, FL 33830 Telephone (863) 533-2051 Ext. 3 Fax: (863) 533-1884

April 14, 2009

Hazen and Sawyer, P.C.
10002 Princess Palm Ave.
Suite 200
Tampa, Florida 33619

ATTN: Mr. Anderson
RE: Onsite Wastewater Treatment research

Dear Sir:

An on site soil investigation was conducted March 26, 2009 at the UF Gulf Coast Research and Education Center to determine the seasonal high water table and ascertain whether or not the soils were mapped correctly in the most recent NRCS soil survey documentation for Hillsborough County. The area of concern is located in section 29, T31S, R21E; Hillsborough County, Florida.

Soil borings were made at preselected sites or points to a depth of eighty inches. The mapping units were identified and the seasonal high water table determined. The Soil Survey of Hillsborough County, Florida and the Web based Soil Survey of Hillsborough County were used in this effort.

Five soil borings were made on site to a depth of eighty inches in the area of concern. The mapped soils in this area are Seffner fine sand (47), Zolfo fine sand (61), and Myakka fine sand. These soils are classified as poorly to somewhat poorly drained.

SB#1 was located five feet NW of PZ#1 and was identified as Zolfo fine sand. This profile had a well developed spodic at about 58 inches. There was also evidence of some sand fill noted at the surface. It was estimated at about 10 inches thick.

SB#2 was located 23 feet NW of PZ#1. This profile was identified as Zolfo fine sand. The well developed spodic was at 54 inches. There was about 10 inches of fill on the surface. The seasonal high water table was determined to be 30 inches plus or minus 6 inches.

SB#3 was located 200 feet east of the mound system's eastern edge. The soil mapped on site and identified in the field was Zolfo fine sand. The seasonal high water table indicators were found between 24 and 39 inches.

SB#4 was located 95 feet east of the field road edge and 95 feet north of the line of trees. This area is mapped Myakka fine sand based on the Soil Survey of Hillsborough County, Florida. The soil identified on site was Seffner fine sand. This soil differs from Myakka fine sand by being somewhat poorly drained rather than poorly drained. The seasonal high was determined to be 30 inches plus or minus 6 inches.

SB#5 was located on the east side of the Farm Manager residence inside the chain link fence. Zolfo fine sand was identified on site. The seasonal high was determined to be 30 inches plus or minus 6 inches.

Based on the soils found on site the soil mapping is representative. Water table depths determined on site were within the range of the mapped soils with only one exception. This occurred at SB#4 where Seffner fine sand was identified not Myakka fine sand.

In addition, the area identified as Haplaquents in the Soil Survey of Hillsborough County was not encountered in the area investigated. If present, this area must exist south of the drainage ditch that forms the southern boundary of the study area, which was not investigated.

Please call if you have any questions. Thank you very much.

Yours truly,

Richard D. Ford
Resource Soil Scientist
cc: Juan Vega, District Conservationist

Appendix C: Soil Analytical Results

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Table C.1
GCREC Mound Instrumentation: Soil Descriptions

Grid Location	Identifier	Surface Elevation (ft)	Depth bgs (ft)	Description
CD6.5	PZ10-CD6-13	129.51	0-0.4’	Grass/fill
			0.4-0.9’	Gray fine sand with yellow and white mottles
			0.9-6.6’	Uniform yellow fine grain sand
			6.5’	Saturation
			6.6-6.7’	Dark brown (10YR 3/3) fine sand
			6.7-10.7’	Light gray (5Y 7/2) fine sand
			10.7-11.5’	Dark brown (10YR 3/3) fine sand
			11.5-12.3’	Yellow (5Y 7/6) fine sand
			12.3-13.45’	Light gray (5Y 7/2) fine sand
			13.45-16.1’	Spodic horizon, dark brown (7.5YR 3/3) fine sand
			16.1-17.4’	Brown (7.5YR 4/4) fine sand
E9	PZ11-E09-10	124.06	0-2.2’	A Horizon top soil
			2.2-2.7’	Pale yellow (5Y 7/3) fine sand with mottles
			2.7-5.8’	Yellowish brown (10YR 5/4) fine sand
			5.8-6.9’	Very dark brown (7.5YR 2.5/3) fine sand
			6.1’	Saturation
			6.9-10.3’	Medium brown (10YR 5/3) fine sand
			10.3-15’	Spodic horizon, black (10YR 2/1) fine sand
F4	PZ13-F04-8	124.42	0-4.2’	A Horizon top soil
			4.2-4.7’	Pale yellow (5Y 8/4) fine sand with mottles
			4.7-13.5’	Spodic horizon, dark brown sand
			6.3’	Saturation

Grid Location	Identifier	Surface Elevation (ft)	Depth bgs (ft)	Description
Westside of Mound Near A9		~129	0-7.4’	Mound sand with some mottles
			7.4-8.4’	Dark oxidized sand
			8.4’	Saturation
			8.4-9.4’	Saturated very pale brown fine sand
			9.4-10’	Spodic horizon, dark brown fine sand
			10-12’	Dark yellowish brown (10YR 4/6) fine sand
			12-15’	Dark brown fine sand
G10	PZ12 Abandoned	123.55	0-1.2’	A Horizon top soil
			1.2-2.8’	White (10YR 8/2) fine sand
			2.8-6.1’	Spodic horizon, black fine sand
			6.1-9’	Brown (10YR 4/3) fine sand
			9’	Saturation
			9-10.1’	Gray (5Y 5/1) fine sand with black mottles
			10.1-13.9’	Black (5Y 2.5/1) fine sand
			13.9-16.6’	Light yellowish brown (10YR 6/4) uniform fine sand
			16.6-19’	Medium sand poorly sorted, well rounded (3mm diameter) with mottles
			19-23’	Pale brown (10YR 6/3) uniform fine sand
			23-27.5’	Very pale brown (10YR 7/3) very fine sand
			27.5-27.9’	Poorly sorted coarse sand
			27.9-30.0’	Greenish gray (Gley1 6/5GY) clay, Hawthorn confining layer

Table C.2
GCREC Mound Instrumentation: Soil Analytical Results

ID#	Sample ID	Depth	pH	BufpH	CEC	TN[1]	TKN	ON[2]	NH3-N	NOx-N	TIN[3]	OrgMt	Est. TOC[4]	K	Ca	Mg	Na
						mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	%	0.68% OM	mg/kg	mg/kg	mg/kg	mg/kg
1	O-10	0-1.57'	6.10	7.80	6.92	800.92	799.0897	797.44	1.65	1.83	3.48	2.11	1.43	27.19	634.0	50.20	23.68
2	O-10	1.57-2.49'	5.30	7.89	2.36	115.37	114.3235	113.31	1.02	1.05	2.06	0.20	0.14	12.89	42.86	1.58	21.25
3	O-10	2.49-3.58'	5.40	7.92	2.19	49.20	48.9296	48.06	0.87	0.27	1.14	0.14	0.10	11.81	38.34	1.99	23.84
4	O-10	3.58-5.1'	5.20	7.92	2.15	41.04	40.777	39.92	0.86	0.26	1.12	0.14	0.10	13.01	39.47	1.88	22.10
5	O-10	5.1-5.6'	4.70	7.76	3.79	66.94	66.7042	65.68	1.03	0.23	1.26	0.20	0.14	17.00	34.48	0.54	28.90
6	O-10	5.6-6.2'	4.60	7.52	6.20	116.14	115.8041	114.62	1.18	0.34	1.52	0.54	0.37	21.73	40.38	1.03	36.54
7	E-06	0-2.4'	6.10	7.81	8.48	741.19	716.9355	715.98	0.96	24.26	25.21	2.04	1.39	65.70	795.0	52.20	19.91
8	E-06	2.44-2.9'	6.10	7.87	3.22	145.49	144.4289	143.50	0.92	1.06	1.99	0.48	0.33	22.54	133.6	11.93	19.09
9	E-06	2.8-3.9'	5.10	NES[5]	1.31	54.49	54.1427	52.77	1.37	0.34	1.71	0.14	0.10	13.05	35.32	0.73	18.29
10	E-06	3.9-4'	6.10	7.93	2.33	56.94	56.5046	55.50	1.00	0.44	1.44	0.14	0.10	19.86	64.20	9.60	19.80
11	E-06	4-4.35'	5.80	7.97	1.65	60.71	58.6418	57.69	0.95	2.07	3.02	0.14	0.10	12.82	68.60	3.20	16.34
12	E-06	4.35-4.85'	4.60	NES[5]	1.52	54.22	52.7575	51.37	1.39	1.46	2.86	0.14	0.10	16.61	39.65	1.41	20.33
13	E-06	4.85-5.35'	4.40	NES[5]	1.73	204.35	201.9656	199.86	2.10	2.38	4.49	1.22	0.83	23.64	35.36	-1.41	22.07
14	E-06	6-8'	4.70	7.30	8.18	322.05	319.6979	318.72	0.98	2.35	3.33	2.38	1.62	19.44	42.37	0.63	42.80
15	G-10	0-1.2'	5.90	7.74	6.25	472.86	470.9396	465.80	5.14	1.92	7.06	1.70	1.16	46.82	352.9	20.01	23.97
16	G-10	1.2-2.8'	4.90	7.61	5.09	105.16	102.5401	98.95	3.59	2.62	6.21	0.41	0.28	20.74	57.40	3.35	25.84
17	G-10	2.8-6.1'	5.70	NES[5]	5.27	566.03	563.7461	557.91	5.84	2.28	8.12	1.50	1.02	65.50	380.3	28.36	33.38
18	G-10	6.1-9'	5.00	7.15	9.47	286.09	283.8583	280.52	3.34	2.23	5.57	2.24	1.52	38.03	91.50	3.93	27.73
19	G-10	9-10.1'	5.20	7.14	9.17	235.29	233.4414	231.18	2.26	1.85	4.10	1.50	1.02	26.30	89.80	3.17	26.30
20	G-10	10.1-13.9'	5.00	7.66	4.57	173.91	171.1635	169.04	2.13	2.74	4.87	1.22	0.83	19.31	65.10	0.78	23.52
21	G-10	13.9-16.6'	5.20	7.55	5.96	122.10	118.4095	115.41	3.00	3.69	6.69	0.75	0.51	28.65	74.30	2.94	28.17
22	G-10	16.6-19'	5.30	7.32	7.63	218.35	215.8369	213.42	2.42	2.52	4.93	1.50	1.02	30.33	77.50	2.77	23.10
23	G-10	19-23'	5.20	7.44	7.08	126.14	122.7524	120.20	2.56	3.39	5.95	0.68	0.46	33.10	109.4	5.16	26.63
24	G-10	23-27.5'	5.40	7.88	3.28	50.61	48.4507	46.62	1.83	2.16	3.99	0.14	0.10	19.62	170.6	9.63	20.22
25	G-10	27.5-27.9'	5.30	NES[5]	9.49	86.50	84.48341	81.07	3.41	2.02	5.43	0.27	0.18	33.57	1293	74.30	35.52
26	G-10	27.9-30'	5.70	7.71	34.05	237.70	235.0367	223.28	11.75	2.66	14.41	0.20	0.14	281.9	3035	850.0	51.70

