# PRB DESIGN BASIS

Former Miller Container Plant
Fulton, NY

## List of Figures

## 1.0 Introduction

URS has prepared a Design Basis to supplement previous design presentations. This Design Basis accompanies the Final 90% Design for Permeable Reactive Barrier Design Specifications and Drawings. This basis presents the relevant elements of the design, and the design rationale for the PRB system at the Former Miller Container Plant site located in Fulton, New York. The figures, tables and design computations referenced are contained in separate PRB 1 and PRB 2 design basis attachment to facilitate review. Testing to support funnel design is also attached.

## 2.0 Groundwater Flow Paths

**PRB 1** - Groundwater flow paths at PRB 1 were developed from groundwater elevations in existing wells and supplemental wells in the vicinity of PRB 1 and the municipal well field. Elevations were measured and used to develop the water surface for shallow and intermediate wells. The groundwater flow path was then assigned perpendicular to the potentiometric surface for the respective zones. The measured groundwater elevations are presented in Table 2-1.

The shallow and intermediate potentiametric surface and flow paths at PRB 1 are shown in Figure 2-1 and Figure 2-2. Generally in the area of PRB 1 and the municipal well field groundwater flow from the site and the Oswego River converge. The Oswego River acts as a hydraulic and groundwater recharge boundary. This tends to limit groundwater flow towards the Oswego River and creates a "dog leg" in the groundwater flow path. This channels groundwater flow through proposed PRB 1 and to the municipal well field.

Based on the proposed trench type excavation of PRB 1, as long as the permeability of the media placed for PRB 1 is the same or greater than the surrounding formation, groundwater flow patterns would not be changed by the installation of the PRB. Based on testing the permeability of the iron is greater than the formation at the site (URS 2001). The proposed sand has greater porosity and permeability than the iron and will result in an iron sand mixture permeability equal to or greater than the surrounding formation.

**PRB 2** – Based on the funnel and gate type design for PRB 2, a more extensive evaluation of the impact of the design on groundwater flow paths was necessary. Groundwater flow paths at proposed PRB 2 were evaluated using the VMODFLOW groundwater model. A box model was constructed for the area surrounding PRB 2 using lithology descriptions from boring logs (summarized in Table 2-2) and hydraulic conductivities determined during previous investigative activities (Malcolm Pirnie 1993). The hydraulic conductivities were evaluated (Table 2-3) and it was found that for the different units (lithologic zones) at the site (i.e., the shallow silt/sand zone, and deep sand/gravel zone) had distinct and different hydraulic conductivites. The hydraulic conductivity within each unit was also relatively uniform, so average conductivities for the silt/sand and sand/gravel zones were used in the groundwater model.

The relatively impermeable till surface, the sand/gravel and silt/sand zone interface, and the ground surface were imported to form a simple block model, and the conductivities discussed above assigned to their respective zone. The model was then calibrated to the water elevations measured during the Supplemental Design Investigation (when the pump and treat system was turned off). The groundwater model calibrated to about 84 % of observed heads, with the match to observed heads biased slightly low. This is within the rule of thumb for an acceptable groundwater model calibration range that is typically within 80% of observed heads. The calibrated shallow and intermediate potentiametric surfaces (pre-PRB 2 insertion) are shown in Figures 2-3 and 2-4, and the predicted versus the observed heads is shown in Figure 2-5. The input parameters and assumptions for the groundwater model are listed in Table 2-4. Several profile views of the groundwater model are shown in Figure 2-6 through Figure 2-9.

Following calibration of the groundwater model, the funnel and gate PRB was input into the model and groundwater flow paths were evaluated. The flow paths are shown on Figure 2-10. The flow paths show groundwater originating in the areas of contamination flow through the gates of PRB 2. Groundwater overtopping the PRB was not observed.

## 3.0 Groundwater Velocity

**PRB 1** - The velocity at PRB 1was computed using the potentiametric surface discussed above and the geometric mean of conductivities of wells in the general vicinity of PRB 1 following:

$$V = ki/n_e$$

Where V = velocity, k = geometric mean of the hydraulic conductivity, i = gradient at PRB and $n_e$ = effective porosity of the PRB media.

Based on a geometric mean of the hydraulic conductivity of 5.5 x 10-3 cm/sec, a gradient of 0.008 ft./ft., and a PRB media effective porosity of 0.35, the velocity was estimated to be about 0.36 feet/day at PRB 1 (Table 3-1). The PRB media is relatively permeable and porous. An effective porosity for this media of 0.35 is considered reasonable. Porosity was determined by adding water to a dry sample. The porosity of the iron/sand mixture is about 0.4, but may vary if a different sand or iron is used.

**PRB 2** - The velocity evaluation at PRB 2 focused on identifying the velocity of groundwater flowing through the gates. The velocities were derived from the groundwater model discussed above, and evaluated for both the shallow and deep zone with PRB 2 in place. The fastest travel times for groundwater traveling through the gates was selected as the design velocity for each gate and for each respective zone (i.ie., silt/sand zone, and sand/gravel zone).

Velocities in the shallow silt/sand zone are typically about an order of magnitude less than velocities in the deep sand/gravel zone (Figure 3-1 through Figure 3-6), except for the area near the southeastern end of PRB 2 – Gate 3 where shallow and deep zone velocities are about the same. Consequently less mass flux is generally anticipated though Gate 1 and Gate 2 in the shallow zone, and as a result, less iron is required in the shallow zone.

## 4.0 Influent Concentrations of Target Constituents and Treatment Objectives

Influent levels of target constituents were identified based on the highest levels of contaminants detected during 2002 for PRB 1 and PRB 2 (Figure 4-1 and Figure 4-2 respectively). While historically some variability is observed in the levels of contaminants throughout the site, the levels of contaminants during 2002 are generally high and as such represent a conservative worst case type scenario for the levels of contaminants requiring treatment.

The levels of contaminants in the vicinity of the PRBs were then evaluated and the highest levels in the vicinity of PRB 1 (Table 4-1) and PRB 2 - Gate 1, PRB 2 - Gate 2 and PRB 2 - Gate 3 (Table 4-1, Table 4-2, Table 4-3 and Table 4-4 respectively) were selected for design influent levels. The selected influent levels are conservative, and in practice may not be seen entering the PRB treatment zones. This is evidenced by the low levels of contaminants (as compared to design levels) detected at MW-16 near PRB 2 - Gate 1, TW-13S and TW-13D at PRB 2 - Gate 2, and at RW-8 near PRB 2 - Gate 3.

Treatment objectives for were set at 0.49 ppb for PRB 1 effluent. Treatment objectives were set at 5 ppb for PRB 2 effluent. These effluent objectives reflect closure levels for the site and are therefore considered suitable for treatment objectives.

## 5.0 Decay Rate Constants and Effective Iron Thickness

Decay rates constants for the target constituents and iron were developed during previous bench scale testing (URS 2001). The rate constants were further evaluated during full-scale pilot testing at the site, where favorable results suggest the constants used were relatively accurate (URS 2001).

The effective thickness of iron required for the various PRB treatment zones is presented in Table 5-1 through Table 5-6. Effective thicknesses provided by the design are also noted. Based on the groundwater velocity, the influent levels of target constituents and the decay rate constant for the various target constituents. The thickness of iron required to treat the target constituents to the clean up criteria was estimated following:

$$C=C_0e^{-\lambda t}$$

Where C = clean up criteria; Co = influent concentration; $\lambda$ = decay rate constant and; t = residence time.

Following the estimate of the required effective thickness of iron, a safety factor and engineering judgement from previous experience were applied, and resulted in a design thickness about four times the thickness required based on previous testing. This is conservative, and should account for variabilites in groundwater velocity, permeability or other important parameters that may vary from design values. The minimum iron effective thickness that may be placed in the proposed 2-foot wide trench is 4.8 inches, so iron reactivity is not adversely affected, based on Environmetal Technologies (the zero-valent iron treatment patent holder) experience. This introduces an additional significant factor of safety for many of the proposed PRB treatment zones. Additional treatment zone iron effective thickness may be provided at Miller Brewing Company's and the design engineer's discretion, as necessary.

## 6.0 Extent (Height and Length) of PRBs

The length and height of the PRBs was determined based on the horizontal and vertical extent of contamination, and groundwater flow patterns at the site. Both PRB 1 and PRB 2 extend vertically over the full saturated thickness. The base water table is the highest identified based on data available to URS. PRB 1 extends above the water table several feet to account for potential furture variability in the water table elevation.

At PRB 2 the height of the PRB gates will extend only to the water table. Given the slow groundwater travel times (fastest is 0.028 feet/day) in the shallow zone at PRB 2, and the thickness of PRB 2 gates (2 feet), it would take about 35.7 days for groundwater to migrate beyond the middle of the treatment zone (1-foot). Therefore extending the PRB gates above the high water table is not considered necessary.

The funnels (impermeable) at PRB 2 will extend vertically a minimum of 3-feet above the water table, and as discussed above, groundwater modeling suggests groundwater flow overtopping the funnels should not occur.