T: for Value < MDL Non-detect

I: for Value >= MDL but < PQL

[1]Total Nitrogen (TN) is a calculated value equal to the sum of TKN and NO_X.

[2]Organic Nitrogen (ON) is a calculated value equal to the difference of TKN and NH_3.

[3]Total Inorganic Nitrogen (TIN) is a calculated value equal to the sum of NH_3 and NO_X.

[4]TOC calculated value typical range 0.58-0.70 of organic matter, using 0.68

[5]NES: for Not Enough Sample

Table C.3
GCREC Mound Instrumentation: Particle Size Distribution

Grid ID	Depth Bgs (ft)	Sand Fractions (%)					Total (%)				Texture Class
		Very Fine	Fine	Medium	Coarse	Very Coarse	Sand	Silt	Clay	Other	
		0.05-0.1 mm	0.25-0.1 mm	0.25-0.5 mm	0.5-1.0 mm	1.0-2.0 mm	0.05-2 mm	0.002-0.05 mm	<0.002 mm	>2 mm	
010	0-1.57	9.9	48.0	29.4	6.7	1.4	95.2	*	*	0.4	sand
	1.57-2.49	10.6	50.8	26.8	6.9	2.0	98.1	*	*	0.2	sand
	2.49-3.58	12.3	49.5	25.8	6.3	1.3	95.6	2.6	1.8	0.1	Sand
	3.58-5.1	12.0	49.1	24.9	6.7	1.8	95.0	4.3	0.7	0.2	sand
	5.1-5.6	7.3	42.4	25.1	7.4	2.4	84.1	3.4	12.5	0.6	loamy sand
	5.6-6.2	5.8	39.9	25.1	7.8	3.2	81.8	2.2	16.1	0.9	sandy loam
E06	0-2.4	11.0	48.7	28.3	5.5	1.1	94.6	3.9	1.5	0.2	sand
	2.4-2.9	12.4	47.0	22.7	4.9	1.3	88.1	11.4	0.5	0.2	sand
	2.8-3.9	11.6	49.5	27.4	7.2	2.0	97.5	2.5	0.0	0.2	sand
	2.9-4	12.7	50.5	24.8	5.3	1.0	94.3	4.3	1.4	0.2	sand
	4-4.35	12.8	50.3	25.7	6.6	1.3	96.9	2.8	0.3	0.3	sand
	4.35-4.85	9.4	47.0	26.9	7.3	2.6	93.1	5.2	1.7	1.3	sand
	4.85-5.35	5.8	46.6	26.9	6.1	2.4	88.3	6.2	5.5	1.4	sand
	6-8	5.2	48.0	32.2	6.2	1.0	93.0	4.1	2.9	0.2	sand
G10	0-1.2	11.9	47.6	27.8	5.9	1.1	94.7	3.2	2.1	0.2	sand
	1.2-2.8	10.0	46.7	27.2	6.9	1.5	92.3	3.6	4.1	0.6	sand
	2.8-6.1	11.7	46.6	27.4	7.0	1.4	94.0	4.3	1.6	0.3	sand
	6.1-9	8.9	49.8	26.2	3.9	1.1	90.1	8.8	1.1	0.8	sand
	9-10.1	7.2	44.1	34.4	6.0	0.8	92.6	6.5	0.9	0.1	sand
	10.1-13.9	3.1	37.5	45.9	5.6	0.7	92.4	6.2	1.4	0.0	sand
	13.9-16.6	2.5	33.7	48.3	7.1	1.0	92.8	3.2	3.9	0.3	sand
	16.6-19	2.3	14.2	54.3	19.3	2.2	92.0	5.4	2.6	1.3	sand
	19-23	1.7	40.4	46.8	5.3	0.4	94.7	1.9	3.4	0.5	sand
	23-27.5	4.2	76.2	6.4	0.4	0.1	87.5	8.2	4.2	0.2	sand
	27.5-27.9	4.5	44.7	11.2	7.1	10.9	79.5	3.5	17.0	41.2	sandy loam
	27.9-30									n/a	n/a

* Clay and silt values were not within acceptable limits.

Table C.4
S&GW Test Facility Instrumentation: Soil Descriptions

Grid Location	Identifier	Approximate Surface Elevation[1] (ft)	Depth bgs (ft)	Description
North of tracer test #2 area	TT	131.5	2-2.5’	10YR3/1 fine sand
			2.5-3.5’	10YR3/2 fine sand
			3.5-5.5’	10YR7/2 fine sand
			5.5-7’	Transition to Bh (spodic horizon)
			7-9.5’	10YR2/2 fine sand Bh (spodic horizon)
			9.5-14’	10YR5/3 fine sand
			14-15.5’	10YR4/3 fine sand
			15.5-16’+	10YR4/4 fine sand
Between TA2 and TA5	MM	130.5	0-2’	A Horizon top soil
			2.5-5.75’	10YR6/3 fine sand
			5.75-12.5’	10YR2/2 fine sand Bh (spodic horizon)
			12.5-17’	10YR4/4 fine sand
			17-27’	10YR5/4 fine sand
			27’+	Hawthorne clay
Test pit south of the S&GW test facility east of the GCREC mound	TP	127.0	0-6”	A horizon
			6”-1.5’	A/E horizon
			1.5-4.3’	E horizon
			4.3’+	Bh spodic horizon

[1]Elevation above mean sea level based on NGVD 1929

Table C.5
S&GW Test Facility Instrumentation: Soil Analytical Results

ID#	Sample ID	Depth	BufpH	CEC	TN[1]	TKN	ON[2]	NH3-N	NOx-N	TIN[3]	OrgMt	Est. TOC	P	K	Ca	Mg	Na
				calc	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	%	%,calc	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg
1	TT	2-3’	7.86	2.09	61.95	61.10	59.16	1.94	0.85	2.78	0.69	0.46	74.85	6.10	54.01	8.78	10.76
2	TT	3.5-5.5’	7.93	1.60	8.94	8.11	6.59	1.52	0.83	2.35	0.31	0.21	59.39	8.61	43.99	5.50	12.68
3	TT	7.5-9.5’	7.68	4.23	80.17	79.42	78.09	1.33	0.75	2.09	1.84	1.23	181.45	8.05	135.37	7.37	16.75
4	TT	10.5-12’	7.77	3.06	2.01	1.33	0.17	1.16	0.68	1.84	1.05	0.70	261.16	6.24	50.00	2.70	18.10
5	TT	12-14’	7.69	3.91	78.62	77.49	75.68	1.81	1.13	2.94	1.86	1.25	207.84	8.20	58.81	4.24	20.38
6	TT	14-15.5’	7.66	4.18	68.90	67.68	66.10	1.58	1.22	2.80	2.01	1.35	206.70	8.73	62.49	4.83	20.39
7	TT	15.5-16’	7.55	5.12	126.45	125.05	123.16	1.89	1.40	3.29	3.79	2.54	261.66	9.07	104.25	8.44	16.07
8	MM	2-2.5’	7.80	2.66	89.34	88.42	85.56	2.86	0.92	3.77	0.97	0.65	62.98	8.69	61.43	3.83	11.40
9	MM	2.5-4’	7.93	1.41	9.76	8.48	7.04	1.44	1.28	2.72	0.38	0.25	27.71	6.82	33.13	3.84	11.08
10	MM	4-5’	7.89	2.52	-6.65	-7.51	-9.48	1.97	0.86	2.82	0.50	0.34	50.58	31.25	54.51	4.25	12.27
11	MM	6-7’	7.31	6.74	365.91	363.95	361.83	2.12	1.96	4.08	4.56	3.06	174.57	7.21	44.71	2.86	18.18
12	MM	7-8’	7.31	6.62	208.93	207.84	206.10	1.74	1.09	2.83	5.45	3.65	55.95	7.74	45.33	2.00	15.13
13	MM	8-9’	7.18	7.83	224.01	223.22	221.63	1.59	0.79	2.38	6.90	4.62	40.88	8.15	56.32	3.25	17.39
14	MM	9-10’	7.38	6.18	159.26	158.21	156.68	1.53	1.05	2.58	6.44	4.31	83.84	6.75	46.47	2.64	18.24
15	MM	12.5-14’	7.52	5.18	96.14	95.42	94.30	1.12	0.72	1.84	3.38	2.26	196.54	6.77	55.24	3.54	19.75
16	MM	14.5-16’	7.48	5.72	99.63	98.84	97.95	0.89	0.79	1.68	5.51	3.69	480.47	11.52	74.31	4.25	19.83
17	MM	17-18’	7.48	5.95	153.33	151.73	150.44	1.29	1.60	2.89	4.36	2.92	291.80	16.78	98.28	7.52	18.47
18	MM	19-20’	7.55	4.88	94.36	93.08	91.84	1.24	1.28	2.51	2.97	1.99	549.39	9.22	69.52	4.18	15.13
19	MM	23-24’	7.61	4.56	68.43	66.30	64.85	1.45	2.13	3.58	1.97	1.32	627.02	9.81	76.67	5.25	17.46
20	MM	25-26'	7.82	3.13	75.47	73.10	71.98	1.12	2.37	3.50	2.03	1.36	727.00	10.05	82.41	6.88	22.18
21	MM	26-27’	7.65	4.45	58.69	57.13	56.44	0.69	1.56	2.26	1.56	1.05	520.46	8.62	73.16	6.09	23.34
22	Test Pit A horizon	0-6" bg	7.70	5.88	610.96	610.10	607.15	2.95	0.86	3.81	2.99	2.00	334.98	17.64	433.67	33.00	13.41
23	Test Pit A/E horizon	1' bg	7.74	3.10	186.16	185.58	184.02	1.56	0.58	2.14	1.52	1.02	92.08	7.96	51.80	4.06	12.12
24	Test Pit E horizon	3' bg	7.96	1.20	20.64	20.11	19.06	1.05	0.53	1.58	0.37	0.25	19.13	3.50	33.85	3.93	13.48
25	Test Pit Spodic	6' bg	7.30	6.56	380.60	379.37	378.14	1.23	1.23	2.46	5.58	3.74	155.35	3.34	39.36	2.57	15.16

T: for Value < MDL Non-detect

I: for Value >= MDL but < PQL

[1]Total Nitrogen (TN) is a calculated value equal to the sum of TKN and NO_X.

[2]Organic Nitrogen (ON) is a calculated value equal to the difference of TKN and NH_3.

[3]Total Inorganic Nitrogen (TIN) is a calculated value equal to the sum of NH_3 and NO_X.

[4]TOC calculated value typical range 0.58-0.70 of organic matter, using 0.68

Table C.6
S&GW Test Facility Instrumentation: Particle Size Distribution

ID	Depth Bgs (ft)	Sand Fractions (%)					Total (%)			Texture Class
		Very Fine	Fine	Medium	Coarse	Very Coarse	Sand	Silt	Clay	
		0.05-0.1 mm	0.25-0.1 mm	0.25-0.5 mm	0.5-1.0 mm	1.0-2.0 mm	0.05-2 mm	0.002-0.05 mm	<0.002 mm	
TT	2-3’	8.4	45.9	31.7	6.1	0.8	95.6	1.2	3.2	Sand
	3.5-5.5’	7.9	44.3	35.6	7.7	1.1	96.4	1.2	2.4	Sand
	7.5-9.5’	5.4	55.0	26.7	5.0	1.3	93.0	2.9	4.1	Fine Sand
	10.5-12’	3.7	49.9	30.3	7.2	3.5	95.0	1.8	3.2	Sand
	12-14’	3.2	52.4	29.0	6.5	3.4	94.9	2.7	2.4	Fine Sand
	14-15.5’	1.1	62.9	28.6	4.2	1.1	98.1	0.3	1.6	Fine Sand
	14-15.5’	1.6	65.2	26.2	4.0	1.1	98.2	0.1	1.6	Fine Sand
	15.5-16’	4.8	51.1	33.3	4.7	1.2	95.6	2.8	1.6	Fine Sand
MM	2-2.5’	7.9	45.4	30.2	6.3	1.1	95.6	1.2	3.2	Sand
	2.5-4’	7.9	47.3	29.4	8.2	1.6	94.9	3.4	3.2	Sand
	4-5’	9.3	47.1	25.7	6.4	1.5	90.3	8.1	1.6	Sand
	6-7’	3.1	55.2	28.5	5.2	2.4	95.1	4.0	1.6	Fine Sand
	7-8’	3.7	50.9	34.6	4.6	0.3	95.6	2.7	1.7	Fine Sand
	8-9’	2.3	35.3	47.7	5.1	0.4	93.7	5.4	0.8	Sand
	9-10’	3.6	25.1	60.8	5.4	0.7	96.0	1.5	2.5	Sand
	12.5-14’	1.8	35.3	54.2	4.5	0.6	96.7	3.3	0.0	Sand
	14.5-16’	2.9	38.9	42.1	5.4	1.8	91.3	6.1	2.5	Sand
	17-18’	3.4	40.7	37.9	7.1	1.5	90.7	9.3	BDL	Sand
	19-20’	1.6	35.3	51.1	7.1	1.5	96.4	1.2	2.4	Sand
	23-24’	1.2	29.4	52.8	8.1	0.6	91.9	5.7	2.4	Sand
	25-26'	2.0	43.2	38.8	0.7	0.8	89.3	9.1	1.6	Sand
	26-27’	1.3	37.6	48.6	7.1	1.1	95.6	2.7	1.6	Sand
Test Pit	0-6"	10.1	49.4	29.2	5.3	1.0	94.9	1.0	4.1	Sand
	1'	6.8	47.4	34.0	7.1	1.2	94.6	2.2	3.2	Sand
	3'	9.9	47.7	27.4	7.1	1.7	93.9	3.6	2.5	Sand
	6'	4.7	44.7	39.1	6.4	1.3	96.3	1.2	2.5	Sand
	6'	4.8	45.8	35.1	5.5	1.6	92.8	5.5	1.7	Sand