At PRB 1 where the levels of contaminants are near or below the generic DEC cleanup criteria the PRB extends horizontally between two wells where contaminants were not detected, TW-2 and TW-4. This extent should treat known residuals migrating in the groundwater towards PRB 1.

PRB 2 is placed to roughly capture the 5 ppb contour of tetrachloroethylene, and 1,1,1 trichloroethane. The groundwater flow paths predicted by the groundwater model above show the proposed extent of PRB 2 should treat groundwater residual migrating towards PRB 2.

## 7.0 Funnel Tests and Design – PRB 2

Supplemental testing was conducted to develop optimal mix ratios for the impermeable funnels of PRB 2. A brief summary report is attached. The tests show that the best mix achieved a permeability of 1.7 x $10^{-7}$ cm/sec, and contained 0.5% bentonite, 8% cement and the 91.5% site soils. This mix also achieved a 28-day compressive strength of 59.3 psi, which is suitable for funnel construction purposes based on experience.

## References

Malcolm Pirnie; *Remedial Investigation Report*, July 1993.

URS Corporation; *PRB Pilot Test and Preliminary Design Report*, May 2001.

Designation: D 854 – 00

# Standard Test Methods for Specific Gravity of Soil Solids by Water Pycnometer[1]

This standard is issued under the fixed designation D 854; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

## 1. Scope *

1.1 These test methods cover the determination of the specific gravity of soil solids that pass the 4.75-mm (No. 4) sieve, by means of a water pycnometer. When the soil contains particles larger than the 4.75-mm sieve, Test Method C 127 shall be used for the soil solids retained on the 4.75-mm sieve and these test methods shall be used for the soil solids passing the 4.75-mm sieve.

1.1.1 Soil solids for these test methods do not include solids which can be altered by these methods, contaminated with a substance that prohibits the use of these methods, or are highly organic soil solids, such as fibrous matter which floats in water.

NOTE 1—The use of Test Method D 5550 may be used to determine the specific gravity of soil solids having solids which readily dissolve in water or float in water, or where it is impracticable to use water.

1.2 Two methods for performing the specific gravity are provided. The method to be used shall be specified by the requesting authority, except when testing the types of soils listed in 1.2.1

1.2.1 *Method A*—Procedure for Moist Specimens, described in 9.2. This procedure is the preferred method. For organic soils; highly plastic, fine grained soils; tropical soils; and soils containing halloysite, Method A shall be used.

1.2.2 *Method B*—Procedure for Oven-Dry Specimens, described in 9.3.

1.3 All observed and calculated values shall conform to the guidelines for significant digits and rounding established in Practice D 6026.

1.3.1 The procedures used to specify how data are collected/recorded and calculated in this standard are regarded as the industry standard. In addition, they are representative of the significant digits that generally should be retained. The procedures used do not consider material variation, purpose for obtaining the data, special purpose studies, or any considerations for the user's objectives; and it is common practice to increase or reduce significant digits of reported data to be commensurate with these considerations. It is beyond the scope of these test methods to consider significant digits used in analysis methods for engineering design.

1.4 *Units*—The values stated in SI units are to be regarded as standard. No other units of measurement are included in these test methods.

1.5 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.*

## 2. Referenced Documents

2.1 *ASTM Standards:*

C 127 Test Method for Specific Gravity and Absorption of Coarse Aggregate[2]

D 653 Terminology Relating to Soil, Rock, and Contained Fluids[3]

D 1140 Test Method for Amount of Material in Soils Finer Than the No. 200 (75-μm) Sieve[3]

D 2216 Test Method for Laboratory Determination of Water (Moisture) Content of Soil and Rock by Mass[3]

D 2487 Practice for Classification of Soils for Engineering Purposes (Unified Soil Classification System)[3]

D 3740 Practice for Minimum Requirements for Agencies Engaged in the Testing and/or Inspection of Soil and Rock as Used in Engineering Design and Construction[3]

D 4753 Specification for Evaluating, Selecting, and Specifying Balances and Scales for Use in Soil, Rock, and Related Construction Materials Testing[3]

D 5550 Test Method for Specific Gravity of Soil Solids by Gas Pycnometer[3]

D 6026 Practice for Using Significant Digits in Geotechnical Data[4]

E 11 Specification for Wire-Cloth Sieves for Testing Purposes[3]

E 177 Practice for Use of the Terms Precision and Bias in ASTM Test Methods[5]

E 691 Practice for Conducting an Interlaboratory Study to Determine the Precision of a Test Method[5]

## 3. Terminology

3.1 *Definitions*—For definitions of terms used in these test methods, refer to Terminology D 653.

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[1] This standard is under the jurisdiction of ASTM Committee D18 on Soil and Rock and is the direct responsibility of Subcommittee D18.03 on Texture, Plasticity, and Density Characteristics of Soils.

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[2] *Annual Book of ASTM Standards*, Vol 04.02.

[3] *Annual Book of ASTM Standards*, Vol 04.08.

[4] *Annual Book of ASTM Standards*, Vol 04.09.

[5] *Annual Book of ASTM Standards*, Vol 14.02.

*A Summary of Changes section appears at the end of this standard.

3.2 *Definitions of Terms Specific to This Standard:*

3.2.1 *specific gravity of soil solids, $G_s$, n*—the ratio of the mass of a unit volume of a soil solids to the mass of the same volume of gas-free distilled water at 20°C.

## 4. Significance and Use

4.1 The specific gravity of a soil solids is used in calculating the phase relationships of soils, such as void ratio and degree of saturation.

4.1.1 The specific gravity of soil solids is used to calculate the density of the soil solids. This is done by multiplying its specific gravity by the density of water (at proper temperature).

4.2 The term soil solids is typically assumed to mean naturally occurring mineral particles or soil like particles that are not readily soluble in water. Therefore, the specific gravity of soil solids containing extraneous matter, such as cement, lime, and the like, water-soluble matter, such as sodium chloride, and soils containing matter with a specific gravity less than one, typically require special treatment (see Note 1) or a qualified definition of their specific gravity.

4.3 The balances, pycnometer sizes, and specimen masses are established to obtain test results with three significant digits.

NOTE 2—The quality of the result produced by these test methods is dependent on the competence of the personnel performing it, and the suitability of the equipment and facilities used. Agencies that meet the criteria of Practice D 3740 are generally considered capable of competent and objective testing/sampling/inspection/etc. Users of these test methods are cautioned that compliance with Practice D 3740 does not in itself assure reliable results. Reliable results depend on many factors; Practice D 3740 provides a means of evaluating some of those factors.

## 5. Apparatus

5.1 *Pycnometer*—The water pycnometer shall be either a stoppered flask, stoppered iodine flask, or volumetric flask with a minimum capacity of 250 mL. The volume of the pycnometer must be 2 to 3 times greater than the volume of the soil-water mixture used during the deairing portion of the test.

5.1.1 The stoppered flask mechanically sets the volume. The stoppered iodine flask has a flared collar that allows the stopper to be placed at an angle during thermal equilibration and prevents water from spilling down the sides of the flask when the stopper is installed. The wetting the outside of the flask is undesirable because it creates changes in the thermal equilibrium. When using a stopper flask, make sure that the stopper is properly labeled to correspond to the flask.

5.2 *Balance*—Meeting the requirements of Specification D 4753, class GP1. This balance has a readability of 0.01 g and capacity of at least 2000 g.

5.3 *Drying Oven*—Thermostatically controlled oven, capable of maintaining a uniform temperature of 110 ± 5°C throughout the drying chamber. These requirements usually require the use of a forced-draft oven.

5.4 *Thermometer*—Thermometer capable of measuring the temperature range within which the test is being performed, readable to the nearest 0.1°C and an immersion depth ranging between 25 to 80 mm. Full immersion thermometers shall not be used. Either a general-purpose precision mercury thermometer or a digital thermometer with a −1 to 57°C range will meet this requirement.

5.5 *Desiccator*—A desiccator cabinet or large desiccator jar of suitable size containing silica gel or anhydrous calcium sulfate.

NOTE 3—It is preferable to use a desiccant that changes color to indicate when it needs reconstitution.

5.6 *Entrapped Air Removal Apparatus*—To remove entrapped air (deairing process), use one of the following:

5.6.1 *Hot Plate or Bunsen Burner*, capable of maintaining a temperature adequate to boil water.

5.6.2 *Vacuum System*, a vacuum pump or water aspirator, capable of producing a partial vacuum of 100 mm of mercury (Hg) or less absolute pressure.

NOTE 4—A partial vacuum of 100 mm Hg absolute pressure is approximately equivalent to a 660 mm (26 in.) Hg reading on vacuum gauge at sea level.

5.7 *Insulated Container*—A Styrofoam cooler and cover or equivalent container that can hold between three and six pycnometers plus a beaker, a water bottle, and a thermometer. This is required to maintain a controlled temperature environment where changes will be uniform and gradual.

5.8 *Funnel*—A non-corrosive smooth surface funnel with a stem that extends past the calibration mark on the volumetric flask or stoppered seal on the stoppered flasks. The diameter of the stem of the funnel must be large enough that soil solids will easily pass through.

5.9 *Pycnometer Filling Tube with Lateral Vents (optional)*—A device to assist in adding deaired water to the pycnometer without disturbing the soil-water mixture. The device may be fabricated as follows. Plug a ¼ to ⅜ in. diameter plastic tube at one end and cut two small vents (notches) just above the plug. The vents should be perpendicular to the axis of the tube and diametrically opposed. Connect a valve to the other end of the tube and run a line to the valve from a supply of deaired water.

5.10 *Sieve*—No. 4 (4.75 mm) conforming to the requirements of Specification E 11.

5.11 *Blender (optional)*—A blender with mixing blades built into the base of the mixing container.[6]

5.12 *Miscellaneous Equipment*, such as a computer or calculator (optional), specimen dishes, and insulated gloves.

## 6. Reagents

6.1 *Purity of Water*—Distilled water is used in this test method. This water may be purchased and is readily available at most grocery stores; hereafter, distilled water will be referred to as water.

## 7. Test Specimen

7.1 The test specimen may be moist or oven-dry soil and shall be representative of the soil solids that passes the U. S. Standard No. 4 sieve in the total sample. Table 1 gives guidelines on recommended dry soil mass versus soil type and pycnometer size.

7.1.1 Two important factors concerning the amount of soil solids being tested are as follows. First, the mass of the soil

[6] Manufacturers of such blenders include, but are not limited to, Waring or Osterizer.

TABLE 1 Recommended Mass for Test Specimen

| Soil Type | Specimen Dry Mass (g) When Using 250 mL Pycnometer | Specimen Dry Mass (g) When Using 500 mL Pycnometer |
|---|---|---|
| SP, SP-SM | 60 ± 10 | 100± 10 |
| SP-SC, SM, SC | 45 ± 10 | 75± 10 |
| Silt or Clay | 35 ± 5 | 50± 10 |

solids divided by its specific gravity will yield four-significant digits. Secondly, the mixture of soil solids and water is a slurry not a highly viscous fluid (thick paint) during the deairing process.

## 8. Calibration of Pycnometer

8.1 Determine the mass of the clean and dry pycnometer to the nearest 0.01 g (typically five significant digits). Repeat this determination five times. One balance should be used for all of the mass measurements. Determine and record the average and standard deviation. The standard deviation shall be less than or equal to 0.02 g. If it is greater, attempt additional measurements or use a more stable or precise balance.

8.2 Fill the pycnometer with deaired water to above or below the calibration mark depending on the type of pycnometer and laboratory preference to add or remove water.

8.2.1 It is recommended that water be removed to bring the water level to the calibration mark. The removal method reduces the chances of altering the thermal equilibrium by reducing the number of times the insulated container is opened.

8.2.2 The water must be deaired to ensure that there are no air bubbles in the water. The water may be deaired using either boiling, vacuum, combination of vacuum and heat, or a deairing device. This deaired water should not be used until it has equilibrated to room temperature. Also, this water shall be added to the pycnometer following the guidance given in 9.6.

8.3 Up to six pycnometers can be calibrated concurrently in each insulated container. Put the pycnometer(s) into a covered insulated container along with the thermometer (in a beaker of water), stopper(s) (if a stoppered pycnometer is being used), and deaired water in a bottle along with either an eyedropper or pipette. Let the pycnometer(s) come to thermal equilibrium (for at least 3 h). The equilibrium temperature should be within 4°C of room temperature and between 15 and 30°C.

8.4 Move the insulated container near the balance or vice versa. Open the container and remove one pycnometer. Only the rim of the pycnometer shall be touched as to prevent the heat from handling changing the thermal equilibrium. Either work in the container or place the pycnometer on an insulated block (Styrofoam) while making water level adjustments.

8.4.1 If using a volumetric flask as a pycnometer, adjust the water to the calibration mark, with the bottom of the meniscus level with the mark. If water has to be added, use the thermally equilibrated water from the insulated container. If water has to be removed, use a small suction tube or paper towel. Check for and remove any water beads on the pycnometer stem or on the exterior of the flask. Measure and record the mass of pycnometer and water to the nearest 0.01 g.

8.4.2 If a stoppered flask is used, place the stopper in the bottle, then remove the excess water using an eyedropper. Dry the rim using a paper towel. Be sure the entire exterior of the flask is dry. Measure and record the mass of pycnometer and water to the nearest 0.01 g.

8.5 Measure and record the temperature of the water to the nearest 0.1°C using the thermometer that has been thermally equilibrated in the insulated container. Insert the thermometer to the appropriate depth of immersion (see 5.4). Return the pycnometer to the insulated container. Repeat the measurements for all pycnometers in the container.

8.6 Readjust the water level in each pycnometer to prepare for the next calibration and allow the pycnometers to thermally equilibrate (for at least 3 h). Repeat the procedure to obtain five independent measurements on each pycnometer. The temperatures do not need to bracket any particular temperature range.

8.7 Using each of these five data points, compute the calibrated volume of each pycnometer, $V_p$, using the following equation:

$$V_p = \frac{(M_{pw,c} - M_p)}{\rho_{w,c}} \quad (1)$$

where:

$M_{pw,c}$ = the mass of the pycnometer and water at the calibration temperature, g,

$M_p$ = the average mass of the dry pycnometer at calibration, g, and

$\rho_{w,c}$ = the mass density of water at the calibration temperature g/mL, (Table 2).

8.8 Calculate the average and the standard deviation of the five volume determinations. The standard deviation shall be less than or equal to 0.05 mL (rounded to two decimal places). If the standard deviation is greater than 0.05 mL, the calibration procedure has too much variability and will not yield accurate specific gravity determinations. Evaluate areas of possible refinement (adjusting the volume to the calibration mark, achieving temperature equilibrium, measuring temperature, deairing method or changing to the stoppered flasks) and revise the procedure until the standard deviation is less than or equal to 0.05 mL.

## 9. Procedure

9.1 *Pycnometer Mass*—Using the same balance used to calibrate the pycnometer, verify that the mass of the pycnometer is within 0.06 g of the average calibrated mass. If it is not, re-calibrate the dry mass of the pycnometer.

9.2 *Method A—Procedure for Moist Specimens:*

9.2.1 Determine the water content of a portion of the sample in accordance with Test Method D 2216. Using this water content, calculate the range of wet masses for the specific gravity specimen in accordance with 7.1. From the sample, obtain a specimen within this range. Do not sample to obtain an exact predetermined mass.

9.2.2 Disperse the soil using a blender or equivalent device to disperse the soil. Add the soil to about 100 mL of water. The minimum volume of slurry that can be prepared by this equipment will typically require using a 500-mL pycnometer.

9.2.3 Using the funnel, pour the slurry into the pycnometer. Rinse any soil particles remaining on the funnel into the pycnometer using a wash/spray squirt bottle.

9.2.4 Proceed as described in 9.4.

9.3 *Method B—Procedure for Oven-Dried Specimens:*

TABLE 2 Density of Water and Temperature Coefficient (*K*) for Various Temperatures[A]