Table C.7
TA3 Instrumentation: Soil Analytical Results

ID#	Sample ID	Depth	pH	BufpH	CEC	TN[1]	TKN	ON[2]	NH3-N	NOx-N	TIN[3]	OrgMt	C[4]	P	K	Ca	Mg	B	Na	Ec	Cl
					calc	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	%	%	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	ds/m	mg/kg
1	P5	0-0.5'	5.77	7.72	6.79	619.87	607.8	607.26	0.51	12.10	12.61	2.25	1.51	203.8	41.57	537.6	51.45	0.21	8.51	0.08	7.44
2	P5	0.5-2.0'	5.78	7.68	6.05	575.50	571.8	571.29	0.50	3.71	4.21	2.49	1.67	176.3	8.15	512.0	43.32	0.24	8.28	0.03	2.26
3	P5	2.0-3.8'	5.92	7.76	4.17	201.82	200.9	200.40	0.46	0.96	1.42	1.25	0.84	74.88	5.09	302.2	24.98	0.05	9.13	0.03	2.28
4	P5	3.8-5'	5.02	7.86	2.39	94.46	89.46	88.78	0.68	5.00	5.68	0.53	0.36	15.92	4.87	59.63	11.72	0.40	17.31	0.03	12.81
5	P5	5-6.7'	5.14	7.88	2.45	73.94	68.72	68.00	0.72	5.22	5.94	0.49	0.33	54.50	6.45	66.55	10.26	0.10	20.85	0.06	5.65
6	P5	6.7-7.4'	4.52	7.10	8.74	259.10	250.5	249.51	1.01	8.58	9.59	5.98	4.01	199.8	11.03	72.29	9.47	-0.22	18.69	0.09	9.07
7	P5	7.4-8.6'	4.69	7.13	8.24	209.76	204.5	202.29	2.19	5.28	7.48	5.17	3.46	132.0	10.10	68.65	8.24	-0.17	13.94	0.07	5.02
8	P5	8.6-10'	4.53	7.47	5.14	185.51	183.5	182.75	0.79	1.97	2.77	2.32	1.55	81.89	3.75	33.64	5.21	-0.20	13.55	0.06	3.79
9	P5	10-12.5'	4.85	6.99	9.25	281.78	279.4	278.69	0.71	2.38	3.09	7.31	4.90	82.45	10.09	74.03	6.98	-0.23	11.00	0.05	2.44
10	P5	12.5-15'	5.06	7.09	8.80	291.21	288.2	285.34	2.86	3.01	5.87	6.37	4.27	112.7	17.15	92.74	9.60	-0.25	12.39	0.05	2.21
11	Obs-N (C2)	0-2.7'	5.99	7.72	7.11	529.77	520.4	520.16	0.26	9.35	9.60	2.06	1.38	313.5	22.06	584.3	52.98	0.16	21.66	0.06	3.76
12	Obs-N (C2)	2.7-3.3'	6.04	7.68	5.53	234.85	229.7	229.17	0.55	5.13	5.68	1.76	1.18	178.6	15.64	303.4	35.04	-0.03	17.45	0.05	4.84
13	Obs-N (C2)	3.3-3.9'	5.16	7.77	2.97	125.71	120.7	120.19	0.51	5.01	5.52	0.91	0.61	32.54	6.47	66.78	11.53	0.12	12.20	0.05	4.27
14	Obs-N (C2)	3.9-5'	4.98	7.84	2.45	109.08	103.2	102.30	0.88	5.90	6.78	0.48	0.32	29.28	5.81	53.23	13.08	0.21	14.83	0.05	6.06
15	Obs-N (C2)	5-6.1'	6.04	7.90	2.03	70.46	69.74	68.88	0.86	0.72	1.58	0.41	0.27	33.93	8.20	86.15	15.83	0.14	10.46	0.03	6.59
16	Obs-N (C2)	6.1-8.2'	5.22	7.36	6.45	171.17	170.8	170.85	-0.09	0.41	0.31	3.59	2.41	269.1	10.20	98.52	13.29	-0.21	10.77	0.05	2.66
17	Obs-N (C2)	8.2-8.6'	5.13	7.14	9.00	272.00	271.5	270.43	1.06	0.51	1.57	4.72	3.16	160.0	34.39	88.74	15.47	0.15	15.31	0.04	2.64
18	Obs-N (C2)	8.6-10'	4.60	7.24	7.54	280.68	278.7	276.46	2.20	2.02	4.22	4.17	2.79	108.0	21.75	56.83	7.14	0.01	12.92	0.05	2.33

T: for Value < MDL Non-detect

I: for Value >= MDL but < PQL

[1]Total Nitrogen (TN) is a calculated value equal to the sum of TKN and NO_X.

[2]Organic Nitrogen (ON) is a calculated value equal to the difference of TKN and NH_3.

[3]Total Inorganic Nitrogen (TIN) is a calculated value equal to the sum of NH_3 and NO_X.

[4]TOC calculated value typical range 0.58-0.70 of organic matter, using 0.67.

Table C.8
TA3 Instrumentation: Particle Size Distribution

			Particle Size Ditribution (% <2mm)								Texture Class
ID#	**Sample ID**	**Depth**	Sand Fractions (%)					Total (%)			
			Very Coarse	Coarse	Medium	Fine	Very Fine	Sand	Silt	Clay	
			2.0-1.0 mm	1.0-0.5 mm	0.5-0.25 mm	0.25-0.10 mm	0.10-0.05 mm	2.0-0.05	0.05-0.002	<0.002	
1	P5	0-0.5'	0.7	4.6	30.3	49.1	11.6	95.2	1.8	3.0	sand
2	P5	0.5-2.0'	0.6	5.5	29.1	49.2	11.0	95.0	1.9	3.1	sand
3	P5	2.0-3.8'	1.2	5.4	25.7	50.7	10.8	93.7	2.9	3.4	fine sand
4	P5	3.8-5'	1.6	6.6	26.6	52.6	10.4	95.5	1.3	3.1	fine sand
5	P5	5-6.7'	1.2	6.5	25.1	50.3	11.0	94.9	2.0	3.1	fine sand
6	P5	6.7-7.4'	2.2	5.5	25.1	49.4	6.6	88.5	5.8	5.7	sand
7	P5	7.4-8.6'	2.0	5.4	27.0	50.3	6.0	91.4	4.7	3.9	fine sand
8	P5	8.6-10'	1.4	5.1	31.7	49.9	4.5	94.0	2.2	3.8	sand
9	P5	10-12.5'	0.5	7.0	56.0	24.7	3.6	92.3	5.1	2.6	sand
10	P5	12.5-15'	0.9	6.8	52.3	29.3	2.5	93.1	4.0	2.9	sand
11	Obs-N (C2)	0-2.7'	0.8	4.5	25.5	51.2	12.7	94.8	1.5	3.7	fine sand
12	Obs-N (C2)	2.7-3.3'	1.2	5.4	58.0	25.5	3.1	94.4	1.7	3.9	sand
13	Obs-N (C2)	3.3-3.9'	0.1	0.5	24.8	51.7	11.6	94.3	2.2	3.6	fine sand
14	Obs-N (C2)	3.9-5'	1.0	8.2	25.7	50.1	10.8	95.1	1.2	3.7	fine sand
15	Obs-N (C2)	5-6.1'	1.5	6.2	25.3	51.5	10.6	94.9	1.2	3.8	fine sand
16	Obs-N (C2)	6.1-8.2'	1.7	7.8	29.1	47.2	4.1	90.3	2.1	7.6	sand
17	Obs-N (C2)	8.2-8.6'	3.8	6.9	26.8	48.9	3.2	89.7	1.6	8.7	sand
18	Obs-N (C2)	8.6-10'	1.1	5.4	26.4	59.0	2.4	94.4	1.0	4.7	fine sand
DUP 9	P5	10-12.5'	0.6	7.3	56.5	24.1	3.2	92.0	5.2	2.7	sand
DUP 17	Obs-N (C2)	8.2-8.6'	3.4	6.7	26.7	50.6	3.4	90.6	1.2	8.3	fine sand

Appendix D: S&GW Test Facility Monitoring Network Identification

Table D.1
S&GW Test Facility Sample Identification

ID #	Sample Identification	Test Area	Grid Location	Northing	Easting	Elev NGVD 29	Notes
1	TA1-PAN-12-N	TA1	North				2' x 3.3' SST pan lysimeter
2	TA1-OBS-N	TA1	North	1244816.74	582859.20	132.50	4"D observation port with slots
3	TA1-OBS-S	TA1	South	1244807.75	582855.08	132.88	4"D observation port without slots
4	TA1-SM-39-N	TA1	North	1244817.38	582860.13	130.27	2"D soil moisture tube with 6" casing
5	TA1-SM-39-C	TA1	Center	1244812.80	582858.09	130.23	2"D soil moisture tube with 6" casing
6	TA1-SM-39-S	TA1	South	1244803.79	582854.15	130.24	2"D soil moisture tube with 6" casing
7	TA1-SM-BKG-S	TA1	South	1244778.23	582851.49	128.69	2"D soil moisture tube with 6" casing
8	TA1-SM-BKG-E	TA1	East	1244814.73	582868.76	129.29	2"D soil moisture tube with 6" casing
9	TA1-PZ-11-EF2	TA1	EF2	1244812.14	582857.35	133.59	1"D standpipe piezometer, 5' screen
10	TA1-LY-24-C	TA1	Center	1244811.87	582857.75	133.69	2"D suction lysimeter, 9" cup
11	TA1-LY-12-S	TA1	South	1244804.42	582853.25	132.60	2"D suction lysimeter, 9" cup
12	TA1-LY-24-S	TA1	South	1244804.42	582854.46	134.14	2"D suction lysimeter, 9" cup
13	TA1-LY-42-S	TA1	South	1244805.37	582853.79	132.66	2"D suction lysimeter, 9" cup
14	TA1-T-6-C	TA1	Center	1244813.56	582858.66	132.34	tensiometer
15	TA1-T-12-C	TA1	Center	1244813.75	582858.12	132.34	tensiometer
16	TA1-T-24-C	TA1	Center	1244813.77	582857.64	132.33	tensiometer
17	TA1-T-36-C	TA1	Center	1244813.80	582857.36	132.36	tensiometer
18	TA1-T-42-C	TA1	Center	1244813.34	582857.00	132.88	tensiometer
19	TA1-T-6-S	TA1	South	1244804.28	582853.77	132.32	tensiometer
20	TA1-T-12-S	TA1	South	1244803.87	582852.93	132.35	tensiometer
21	TA1-T-24-S	TA1	South	1244803.71	582852.77	132.36	tensiometer
22	TA1-T-36-S	TA1	South	1244803.49	582852.89	132.38	tensiometer
23	TA1-T-42-S	TA1	South	1244803.01	582853.26	132.80	tensiometer
24	TA1-PZ-11-J4	TA1	J4	1244805.79	582849.87	133.57	1"D standpipe piezometer, 5' screen
25	TA1-PZ-11-K4	TA1	K4	1244803.97	582849.03	133.58	1"D standpipe piezometer, 5' screen
26	TA1-PZ-11-L2	TA1	L2	1244800.25	582851.77	133.57	1"D standpipe piezometer, 5' screen
27	TA1-PZ-11-L3	TA1	L3	1244801.20	582849.94	133.57	1"D standpipe piezometer, 5' screen