| Temperature (°C) | Density (g/mL)[B] | Temperature Coefficient (*K*) | Temperature (°C) | Density (g/mL)[B] | Temperature Coefficient (*K*) | Temperature (°C) | Density (g/mL)[B] | Temperature Coefficient (*K*) | Temperature (°C) | Density (g/mL)[B] | Temperature Coefficient (*K*) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 15.0 | 0.99910 | 1.00090 | 16.0 | 0.99895 | 1.00074 | 17.0 | 0.99878 | 1.00057 | 18.0 | 0.99860 | 1.00039 |
| .1 | 0.99909 | 1.00088 | .1 | 0.99893 | 1.00072 | .1 | 0.99876 | 1.00055 | .1 | 0.99858 | 1.00037 |
| .2 | 0.99907 | 1.00087 | .2 | 0.99891 | 1.00071 | .2 | 0.99874 | 1.00054 | .2 | 0.99856 | 1.00035 |
| .3 | 0.99906 | 1.00085 | .3 | 0.99890 | 1.00069 | .3 | 0.99872 | 1.00052 | .3 | 0.99854 | 1.00034 |
| .4 | 0.99904 | 1.00084 | .4 | 0.99888 | 1.00067 | .4 | 0.99871 | 1.00050 | .4 | 0.99852 | 1.00032 |
| .5 | 0.99902 | 1.00082 | .5 | 0.99886 | 1.00066 | .5 | 0.99869 | 1.00048 | .5 | 0.99850 | 1.00030 |
| .6 | 0.99901 | 1.00080 | .6 | 0.99885 | 1.00064 | .6 | 0.99867 | 1.00047 | .6 | 0.99848 | 1.00028 |
| .7 | 0.99899 | 1.00079 | .7 | 0.99883 | 1.00062 | .7 | 0.99865 | 1.00045 | .7 | 0.99847 | 1.00026 |
| .8 | 0.99898 | 1.00077 | .8 | 0.99881 | 1.00061 | .8 | 0.99863 | 1.00043 | .8 | 0.99845 | 1.00024 |
| .9 | 0.99896 | 1.00076 | .9 | 0.99879 | 1.00059 | .9 | 0.99862 | 1.00041 | .9 | 0.99843 | 1.00022 |
| 19.0 | 0.99841 | 1.00020 | 20.0 | 0.99821 | 1.00000 | 21.0 | 0.99799 | 0.99979 | 22.0 | 0.99777 | 0.99957 |
| .1 | 0.99839 | 1.00018 | .1 | 0.99819 | 0.99998 | .1 | 0.99797 | 0.99977 | .1 | 0.99775 | 0.99954 |
| .2 | 0.99837 | 1.00016 | .2 | 0.99816 | 0.99996 | .2 | 0.99795 | 0.99974 | .2 | 0.99773 | 0.99952 |
| .3 | 0.99835 | 1.00014 | .3 | 0.99814 | 0.99994 | .3 | 0.99793 | 0.99972 | .3 | 0.99770 | 0.99950 |
| .4 | 0.99833 | 1.00012 | .4 | 0.99812 | 0.99992 | .4 | 0.99791 | 0.99970 | .4 | 0.99768 | 0.99947 |
| .5 | 0.99831 | 1.00010 | .5 | 0.99810 | 0.99990 | .5 | 0.99789 | 0.99968 | .5 | 0.99766 | 0.99945 |
| .6 | 0.99829 | 1.00008 | .6 | 0.99808 | 0.99987 | .6 | 0.99788 | 0.99966 | .6 | 0.99764 | 0.99943 |
| .7 | 0.99827 | 1.00006 | .7 | 0.99806 | 0.99985 | .7 | 0.99784 | 0.99963 | .7 | 0.99761 | 0.99940 |
| .8 | 0.99825 | 1.00004 | .8 | 0.99804 | 0.99983 | .8 | 0.99782 | 0.99961 | .8 | 0.99759 | 0.99938 |
| .9 | 0.99823 | 1.00002 | .9 | 0.99802 | 0.99981 | .9 | 0.99780 | 0.99959 | .9 | 0.99756 | 0.99936 |
| 23.0 | 0.99754 | 0.99933 | 24.0 | 0.99730 | 0.99909 | 25.0 | 0.99705 | 0.99884 | 26.0 | 0.99679 | 0.99858 |
| .1 | 0.99752 | 0.99931 | .1 | 0.99727 | 0.99907 | .1 | 0.99702 | 0.99881 | .1 | 0.99676 | 0.99855 |
| .2 | 0.99749 | 0.99929 | .2 | 0.99725 | 0.99904 | .2 | 0.99700 | 0.99879 | .2 | 0.99673 | 0.99852 |
| .3 | 0.99747 | 0.99926 | .3 | 0.99723 | 0.99902 | .3 | 0.99697 | 0.99876 | .3 | 0.99671 | 0.99850 |
| .4 | 0.99745 | 0.99924 | .4 | 0.99720 | 0.99899 | .4 | 0.99694 | 0.99874 | .4 | 0.99668 | 0.99847 |
| .5 | 0.99742 | 0.99921 | .5 | 0.99717 | 0.99897 | .5 | 0.99692 | 0.99871 | .5 | 0.99665 | 0.99844 |
| .6 | 0.99740 | 0.99919 | .6 | 0.99715 | 0.99894 | .6 | 0.99689 | 0.99868 | .6 | 0.99663 | 0.99842 |
| .7 | 0.99737 | 0.99917 | .7 | 0.99712 | 0.99892 | .7 | 0.99687 | 0.99866 | .7 | 0.99660 | 0.99839 |
| .8 | 0.99735 | 0.99914 | .8 | 0.99710 | 0.99889 | .8 | 0.99684 | 0.99863 | .8 | 0.99657 | 0.99836 |
| .9 | 0.99732 | 0.99912 | .9 | 0.99707 | 0.99887 | .9 | 0.99681 | 0.99860 | .9 | 0.99654 | 0.99833 |
| 27.0 | 0.99652 | 0.99831 | 28.0 | 0.99624 | 0.99803 | 29.0 | 0.99595 | 0.99774 | 30.0 | 0.99565 | 0.99744 |
| .1 | 0.99649 | 0.99828 | .1 | 0.99621 | 0.99800 | .1 | 0.99592 | 0.99771 | .1 | 0.99562 | 0.99741 |
| .2 | 0.99646 | 0.99825 | .2 | 0.99618 | 0.99797 | .2 | 0.99589 | 0.99768 | .2 | 0.99559 | 0.99738 |
| .3 | 0.99643 | 0.99822 | .3 | 0.99615 | 0.99794 | .3 | 0.99586 | 0.99765 | .3 | 0.99556 | 0.99735 |
| .4 | 0.99641 | 0.99820 | .4 | 0.99612 | 0.99791 | .4 | 0.99583 | 0.99762 | .4 | 0.99553 | 0.99732 |
| .5 | 0.99638 | 0.99817 | .5 | 0.99609 | 0.99788 | .5 | 0.99580 | 0.99759 | .5 | 0.99550 | 0.99729 |
| .6 | 0.99635 | 0.99814 | .6 | 0.99607 | 0.99785 | .6 | 0.99577 | 0.99756 | .6 | 0.99547 | 0.99726 |
| .7 | 0.99632 | 0.99811 | .7 | 0.99604 | 0.99783 | .7 | 0.99574 | 0.99753 | .7 | 0.99544 | 0.99723 |
| .8 | 0.99629 | 0.99808 | .8 | 0.99601 | 0.99780 | .8 | 0.99571 | 0.99750 | .8 | 0.99541 | 0.99720 |
| .9 | 0.99627 | 0.99806 | .9 | 0.99598 | 0.99777 | .9 | 0.99568 | 0.99747 | .9 | 0.99538 | 0.99718 |

[A] Reference: CRC Handbook of Chemistry and Physics, David R. Lide, Editor-in-Chief, 74th Edition, 1993–1994.
[B] mL = $cm^3$.

9.3.1 Dry the specimen to a constant mass in an oven maintained at 110 ± 5°C. Break up any clods of soil using a mortar and pestle. If the soil will not easily disperse after drying or has changed composition, use Test Method A. Refer to 1.2.1 for soils that require use of Test Method A.

9.3.2 Place the funnel into the pycnometer. The stem of the funnel must extend past the calibration mark or stopper seal. Spoon the soil solids directly into the funnel. Rinse any soil particles remaining on the funnel into the pycnometer using a wash/spray squirt bottle.

9.4 *Preparing the Soil Slurry*—Add water until the water level is between ⅓ and ½ of the depth of the main body of the pycnometer. Agitate the water until slurry is formed. Rinse any soil adhering to the pycnometer into the slurry.

9.4.1 If slurry is not formed, but a viscous paste, use a pycnometer having a larger volume. See 7.1.1.

NOTE 5—For some soils containing a significant fraction of organic matter, kerosene is a better wetting agent than water and may be used in place of distilled water for oven-dried specimens. If kerosene is used, the entrapped air should only be removed by use of an aspirator. Kerosene is a flammable liquid that must be used with extreme caution.

9.5 *Deairing the Soil Slurry*—Entrapped air in the soil slurry can be removed using either heat (boiling), vacuum or combining heat and vacuum.

9.5.1 When using the heat-only method (boiling), use a duration of at least 2 h after the soil-water mixture comes to a full boil. Use only enough heat to keep the slurry boiling. Agitate the slurry as necessary to prevent any soil from sticking to or drying onto the glass above the slurry surface.

9.5.2 If only a vacuum is used, the pycnometer must be continually agitated under vacuum for at least 2 h. Continually agitated means the silt/clay soil solids will remain in suspension, and the slurry is in constant motion. The vacuum must remain relatively constant and be sufficient to cause bubbling at the beginning of the deairing process.

9.5.3 If a combination of heat and vacuum are used, the pycnometers can be placed in a warm water bath (not more than 40°C) while applying the vacuum. The water level in the bath should be slightly below the water level in the pycnometer, if the pycnometer glass becomes hot, the soil will typically stick to or dry onto the glass. The duration of vacuum and heat must be at least 1 h after the initiation of boiling. During the process, the slurry should be agitated as necessary to maintain boiling and prevent soil from drying onto the pycnometer.

9.6 *Filling the Pycnometer with Water*—Fill the pycnometer with deaired water (see 8.2.2) by introducing the water through a piece of small-diameter flexible tubing with its outlet end kept just below the surface of the slurry in the pycnometer or by using the pycnometer filling tube. If the pycnometer filling tube is used, fill the tube with water, and close the valve. Place the tube such that the drainage holes are just at the surface of the slurry. Open the valve slightly to allow the water to flow over the top of the slurry. As the clear water layer develops, raise the tube and increase the flow rate. If the added water becomes cloudy, do not add water above the calibration mark or into the stopper seal area. Add the remaining water the next day.

9.6.1 If using the stoppered iodine flask, fill the flask, such that the base of the stopper will be submerged in water. Then rest the stopper at an angle on the flared neck to prevent air entrapment under the stopper. If using a volumetric or stoppered flask, fill the flask to above or below the calibration mark depending on preference.

9.7 If heat has been used, allow the specimen to cool to approximately room temperature.

9.8 *Thermal Equilibrium*—Put the pycnometer(s) into the insulated container. The thermometer (in a beaker of water), and some deaired water in a bottle along with either an eyedropper or pipette should also be placed in the insulated container. Keep these items in the closed container overnight to achieve thermal equilibrium.

9.9 *Pycnometer Mass Determination*—If the insulated container is not positioned near a balance, move the insulated container near the balance or vice versa. Open the container and remove the pycnometer. Only touch the rim of the pycnometer because the heat from hands can change the thermal equilibrium. Place the pycnometer on an insulated block (Styrofoam or equivalent).

9.9.1 If using a volumetric flask, adjust the water to the calibration mark following the procedure in 8.4.1.

9.9.2 If a stoppered flask is used, place the stopper in the bottle while removing the excess water using an eyedropper. Dry the rim using a paper towel. Be sure the entire exterior of the flask is dry.

9.10 Measure and record the mass of pycnometer, soil, and water to the nearest 0.01 g using the same balance used for pycnometer calibration.

9.11 *Pycnometer Temperature Determination*—Measure and record the temperature of the slurry/soil-water mixture to the nearest 0.1°C using the thermometer and method used during calibration in 8.5. This is the test temperature, $T_t$.

9.12 *Mass of Dry Soil*—Determine the mass of a tare or pan to the nearest 0.01 g. Transfer the soil slurry to the tare or pan. It is imperative that all of the soil be transferred. Water can be added. Dry the specimen to a constant mass in an oven maintained at 110 ± 5°C and cool it in a desiccator. If the tare can be sealed so that the soil can not absorb moisture during cooling, a desiccator is not required. Measure the dry mass of soil solids plus tare to the nearest 0.01 g using the designated balance. Calculate and record the mass of dry soil solids to the nearest 0.01 g.

NOTE 6—This method has been proven to provide more consistent repeatable results than determining the dry mass prior to testing. This is most probably due to the loss of soil solids during the de-airing phase of testing.

## 10. Calculation

10.1 Calculate the mass of the pycnometer and water at the test temperature as follows:

$$M_{pw,t} = M_p + (V_p \cdot \rho_{w,t}) \tag{2}$$

where:

$M_{pw,t}$ = mass of the pycnometer and water at the test temperature ($T_t$), g,

$M_p$ = the average calibrated mass of the dry pycnometer, g,

$V_p$ = the average calibrated volume of the pycnometer, mL, and

$\rho_{w,t}$ = the density of water at the test temperature ($T_t$), g/mL from Table 2.

10.2 Calculate the specific gravity at soil solids the test temperature, $G_t$ as follows:

$$G_t = \frac{\rho_s}{\rho_{w,t}} = \frac{M_s}{(M_{pw,t} - (M_{pws,t} - M_s))} \tag{3}$$

where:

$\rho_s$ = the density of the soil solids Mg/m$^3$ or g/cm$^3$,

$\rho_{w,t}$ = the density of water at the test temperature ($T_t$), from Table 2, g/mL or g/cm$^3$.

$M_s$ = the mass of the oven dry soil solids (g), and

$M_{pws,t}$ = the mass of pycnometer, water, and soil solids at the test temperature, ($T_t$), g.

10.3 Calculate the specific gravity of soil solids at 20°C as follows:

$$G_{20°C} = K \cdot G_t \tag{4}$$

where:

$K$ = the temperature coefficient given in Table 2.

10.4 For soil solids containing particles greater than the 4.75-mm (No. 4) sieve for which Test Method C 127 was used to determine the specific gravity of these particles, calculate an average specific gravity. Test Method C 127 requires the test be performed at 23 ± 1.7°C and does not require the specific gravity data to be corrected to 20°C. Use 10.3 to correct this measurement to 20°C. Use the following equation to calculate the average specific gravity:

$$G_{avg@20°C} = \frac{1}{\dfrac{R}{100 \cdot G_{1@20°C}} + \dfrac{P}{100 \cdot G_{2@20°C}}} \tag{5}$$

where:

$R$ = the percent of soil retained on the 4.75-mm sieve,

$P$ = the percent of soil passing the 4.75-mm sieve,

$G_{1@20°C}$ = the apparent specific gravity of soils retained on the 4.75-mm sieve as determined by Test Method C 127, corrected to 20°C

$G_{2@20°C}$ = the specific gravity of soil solids passing the 4.75-mm sieve as determined by these test methods (Equation 4).

## 11. Report: Test Data Sheets(s)/Form(s)

11.1 The method used to specify how data are recorded on the test data sheets or forms, as given below, is the industry standard, and are representative of the significant digits that should be retained. These requirements do not consider in situ material variation, use of the data, special purpose studies, or any considerations for the user's objectives. It is common practice to increase or reduce significant digits of reported data commensurate with these considerations. It is beyond the scope of the standard to consider significant digits used in analysis methods for engineering design.

11.2 Record as a minimum the following information (data):

11.2.1 Identification of the soil (material) being tested, such as boring number, sample number, depth, and test number.

11.2.2 Visual classification of the soil being tested (group name and symbol in accordance with Practice D 2487).

11.2.3 Percent of soil particles passing the No. 4 (4.75-mm) sieve.

11.2.4 If any soil or material was excluded from the test specimen, describe the excluded material.

11.2.5 Method used (Method A or Method B).

11.2.6 All mass measurements (to the nearest 0.01 g).

11.2.7 Test temperature (to the nearest 0.1°C).

11.2.8 Specific gravity at 20°C ($G$, $G_s$, $G_{20°C}$) to the nearest 0.01. If desired, values to the nearest 0.001 may be recorded.

11.2.9 Average specific gravity at 20°C ($G_{avg}$ or $G_{avg@20°C}$) to the nearest 0.01, if applicable.

## 12. Precision and Bias

12.1 *Precision*—Criteria for judging the acceptability of test results obtained by these test methods on a range of soil types using Method A (except the soil was air dried) is given in Tables 3 and 4. These estimates of precision are based on the results of the interlaboratory program conducted by the ASTM Reference Soils and Testing Program.[7] In this program, some laboratories performed three replicate tests per soil type (triplicate test laboratory), while other laboratories performed a single test per soil type (single test laboratory). A description of the soils tested is given in 12.1.4. The precision estimates may vary with soil type and method used (Method A or B). Judgement is required when applying these estimates to another soil or method.

12.1.1 The data in Table 3 are based on three replicate tests performed by each triplicate test laboratory on each soil type. The single operator and multilaboratory standard deviation shown in Table 3, Column 4 were obtained in accordance with Practice E 691, which recommends each testing laboratory perform a minimum of three replicate tests. Results of two properly conducted tests performed by the same operator on the same material, using the same equipment, and in the shortest practical period of time should not differ by more than the single-operator d2s limits shown in Table 3, Column 5. For definition of d2s see Footnote C in Table 3. Results of two properly conducted tests performed by different operators and on different days should not differ by more than the multilaboratory d2s limits shown in Table 3, Column 5.

12.1.2 In the ASTM Reference Soils and Testing Program, many of the laboratories performed only a single test. This is common practice in the design and construction industry. The data in Table 4 are based upon the first test result from the triplicate test laboratories and the single test results from the other laboratories. Results of two properly conducted tests performed by two different laboratories with different operators using different equipment and on different days should not vary by more than the d2s limits shown in Table 4, Column 5. The results in Tables 3 and 4 are dissimilar because the data sets are different.

12.1.3 Table 3 presents a rigorous interpretation of triplicate test data in accordance with Practice E 691 from prequalified laboratories. Table 4 is derived from test data that represents common practice.

12.1.4 *Soil Type*—Based on the multilaboratory test results, the soil used in the program is described below in accordance with Practice D 2487. In addition, the local name of the soil is given.

TABLE 3 Summary of Test Results from Triplicate Test Laboratories (Specific Gravity)

| (1) Soil Type | (2) Number of Triplicate Test Labs | (3) Average Value[A] | (4) Standard Deviation[B] | (5) Acceptable Range of Two Results[C] |
|---|---|---|---|---|
| *Single-Operator Results (Within- Laboratory Repeatability):* | | | | |
| CH | 14 | 2.717 | 0.009 | 0.03 |
| CL | 13 | 2.670 | 0.008 | 0.02 |
| ML | 14 | 2.725 | 0.006 | 0.02 |
| SP | 14 | 2.658 | 0.006 | 0.02 |
| *Multilaboratory Results (Between- Laboratory Reproducibility):* | | | | |
| CH | 14 | 2.717 | 0.028 | 0.08 |
| CL | 13 | 2.670 | 0.022 | 0.06 |
| ML | 14 | 2.725 | 0.022 | 0.06 |
| SP | 14 | 2.658 | 0.008 | 0.02 |

[A] The number of significant digits and decimal places presented are representative of the input data. In accordance with Practice D 6026, the standard deviation and acceptable range of results cannot have more decimal places than the input data.