Table D.1
S&GW Test Facility Sample Identification

ID #	Sample Identification	Test Area	Grid Location	Northing	Easting	Elev NGVD 29	Notes
28	TA1-PZ-11-L4	TA1	L4	1244802.21	582848.15	133.57	1"D standpipe piezometer, 5' screen
29	TA1-PZ-11-L5	TA1	L5	1244803.08	582846.26	133.57	1"D standpipe piezometer, 5' screen
30	TA1-PZ-09-N3	TA1	N3	1244798.01	582846.48	130.43	1"D standpipe piezometer, 5' screen
31	TA1-PZ-16-N3	TA1	N3	1244798.02	582846.37	130.44	1"D standpipe piezometer, 2.5' screen
32	TA1-PZ-09-O7	TA1	O7	1244798.67	582839.96	130.08	1"D standpipe piezometer, 5' screen
33	TA1-PZ-16-O7	TA1	O7	1244799.11	582839.97	130.30	1"D standpipe piezometer, 2.5' screen
34	TA1-PZ-09-M9	TA1	M9	1244804.22	582839.66	130.60	1"D standpipe piezometer, 5' screen
35	TA1-PZ-16-M9	TA1	M9	1244804.35	582839.62	130.64	1"D standpipe piezometer, 2.5' screen
36	TA1-PZ-09-I7	TA1	I7	1244810.91	582845.19	130.27	1"D standpipe piezometer, 5' screen
37	TA1-PZ-16-I7	TA1	I7	1244810.78	582845.02	130.33	1"D standpipe piezometer, 2.5' screen
38	TA1-PZ-09-RS16	TA1	RS16	1244792.19	582817.42	129.65	1"D standpipe piezometer, 5' screen
39	TA1-PZ-16-RS16	TA1	RS16	1244792.14	582817.50	129.72	1"D standpipe piezometer, 2.5' screen
40	TA1-PZ-09-RS18	TA1	RS18	1244792.34	582812.82	130.25	1"D standpipe piezometer, 5' screen
41	TA1-PZ-16-RS18	TA1	RS18	1244792.43	582812.72	130.25	1"D standpipe piezometer, 2.5' screen
42	TA2-PAN-12-N	TA2	North				2' x 3.3' SST pan lysimeter
43	TA2-OBS-N	TA2	North	1244818.77	582722.04	131.67	4"D observation port with slots
44	TA2-OBS-S	TA2	South	1244809.76	582718.30	132.27	4"D observation port without slots
45	TA2-SM-39-C	TA2	Center	1244814.95	582721.02	129.80	2"D soil moisture tube with 6" casing
46	TA2-PZ-10-EF2	TA2	EF2	1244814.23	582720.22	133.90	1"D standpipe piezometer, 5' screen
47	TA2-LY-24-C	TA2	Center	1244814.09	582720.59	132.60	2"D suction lysimeter, 9" cup
48	TA2-LY-12-S	TA2	South	1244806.60	582716.48	132.02	2"D suction lysimeter, 9" cup
49	TA2-LY-24-S	TA2	South	1244806.64	582717.52	132.62	2"D suction lysimeter, 9" cup
50	TA2-LY-42-S	TA2	South	1244807.39	582716.98	133.11	2"D suction lysimeter, 9" cup
51	TA2-PZ-10-H5	TA2	H5	1244810.74	582712.43	133.76	1"D standpipe piezometer, 5' screen
52	TA2-PZ-10-J5	TA2	J5	1244807.11	582710.94	133.73	1"D standpipe piezometer, 5' screen
53	TA2-PZ-10-K5	TA2	K5	1244805.14	582710.05	133.74	1"D standpipe piezometer, 5' screen
54	TA2-PZ-10-L2	TA2	L2	1244801.12	582714.87	133.74	1"D standpipe piezometer, 5' screen
55	TA2-PZ-10-L3	TA2	L3	1244801.83	582713.03	133.73	1"D standpipe piezometer, 5' screen
56	TA2-PZ-10-L4	TA2	L4	1244802.60	582711.25	133.52	1"D standpipe piezometer, 5' screen

Table D.1
S&GW Test Facility Sample Identification

ID #	Sample Identification	Test Area	Grid Location	Northing	Easting	Elev NGVD 29	Notes
57	TA2-PZ-10-L5	TA2	L5	1244803.37	582709.39	133.73	1"D standpipe piezometer, 5' screen
58	TA2-PZ-10-L6	TA2	L6	1244804.19	582707.50	133.72	1"D standpipe piezometer, 5' screen
59	TA2-PZ-09-M4	TA2	M4	1244800.19	582709.27	129.51	1"D standpipe piezometer, 5' screen
60	TA2-PZ-16-M4	TA2	M4	1244800.27	582709.49	129.50	1"D standpipe piezometer, 2.5' screen
61	TA2-PZ-09-N7	TA2	N7	1244801.15	582703.29	129.36	1"D standpipe piezometer, 5' screen
62	TA2-PZ-16-N7	TA2	N7	1244801.21	582703.43	129.37	1"D standpipe piezometer, 2.5' screen
63	TA2-PZ-09-I7	TA2	I7	1244810.20	582707.91	129.10	1"D standpipe piezometer, 5' screen
64	TA2-PZ-16-I7	TA2	I7	1244810.37	582707.66	129.52	1"D standpipe piezometer, 2.5' screen
65	TA2-PZ-09-L8	TA2	L8	1244806.27	582704.93	129.28	1"D standpipe piezometer, 5' screen
66	TA2-PZ-16-L8	TA2	L8	1244806.33	582704.81	129.27	1"D standpipe piezometer, 2.5' screen
67	TA2-PZ-09-TU19	TA2	TU19	1244790.44	582673.66	128.68	1"D standpipe piezometer, 5' screen
68	TA2-PZ-16-TU19	TA2	TU19	1244790.49	582673.49	128.62	1"D standpipe piezometer, 2.5' screen
69	TA2-PZ-09-TU21	TA2	TU21	1244790.32	582669.75	128.58	1"D standpipe piezometer, 5' screen
70	TA2-PZ-16-TU21	TA2	TU21	1244790.60	582669.40	128.98	1"D standpipe piezometer, 2.5' screen
71	TA3-PAN-12-N	TA3	North				2' x 3.3' SST pan lysimeter
72	TA3-OBS-N	TA3	North	1244817.49	582814.57	131.20	4"D observation port with slots
73	TA3-OBS-S	TA3	South	1244808.15	582811.07	131.11	4"D observation port without slots
74	TA3-SM-39-N	TA3	North	1244817.96	582815.53	130.59	2"D soil moisture tube with 6" casing
75	TA3-SM-39-C	TA3	Center	1244813.53	582813.63	130.60	2"D soil moisture tube with 6" casing
76	TA3-SM-39-S	TA3	South	1244804.15	582809.89	130.57	2"D soil moisture tube with 6" casing
77	TA3-SM-BKG-S	TA3	South	1244795.29	582807.19	129.32	2"D soil moisture tube with 6" casing
78	TA3-SM-BKG-E	TA3	East				2"D soil moisture tube with 6" casing
79	TA3-LY-24-C	TA3	Center	1244812.47	582813.21	133.45	2"D suction lysimeter, 9" cup
80	TA3-LY-12-S	TA3	South	1244804.97	582809.16	132.24	2"D suction lysimeter, 9" cup
81	TA3-LY-24-S	TA3	South	1244804.93	582810.17	132.90	2"D suction lysimeter, 9" cup
82	TA3-LY-42-S	TA3	South	1244805.73	582809.79	132.98	2"D suction lysimeter, 9" cup
83	TA3-T-6-C	TA3	Center	1244814.37	582813.76	132.19	tensiometer
84	TA3-T-12-C	TA3	Center	1244814.50	582813.46	132.70	tensiometer
85	TA3-T-24-C	TA3	Center	1244814.56	582813.15	132.23	tensiometer