[B] Standard deviation is calculated in accordance with Practice E 691 and is referred to as the 1s limit.

[C] Acceptable range of two results is referred to as the d2s limit. It is calculated as $1.960\sqrt{2} \cdot 1s$, as defined by Practice E 177. The difference between two properly conducted tests should not exceed this limit. The number of significant digits/decimal places presented is equal to that prescribed by these test methods or Practice D 6026. In addition, the value presented can have the same number of decimal places as the standard deviation, even if that result has more significant digits than the standard deviation.

TABLE 4 Summary of Single Test Result from Each Laboratory (Specific Gravity)[A]

| (1) Soil Type | (2) Number of Test Laboratories | (3) Average Value | (4) Standard Deviation | (5) Acceptable Range of Two Results |
|---|---|---|---|---|
| *Multilaboratory Results (Single-Test Performed by Each Laboratory):* | | | | |
| CH | 18 | 2.715 | 0.027 | 0.08 |
| CL | 18 | 2.673 | 0.018 | 0.05 |
| ML | 18 | 2.726 | 0.022 | 0.06 |
| SP | 18 | 2.660 | 0.007 | 0.02 |

[A] See footnotes in Table 3.

[7] Supporting data is available from ASTM Headquarters. Request RR: D18-1009.

CH—Fat clay, CH, 99 % fines, LL=60, PI=39, grayish brown, soil had been air dried and pulverized. Local name—Vicksburg Buckshot Clay
CL—Lean clay, CL, 89 % fines, LL=33, PI=13, gray, soil had been air dried and pulverized. Local name—Annapolis Clay
ML—Silt, ML, 99 % fines, LL=27, PI=4, light brown, soil had been air dried and pulverized. Local name—Vicksburg Silt
SP—Poorly graded sand; SP, 20 % coarse sand, 48 % medium sand, 30 % fine sand, 2 % fines, yellowish brown. Local name—Frederick sand

12.2 *Bias*—There is no acceptable reference value for this test method, therefore, bias cannot be determined.

## SUMMARY OF CHANGES

In accordance with Committee D18 policy, this section identifies the location of changes to this standard since the last edition (98) that may impact the use of this standard.

(*1*) The title changed to reflect multiple methods are used, soil solids are tested, and water pycnometer is used.
(*2*) In Scope section, reworded 1.1.1 and added note (Note 1) that references D 5550. The remaining notes were renumbered.
(*3*) Additional referenced documents were added.
(*4*) In Significance and Use section, inserted 4.1.1 covering the use of specific gravity to calculate the density of soil solids and reworded 4.2 to include "soil like particles" may be tested.
(*5*) In Apparatus section, added such apparatus as *insulted container* (for thermal equilibration), *funnel, pycnometer filling tube (optional), No. 4 sieve, blender (optional), and computer or calculator (optional).* In addition, the acceptable size of pycnometer was changed along with the thermometer requirements to increase the test precision.
(*6*) Requirement that water is distilled.
(*7*) The specimen mass requirements were changed to be a function of soil type and pycnometer size. Added subsection 7.1.1 explaining these requirements.
(*8*) The calibration technique for the pycnometer was completely changed to increase the precision of the test results.
(*9*) The testing methods were changed to increase the precision of the test results.
(*10*) The calculations were changed because of the changes in the testing methods.
(*11*) The table for the density and temperature coefficient of water was expanded to be readable to the same accuracy as the temperature measurement.
(*12*) The precision data was changed because test results with the above changes produced more precise data.

# Design Basis PRB 1

Former Miller Container Plant
Fulton, NY

# Table 2-1 Groundwater Elevations

| Well | X (ft) | Y (ft) | Meas. Pt. Elev. | Ground Elev. | Well Depth | Screened Int. (ft bgs) | Top Screened Int. | Bottom Screened Int. | Top Screen (ft bgs) | Bottom Screen (ft bgs) | DTW 091902 | Water Elv 091902 | DTW 062103 | Water Elv 062103 | DTW 071003 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| MW10S | -344.7512394 | -243.7133984 | 364.41 | 362.74 | 16 | 10.4-15.4 | 10.4 | 15.4 | 354.01 | 349.01 | 16.4 | 348.01 | | 364.41 | 12.15 |
| MW10D | -348.4648317 | -234.0703366 | 363.89 | 362.6 | 69.4 | 64.5-69.5 | 64.5 | 69.5 | 299.39 | 294.39 | 16.55 | 347.34 | | 363.89 | 12.23 |
| MW14S | 49.16823953 | -440.2118738 | 380.07 | 378.3 | 30.5 | 25-30 | 25 | 30 | 355.07 | 350.07 | 31.84 | 348.23 | | 380.07 | 26.35 |
| MW14D | 51.11 | -451.08 | 380.19 | 378.4 | 56 | 40-55.5 | 40 | 55.5 | 340.19 | 324.69 | 30.56 | 349.63 | | 380.19 | 26.55 |
| MW21S | 126.660596 | -661.6186067 | 379.26 | 377.11 | 30 | 25-30 | 25 | 30 | 354.26 | 349.26 | 29.9 | 349.36 | | 379.26 | 25.77 |
| MW21D | 124.004125 | -656.89 | 379.95 | 377.69 | 37.5 | 33-38 | 33 | 38 | 346.95 | 341.95 | 30.52 | 349.43 | | 379.95 | 26.49 |
| MW24S | -242.3506254 | -130.2424478 | 363.54 | 361.78 | 17 | 12-17 | 12 | 17 | 351.54 | 346.54 | | | | 363.54 | 10.03 |
| MW24D | -238.1549577 | -140.3801692 | 363.67 | 361.72 | 42 | 37-42 | 37 | 42 | 326.67 | 321.67 | 14.57 | 349.1 | | 363.67 | 10.28 |