Table D.1
S&GW Test Facility Sample Identification

ID #	Sample Identification	Test Area	Grid Location	Northing	Easting	Elev NGVD 29	Notes
86	TA3-T-36-C	TA3	Center	1244814.31	582812.76	131.70	tensiometer
87	TA3-T-42-C	TA3	Center	1244813.89	582812.49	132.20	tensiometer
88	TA3-T-6-S	TA3	South	1244805.33	582809.71	132.19	tensiometer
89	TA3-T-12-S	TA3	South	1244804.36	582809.00	132.69	tensiometer
90	TA3-T-24-S	TA3	South	1244803.69	582808.77	132.22	tensiometer
91	TA3-T-36-S	TA3	South	1244803.59	582808.72	131.71	tensiometer
92	TA3-T-42-S	TA3	South	1244803.27	582809.06	132.21	tensiometer
93	TA3-PZ-11-EF2	TA3	EF2	1244812.64	582812.80	133.82	1"D standpipe piezometer, 5' screen
94	TA3-PZ-11-I2	TA3	I2	1244806.39	582810.24	133.54	1"D standpipe piezometer, 5' screen
95	TA3-PZ-10-J5	TA3	J5	1244806.06	582803.49	133.49	1"D standpipe piezometer, 5' screen
96	TA3-PZ-10-K5	TA3	K5	1244804.12	582802.85	133.49	1"D standpipe piezometer, 5' screen
97	TA3-PZ-11-L2	TA3	L2	1244800.38	582808.17	133.51	1"D standpipe piezometer, 5' screen
98	TA3-PZ-11-L3	TA3	L3	1244800.93	582806.21	133.51	1"D standpipe piezometer, 5' screen
99	TA3-PZ-11-L4	TA3	L4	1244801.63	582804.23	133.50	1"D standpipe piezometer, 5' screen
100	TA3-PZ-10-L5	TA3	L5	1244802.21	582802.23	133.49	1"D standpipe piezometer, 5' screen
101	TA3-PZ-09-N3	TA3	N3	1244798.56	582803.29	129.88	1"D standpipe piezometer, 5' screen
102	TA3-PZ-16-N3	TA3	N3	1244798.87	582803.18	129.89	1"D standpipe piezometer, 2.5' screen
103	TA3-PZ-09-O7	TA3	O7	1244798.85	582797.09	130.06	1"D standpipe piezometer, 5' screen
104	TA3-PZ-16-O7	TA3	O7	1244798.94	582796.81	130.26	1"D standpipe piezometer, 2.5' screen
105	TA3-PZ-09-I7	TA3	I7	1244809.85	582798.46	130.06	1"D standpipe piezometer, 5' screen
106	TA3-PZ-16-I7	TA3	I7	1244810.00	582798.53	130.06	1"D standpipe piezometer, 2.5' screen
107	TA3-PZ-09-M9	TA3	M9	1244803.45	582796.14	130.18	1"D standpipe piezometer, 5' screen
108	TA3-PZ-16-M9	TA3	M9	1244803.44	582796.02	130.12	1"D standpipe piezometer, 2.5' screen
109	TA3-PZ-09-ST14	TA3	ST14	1244790.15	582780.80	129.88	1"D standpipe piezometer, 5' screen
110	TA3-PZ-16-ST14	TA3	ST14	1244790.27	582780.68	129.81	1"D standpipe piezometer, 2.5' screen
111	TA3-PZ-09-ST16	TA3	ST16	1244790.74	582776.81	129.54	1"D standpipe piezometer, 5' screen
112	TA3-PZ-16-ST16	TA3	ST16	1244790.24	582776.71	130.00	1"D standpipe piezometer, 2.5' screen
113	TA4-PAN-12-N	TA4	North				2' x 3.3' SST pan lysimeter
114	TA4-OBS-N	TA4	North	1244819.86	582676.19	129.91	4"D observation port with slots

Table D.1
S&GW Test Facility Sample Identification

ID #	Sample Identification	Test Area	Grid Location	Northing	Easting	Elev NGVD 29	Notes
115	TA4-OBS-S	TA4	South	1244810.58	582672.01	129.85	4"D observation port without slots
116	TA4-SM-39-C	TA4	Center	1244815.85	582674.87	129.25	2"D soil moisture tube with 6" casing
117	TA4-LY-24-C	TA4	Center	1244814.82	582674.46	132.10	2"D suction lysimeter, 9" cup
118	TA4-LY-12-S	TA4	South	1244807.65	582670.18	130.89	2"D suction lysimeter, 9" cup
119	TA4-LY-24-S	TA4	South	1244807.45	582671.38	132.75	2"D suction lysimeter, 9" cup
120	TA4-LY-42-S	TA4	South	1244808.40	582670.62	132.57	2"D suction lysimeter, 9" cup
121	TA4-PZ-11-EF2	TA4	EF2	1244815.06	582674.02	132.53	1"D standpipe piezometer, 5' screen
122	TA4-PZ-10-H5	TA4	H5	1244812.91	582666.75	132.48	1"D standpipe piezometer, 5' screen
123	TA4-PZ-10-J5	TA4	J5	1244809.21	582664.90	132.47	1"D standpipe piezometer, 5' screen
124	TA4-PZ-10-K5	TA4	K5	1244807.45	582664.07	132.47	1"D standpipe piezometer, 5' screen
125	TA4-PZ-11-L2	TA4	L2	1244803.06	582668.66	132.47	1"D standpipe piezometer, 5' screen
126	TA4-PZ-11-L3	TA4	L3	1244804.02	582666.85	132.48	1"D standpipe piezometer, 5' screen
127	TA4-PZ-11-L4	TA4	L4	1244804.79	582665.10	132.46	1"D standpipe piezometer, 5' screen
128	TA4-PZ-11-L5	TA4	L5	1244805.65	582663.28	132.46	1"D standpipe piezometer, 5' screen
129	TA4-PZ-11-L6	TA4	L6	1244806.56	582661.46	132.46	1"D standpipe piezometer, 5' screen
130	TA4-PZ-09-M4	TA4	M4	1244802.46	582663.97	128.96	1"D standpipe piezometer, 5' screen
131	TA4-PZ-16-M4	TA4	M4	1244802.29	582664.28	129.54	1"D standpipe piezometer, 5' screen
132	TA4-PZ-09-N7	TA4	N7	1244807.44	582664.14	132.47	1"D standpipe piezometer, 5' screen
133	TA4-PZ-16-N7	TA4	N7	1244803.91	582657.76	128.94	1"D standpipe piezometer, 5' screen
134	TA4-PZ-09-I7	TA4	I7	1244812.68	582663.21	128.83	1"D standpipe piezometer, 5' screen
135	TA4-PZ-16-I7	TA4	I7	1244812.80	582663.08	129.25	1"D standpipe piezometer, 5' screen
136	TA4-PZ-09-L8	TA4	L8	1244807.67	582657.70	128.63	1"D standpipe piezometer, 5' screen
137	TA4-PZ-16-L8	TA4	L8	1244807.84	582657.44	128.92	1"D standpipe piezometer, 5' screen
138	TA4-PZ-09-TU14	TA4	TU14	1244793.10	582638.92	128.32	1"D standpipe piezometer, 5' screen
139	TA4-PZ-16-TU14	TA4	TU14	1244792.96	582639.30	129.06	1"D standpipe piezometer, 5' screen
140	TA4-PZ-09-TU16	TA4	TU16	1244794.18	582633.89	128.57	1"D standpipe piezometer, 5' screen
141	TA4-PZ-16-TU16	TA4	TU16	1244793.99	582634.17	128.70	1"D standpipe piezometer, 5' screen
142	TA5-OBS-I	TA5	Center	1244812.47	582770.36	132.52	4"D observation port, for infiltrator system
143	TA5-OBS-N	TA5	North	1244817.64	582767.53	132.87	3"D observation port connected to collection pipe at bottom of sloped liner

Table D.1
S&GW Test Facility Sample Identification

ID #	Sample Identification	Test Area	Grid Location	Northing	Easting	Elev NGVD 29	Notes
144	TA5-OBS-S	TA5	South	1244810.89	582764.74	132.91	3"D observation port connected to collection pipe at bottom of sloped liner
145	TA5-PZ-I	TA5	South	1244802.11	582764.97	133.23	1"D standpipe piezometer, 5' screen south of infiltrator
146	TA5-LY-C	TA5	Center	1244814.05	582766.03	133.15	2"D suction lysimeter, 9" cup at mix-ture and sand interface
147	TA5-LINER-SP	TA5	North	1244827.69	582771.40	131.20	3"D sample port
148	TA5-CLEANOUT	TA5	North	1244829.07	582772.03	131.60	4"D clean-out
149	TA5-Denite Tank	TA5	North	1244831.25	582772.19	129.90	
150	TA6-OBS-I	TA6	Center	1244814.51	582630.94	131.40	4"D observation port, for infiltrator system
151	TA6-OBS-N	TA6	North	1244819.57	582628.85	131.94	3"D observation port connected to collection pipe at bottom of sloped liner
152	TA6-OBS-S	TA6	South	1244812.49	582625.84	132.28	3"D observation port connected to collection pipe at bottom of sloped liner
153	TA6-PZ-I	TA6	South	1244804.06	582626.81	133.43	1"D standpipe piezometer, 5' screen south of infiltrator
154	TA6-LY-C	TA6	Center	1244815.99	582627.26	132.41	2"D suction lysimeter, 9" cup at mix-ture and sand interface
155	TA6-LINER-SP	TA6	North	1244829.10	582632.72	130.89	3"D sample port
156	TA6-CLEANOUT	TA6	North	1244830.50	582633.21	130.48	4"D clean-out
157	TA6-Denite Tank	TA6	North	1244832.30	582633.85	128.98	
158	PZ01-BKG-09	BKG		1244957.50	582852.42	131.28	1.25”D standpipe piezometer, 5’ screen
159	LY01-BKG-24	BKG		1244957.82	582856.59	131.60	2"D suction lysimeter, 9" cup
160	LY02-BKG-42	BKG		1244960.88	582857.29	132.03	2"D suction lysimeter, 9" cup
161	BKG-SM-N	BKG		1244959.90	582854.52	130.62	2"D soil moisture tube with 6" casing
162	PZ04-BKG-09	BKG		1244850.25	582615.24	129.45	1.25”D standpipe piezometer, 5’ screen
163	PZ24-BKG-26	BKG		1244854.09	582614.74	132.38	2”D standpipe piezometer, 5’ screen
164	PZ29-BKG-09	BKG		1244846.58	582755.86	130.93	¾”D standpipe piezometer, 5’ screen
165	PZ30-BKG-16	BKG		1244845.66	582758.17	132.29	1"D standpipe piezometer, 5' screen
166	PZ31-BKG-26	BKG		1244845.87	582757.80	128.99	1"D standpipe piezometer, 5' screen
167	PZ32-BKG-09	BKG		1244843.82	582842.31	133.51	1"D standpipe piezometer, 5' screen
168	PZ33-BKG-16	BKG		1244844.30	582845.33	132.84	1"D standpipe piezometer, 5' screen

Table D.1
S&GW Test Facility Sample Identification

ID #	Sample Identification	Test Area	Grid Location	Northing	Easting	Elev NGVD 29	Notes
169	PZ34-BKG-26	BKG		1244843.73	582845.24	130.45	1"D standpipe piezometer, 5' screen
170	PZ35-BKG-09	BKG		1244702.71	582872.85	129.18	1"D standpipe piezometer, 5' screen
171	PZ36-BKG-16	BKG		1244702.63	582873.08	131.84	1"D standpipe piezometer, 5' screen
172	PZ37-BKG-26	BKG		1244702.80	582872.92	128.31	1"D standpipe piezometer, 5' screen
173	PZ38-BKG-09	BKG		1244582.29	582675.83	126.66	1"D standpipe piezometer, 5' screen
174	PZ39-BKG-16	BKG		1244582.30	582675.42	129.60	1"D standpipe piezometer, 5' screen
175	PZ40-BKG-26	BKG		1244582.13	582675.66	126.10	1"D standpipe piezometer, 5' screen
176	STE Pump Tank			1244840.78	582676.05	129.10	STE effluent dose tank
177	ATU Clarifier			1244841.16	582671.78	129.12	
178	ATU Eff Pump Tank			1244840.54	582681.28	129.16	Nitrified effluent dose tank
179	GCREC Pump Station						GCREC mound lift station
180	PNRS II STE-Tank 1						PNRS II Tank 1
181	PZ41	TA1		1244799.29	582853.53	132.29	1"D standpipe piezometer, 5' screen
182	PZ42	TA1		1244796.65	582850.26	132.99	1"D standpipe piezometer, 5' screen
183	PZ43	TA1		1244825.21	582874.55	131.34	1"D standpipe piezometer, 5' screen
184	PZ44	TA3		1244796.21	582804.15	131.82	1"D standpipe piezometer, 5' screen
185	PZ45	TA3		1244799.84	582810.10	132.48	1"D standpipe piezometer, 5' screen
186	PZ46	TA1		1244794.92	582853.97	131.81	1"D standpipe piezometer, 5' screen
187	PZ47	TA1		1244797.39	582857.04	131.78	1"D standpipe piezometer, 5' screen
188	PZ48	TA1		1244792.81	582857.49	129.70	1"D standpipe piezometer, 5' screen
189	PZ49	TA2		1244797.70	582710.95	131.91	1"D standpipe piezometer, 5' screen
190	PZ50	TA2		1244800.34	582716.87	131.76	1"D standpipe piezometer, 5' screen
191	PZ51	TA4		1244828.71	582693.52	131.90	1"D standpipe piezometer, 5' screen
192	PZ52	TA4		1244799.14	582665.17	131.69	1"D standpipe piezometer, 5' screen
193	PZ53	TA4		1244802.18	582670.34	131.57	1"D standpipe piezometer, 5' screen
194	PZ54	TA4		1244797.40	582668.77	128.85	1"D standpipe piezometer, 5' screen
195	PZ55	TA2		1244796.18	582714.66	129.61	1"D standpipe piezometer, 5' screen
196	PZ56	TA3		1244795.18	5825808.75	130.86	1"D standpipe piezometer, 5' screen
197	PZ57	TA4		1244795.69	582672.29	128.99	3/4"D standpipe piezometer, 5' screen
198	TA3-PZ-A'5	TA3	A'5	1244833	582814.1	131.36	1"D standpipe piezometer, 5' screen

Table D.1
S&GW Test Facility Sample Identification

ID #	Sample Identification	Test Area	Grid Location	Northing	Easting	Elev NGVD 29	Notes
199	TA3-PZ-C2	TA3	C2	1244817	582814.6	132.08	1"D standpipe piezometer, 5' screen
200	TA3-PZ-EF0.5	TA3	EF0.5	1244812	582815.7	131.24	1"D standpipe piezometer, 5' screen
201	TA3-PZ-EF3.5	TA3	EF3.5	1244814	582810	131.52	1"D standpipe piezometer, 5' screen
202	TA3-PZ-G3.5	TA3	G3.5	1244811	58288.9	131.05	1"D standpipe piezometer, 5' screen
203	TA3-PZ-H1'	TA3	H1'	1244806	58216.6	131.41	1"D standpipe piezometer, 5' screen
204	TA3-PZ-H0.5	TA3	H0.5	1244807	582814	131.25	1"D standpipe piezometer, 5' screen
205	TA3-PZ-H3.5	TA3	H3.5	1244809	582808.2	131.04	1"D standpipe piezometer, 5' screen
206	TA3-PZ-I3.5	TA3	I3.5	1244807	582807.6	131.49	1"D standpipe piezometer, 5' screen
207	TA3-PZ-I5	TA3	I5	1244808	582804.7	130.90	1"D standpipe piezometer, 5' screen
208	TA3-PZ-J1'	TA3	J1'	1244802	582815.2	131.24	1"D standpipe piezometer, 5' screen
209	TA3-PZ-J0.5	TA3	J0.5	1244803	582812.4	131.34	1"D standpipe piezometer, 5' screen
210	TA3-PZ-J3.5	TA3	J3.5	1244805	582806.8	130.91	1"D standpipe piezometer, 5' screen
211	TA3-PZ-K2	TA3	K2	1244802	582808.9	131.46	1"D standpipe piezometer, 5' screen
212	TA3-PZ-K3.5	TA3	K3.5	1244804	582806.1	131.28	1"D standpipe piezometer, 5' screen
213	TA3-PZ-L1'	TA3	L1'			131.52	1"D standpipe piezometer, 5' screen
214	TA3-PZ-L0	TA3	L0	1244799	582811.9	131.18	1"D standpipe piezometer, 5' screen
215	TA3-PZ-M1	TA3	M1	1244798	582809.3	131.54	1"D standpipe piezometer, 5' screen
216	TA3-PZ-M2	TA3	M2	1244799	582807.4	131.40	1"D standpipe piezometer, 5' screen
217	TA3-PZ-M3	TA3	M3	1244799	582805.5	131.34	1"D standpipe piezometer, 5' screen
218	TA3-PZ-M5	TA3	M5	1244801	582801.8	131.45	1"D standpipe piezometer, 5' screen
219	TA3-PZ-O1.5	TA3	O1.5	1244795	582807.2	131.16	1"D standpipe piezometer, 5' screen
220	TA3-PZ-O3	TA3	O3	1244796	582804.2	130.88	1"D standpipe piezometer, 5' screen
221	TA3-PZ-P5	TA3	P5	1244795	582799.7	129.28	1"D standpipe piezometer, 5' screen