| MW25S | -182.3863019 | -330.4310354 | 365.98 | 364.36 | 24 | 19-24 | 19 | 24 | 346.98 | 341.98 | 16.95 | 349.03 | | 365.98 | 12.75 |
| MW25D | -192 | -339 | 368.14 | 366.14 | 56.5 | 52-57 | 52 | 57 | 316.14 | 311.14 | 18.81 | 349.33 | | 368.14 | 14.89 |
| MW28S | -531.1019062 | -275.0793522 | 356.94 | 355.08 | 13 | 8-13 | 8 | 13 | 348.94 | 343.94 | 12.3 | 344.64 | | 356.94 | 7.86 |
| MW28I | -526.3179949 | -267.2184011 | 357.44 | 355.36 | 39.7 | 30-40 | 30 | 40 | 327.44 | 317.44 | 12.51 | 344.93 | | 357.44 | 8.49 |
| MW28D | -535.6670625 | -280.66825 | 357.04 | 354.89 | 66 | 61.5-66 | 61.5 | 66 | 295.54 | 291.04 | | | | 357.04 | 8.26 |
| MW29S | -594.7563419 | -273.2342961 | 355.27 | 353.35 | 13 | 8-13 | 8 | 13 | 347.27 | 342.27 | | | | 355.27 | 6.26 |
| MW29I | -587.134781 | -275.9065134 | 355.37 | 353.55 | 44.8 | 30-45 | 30 | 45 | 325.37 | 310.37 | 10.41 | 344.96 | | 355.37 | 6.4 |
| MW29D | -580 | -279.0011875 | 355.25 | 353.61 | 64 | 59.5-64 | 59.5 | 64 | 295.75 | 291.25 | 10.98 | 344.27 | | 355.25 | 6.87 |
| MW32D | -57.21 | -516.01 | 381.31 | 379.77 | 61 | 56-61 | 56 | 61 | 325.31 | 320.31 | | | | 381.31 | 28.04 |
| MW33S | 34.40779067 | -687.4493922 | 383.23 | 380.88 | 37 | 32-37 | 32 | 37 | 351.23 | 346.23 | 33.97 | 349.26 | | 383.23 | 29.96 |
| MW34D | 44.68 | -576.39 | 385.08 | 382.5 | 60 | 55-60 | 55 | 60 | 330.08 | 325.08 | | | | 385.08 | 31.68 |
| MW35D | -122.62 | -612.24 | 381.36 | 378.98 | 72 | 67-72 | 67 | 72 | 314.36 | 309.36 | | | | 381.36 | 29.54 |
| MW52S | 163.5617182 | -934.6869106 | 368.74 | 367.2 | 18.0 | 13-18 | 13 | 18 | 355.74 | 350.74 | 19.29 | 349.45 | | 368.74 | 15.35 |
| MW52I | 162.9389144 | -941.9951233 | 368.36 | 367.0 | 27.0 | 22-27 | 22 | 27 | 346.36 | 341.36 | 18.94 | 349.42 | | 368.36 | 14.94 |
| MW52D | 163.1720625 | -947.2911875 | 368.09 | 366.7 | 39.0 | 34-39 | 34 | 39 | 334.09 | 329.09 | 18.65 | 349.44 | | 368.09 | 14.67 |
| TW1S | -428.880612 | -315.803281 | 360.12 | 360.22 | 20 | 10-20 | 10 | 20 | 350.12 | 340.12 | 14.49 | 345.63 | | 360.12 | 10.45 |
| TW1D | -430.577089 | -316.794868 | 359.73 | 359.83 | 38 | 28-38 | 28 | 38 | 331.73 | 321.73 | 14.01 | 345.72 | | 359.73 | 10.11 |
| TW2S | -386.75649 | -396.603016 | 360.17 | 360.27 | 21.5 | 11.5-21.5 | 11.5 | 21.5 | 348.67 | 338.67 | 13.38 | 346.79 | | 360.17 | 9.64 |
| TW2I | -388.50852 | -397.832994 | 359.915 | 360.015 | 39 | 29-39 | 29 | 39 | 330.915 | 320.915 | 13.14 | 346.775 | | 359.915 | 9.6 |
| TW2D | -385.575299 | -398.341254 | 360.055 | 360.155 | 62 | 52-62 | 52 | 62 | 308.055 | 298.055 | 13.29 | 346.765 | | 360.055 | 9.74 |
| TW3S | -350.723031 | -479.064201 | 359.91 | 360.01 | 20.5 | 10.5-20.5 | 10.5 | 20.5 | 349.41 | 339.41 | 12.89 | 347.02 | | 359.91 | 9.27 |
| TW3I | -352.601875 | -478.953054 | 360.11 | 360.21 | 39 | 29-39 | 29 | 39 | 331.11 | 321.11 | 13.26 | 346.85 | | 360.11 | 9.6 |
| TW4I | -427.640607 | -542.815706 | 352.16 | 352.26 | 40 | 30-40 | 30 | 40 | 322.16 | 312.16 | 5.18 | 346.98 | | 352.16 | 1.57 |
| TW4D | -412.475506 | -536.607394 | 352.39 | 352.49 | 63 | 53-63 | 53 | 63 | 299.39 | 289.39 | 5.24 | 347.15 | | 352.39 | 1.72 |
| TW9S | -455.362516 | -265.286922 | 359.98 | 360.08 | 18.5 | 8.5-18.5 | 8.5 | 18.5 | 351.48 | 341.48 | 14.06 | 345.92 | | 359.98 | 9.86 |
| TW9D | -455.358652 | -264.24935 | 360.15 | 360.25 | 40 | 30-40 | 30 | 40 | 330.15 | 320.15 | 14.56 | 345.59 | | 360.15 | 10.41 |
| TW-10S | -405.466171 | -597.558845 | 352.2 | | 20 | 10-20 | 10 | 20 | 342.2 | 332.2 | 4.93 | 347.27 | | 352.2 | 1.56 |
| TW-10D | -410.8263687 | -603.172 | 351.95 | 352.13 | 39.4 | 29.4-39.4 | 29.4 | 39.4 | 322.55 | 312.55 | | 351.95 | 0.64 | 351.31 | 1.25 |
| TW-14D | -289.92756 | -556.44477 | 361 | 361.22 | 35 | 25-35 | 25 | 35 | 336 | 326 | | 361 | 9.7 | 351.3 | 10.3 |
| TW-14S | -286.765 | -556.8866 | 359.88 | 360.05 | 19.9 | 9.9-19.9 | 9.9 | 19.9 | 349.98 | 339.98 | | 359.88 | 8.41 | 351.47 | 9.04 |
| TW-15D | -253.3297 | -545.045 | 326.08 | 362.08 | 38.9 | 28.9-38.9 | 28.9 | 38.9 | 297.18 | 287.18 | | 326.08 | 9.92 | 316.16 | 10.55 |
| TW-15S | -253.3889 | -553.91978 | 363.11 | 363.17 | 19.8 | 9.8-19.8 | 9.8 | 19.8 | 353.31 | 343.31 | | 363.11 | 10.88 | 352.23 | 11.56 |
| TW-16D | -289.1858 | -471.88977 | 361.24 | 361.14 | 39.3 | 29.3-39.3 | 29.3 | 39.3 | 331.94 | 321.94 | | 361.24 | 9.46 | 351.78 | 10.1 |
| TW-16S | -287.5076409 | -480.49 | 361.23 | 361.32 | 19.9 | 9.9-19.9 | 9.9 | 19.9 | 351.33 | 341.33 | | 361.23 | 9.2 | 352.03 | 9.88 |
| TW-17S | -340.6 | -396.6 | 361.98 | 362.95 | 18.1 | 8.1-18.1 | 8.1 | 18.1 | 353.88 | 343.88 | | 361.98 | 8.3 | 353.68 | 9.95 |
| TW-18D | -480.577 | -411.603 | 354.97 | 355.1 | 36.2 | 26.2-36.2 | 26.2 | 36.2 | 328.77 | 318.77 | | 354.97 | 4.5 | 350.47 | 5.11 |
| TW-18S | -475.577 | -426.603 | 354.44 | 354.37 | 11.3 | | | | 354.44 | 354.44 | | 354.44 | 3.89 | 350.55 | 4.52 |
| River Surface1 | -738.577 | -211.603 | 353 | | | | | | 353 | 353 | | 353 | | 353 | 0 |
| River Surface2 | -702.865 | -409.286 | 353 | | | | | | 353 | 353 | | 353 | | 353 | 0 |
| River Surface3 | -602.577 | -552.603 | 353 | | | | | | 353 | 353 | | 353 | | 353 | 0 |
| River Surface4 | -540.577 | -711.603 | 353 | | | | | | 353 | 353 | | 353 | | 353 | 0 |