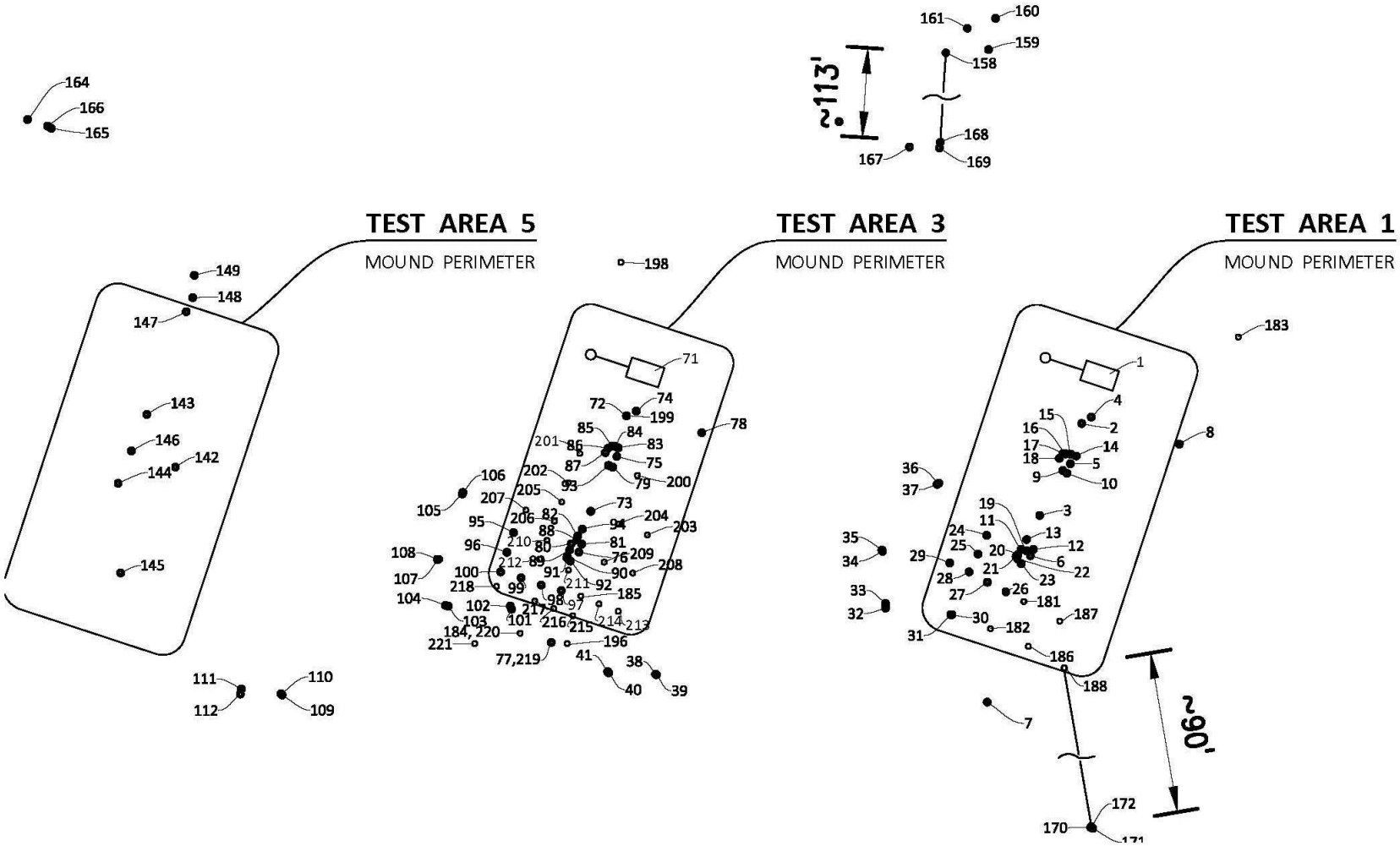

Figure D.1
S&GW Test Facility System Schematic of TA1, TA3, and TA5 (STE System)
[1]Location identification corresponds to Table A.1 ID #

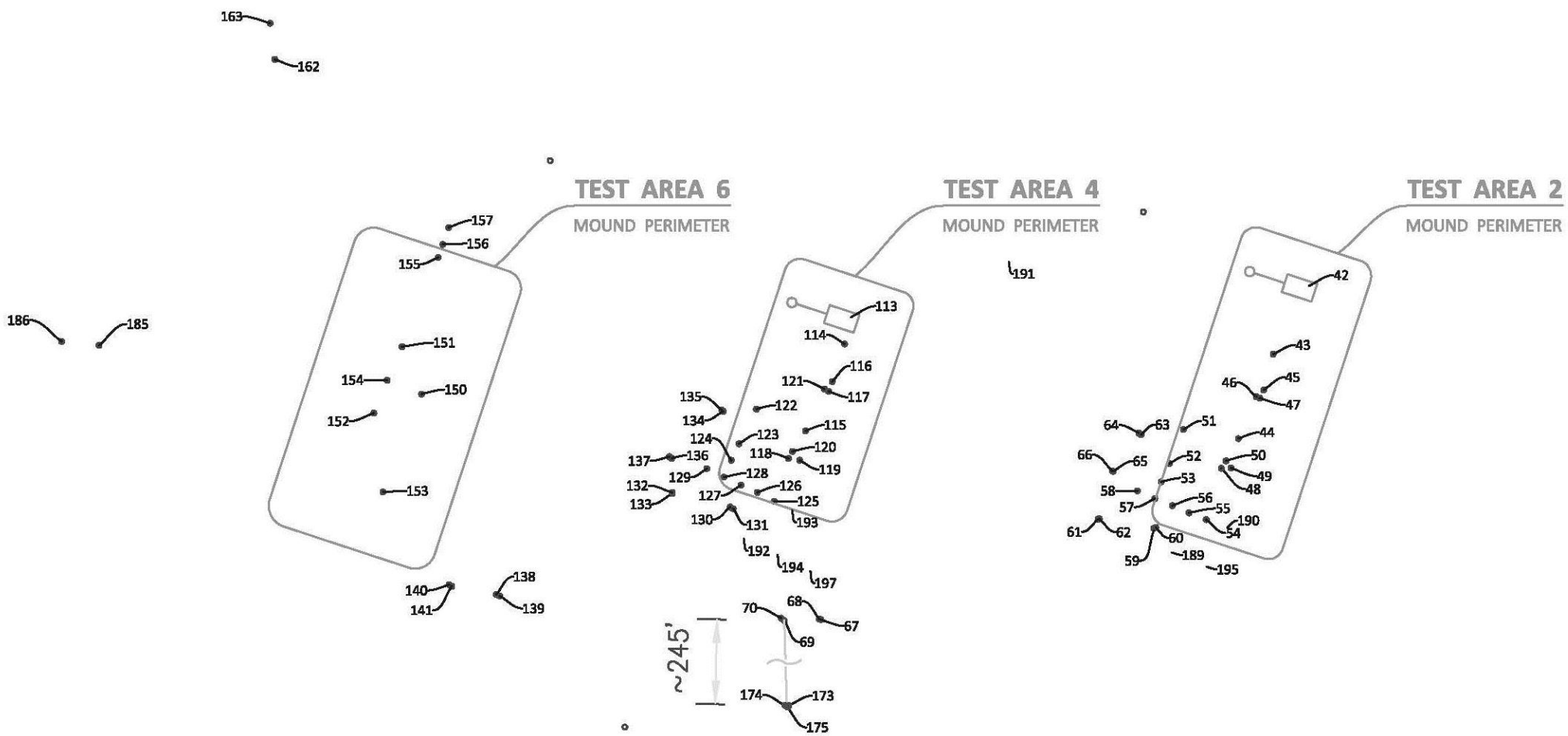

Figure D.2
S&GW Test Facility System Schematic of TA2, TA4, and TA6 (ATU Effluent System)
[1]Location identification corresponds to Table A.1 ID #