* MW-10I, MW-34S removed from table because there is insufficient data.

** TW-17D removed from table because well integrity is questionable.

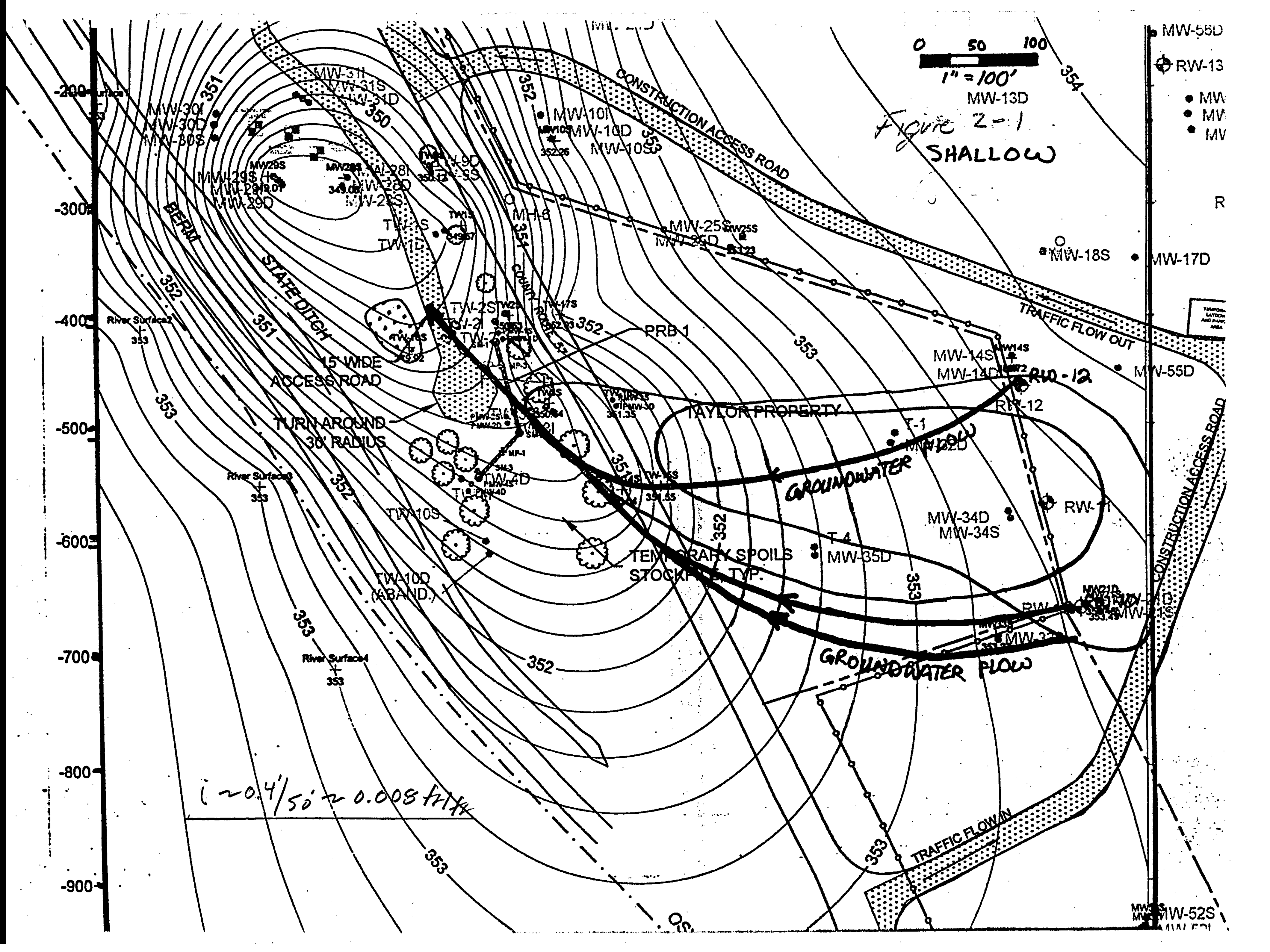


Figure 2-1
SHALLOW
0 50 100
1" = 100'
CONSTRUCTION ACCESS ROAD
TRAFFIC FLOW OUT
TRAFFIC FLOW IN
TAYLOR PROPERTY
GROUNDWATER FLOW
GROUNDWATER FLOW
RW-12
STATE DITCH
BERM
15' WIDE ACCESS ROAD
TURN AROUND 30' RADIUS
TEMPORARY SPOILS STOCKPILE, TYP.
TW-10D (ABAND.)
PRB 1
MH-8
MW-55D
RW-13
MW-13D
MW-18S
MW-17D
MW-14S
MW-14D
RW-11
MW-34D
MW-34S
MW-35D
MW-25S
MW-10I
MW-10D
MW-10S
MW-30I
MW-30D
MW-30S
MW-29S
MW-29D
MW-31S
MW-31D
MW-52S
TW-2S
TW-10S
TW-1D
River Surface2
River Surface3
River Surface4
353
352
351
350
354
-200
-300
-400
-500
-600
-700
-800
-900
i ~ 0.4'/50' ~ 0.008 ft/ft

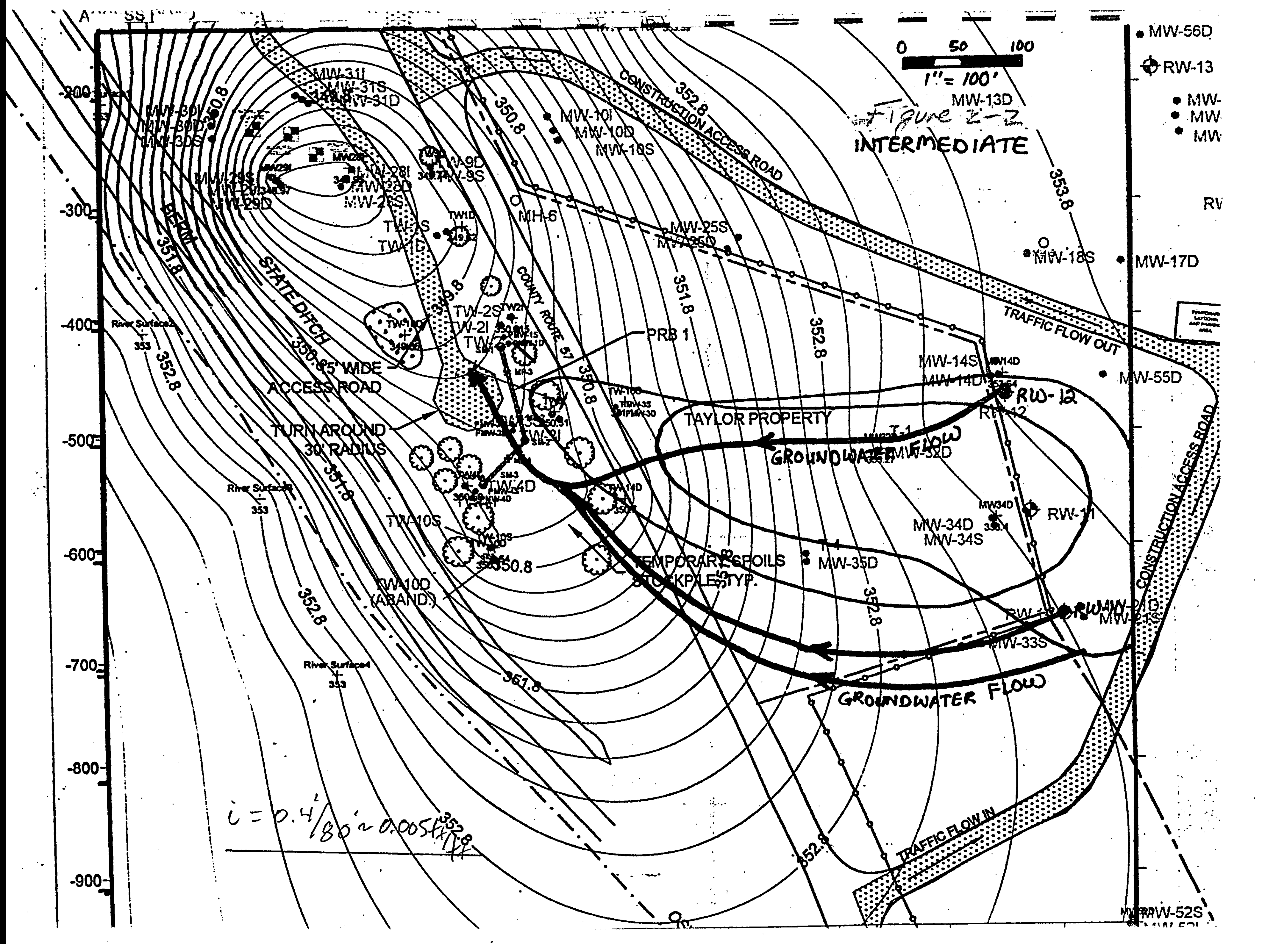


Figure 2-2
INTERMEDIATE
0 50 100
1" = 100'
CONSTRUCTION ACCESS ROAD
TRAFFIC FLOW OUT
TRAFFIC FLOW IN
COUNTY ROUTE 57
STATE DITCH
BERM
25' WIDE ACCESS ROAD
TURN AROUND 30' RADIUS
TAYLOR PROPERTY
TEMPORARY SPOILS STOCKPILE TYP.
PRB 1
GROUNDWATER FLOW
GROUNDWATER FLOW
RW-12
RW-11
RW-13
MW-56D
MW-13D
MW-17D
MW-18S
MW-55D
MW-14S
MW-14D
MW-10I
MW-10D
MW-10S
MW-25S
MW-25D
MW-31I
MW-31S
MW-31D
MW-30I
MW-30D
MW-30S
MW-29S
MW-29D
MW-28I
MW-28D
MW-26S
MW-9D
MW-9S
MW-34D
MW-34S
MW-35D
MW-33S
MW-21D
MW-21S
MW-32D
MW-52S
MH-6
TW-1S
TW-1D
TW-2S
TW-2I
TW-4D
TW-10S
TW-10D (ABAND.)
River Surface
353
349.8
350.8
351.8
352.8
353.8
-200
-300
-400
-500
-600
-700
-800
-900
i = 0.4'/80' ≈ 0.005 ft/ft

*Table 3-1*

**Design Velocity - PRW-1**
**Former Miller Container Plant, Volney NY**

**Estimated Hydraulic Conductivity**

| Monitoring Well | Formation | Hydraulic Conductivity (cm/sec) | Units |
|---|---|---|---|
| MW-10S | Silt/Sand | 0.0009 | cm/sec |
| MW-14S | Silt/Sand | 0.0002 | cm/sec |
| MW-25S | Silt/Sand | 0.004 | cm/sec |
| MW-28S | Sand/Gravel | 0.005 | cm/sec |
| MW-33S | Sand/Gravel | 0.0004 | cm/sec |
| MW-28I | Sand/Gravel | 0.1 | cm/sec |
| MW-10D | Sand/Gravel | 0.004 | cm/sec |
| MW-14D | Sand/Gravel | 0.004 | cm/sec |
| MW-25D | Sand/Gravel | 0.02 | cm/sec |
| MW-32D | Sand/Gravel | 0.2 | cm/sec |
| MW-34D | Sand/Gravel | 0.005 | cm/sec |
| MW-35D | Sand/Gravel | 0.001 | cm/sec |
| MW-25D | Sand/Gravel | 0.1 | cm/sec |

$Mean_{Geo}$ = 0.0055 cm/sec

**Steepest Gradient**

I = 0.008 dimless (see attached calcs)

**Porosity**

$n_e$ = 0.35 dimless *(media porosity is ~ 0.4)*

**Design Velocity**

v = 0.36 ft/d

Note: 0.1 Recharge too fast to measure, assumed value.

~~Table 1~~ Table 4-1

## Groundwater Concentrations versus NYSDEC Criteria - PRB 1

### Former Miller Container Plant, Volney, NY

| | | | Shallow Well | Deep Well |
|---|---|---|---|---|
| Constituent | NYSDEC Generic Criteria (ug/L) | EPA MCLs (ug/L) | TW-3S | TW-3I |
| 1,1 DCA | 5 | - | <1 | <1 |
| 1,1 DCE | 5 | 7 | <1 | 1.5 |
| 1,2 DCE | 5 | 70 | <1 | <1 |
| PCE | 5 | 5 | 1.2 | 3.8 |
| 1,1,1 TCA | 5 | 200 | 2.3 | 5.4 |
| TCE | 5 | 5 | <1 | <1 |
| VC | 5 | 5 | <2 | <2 |

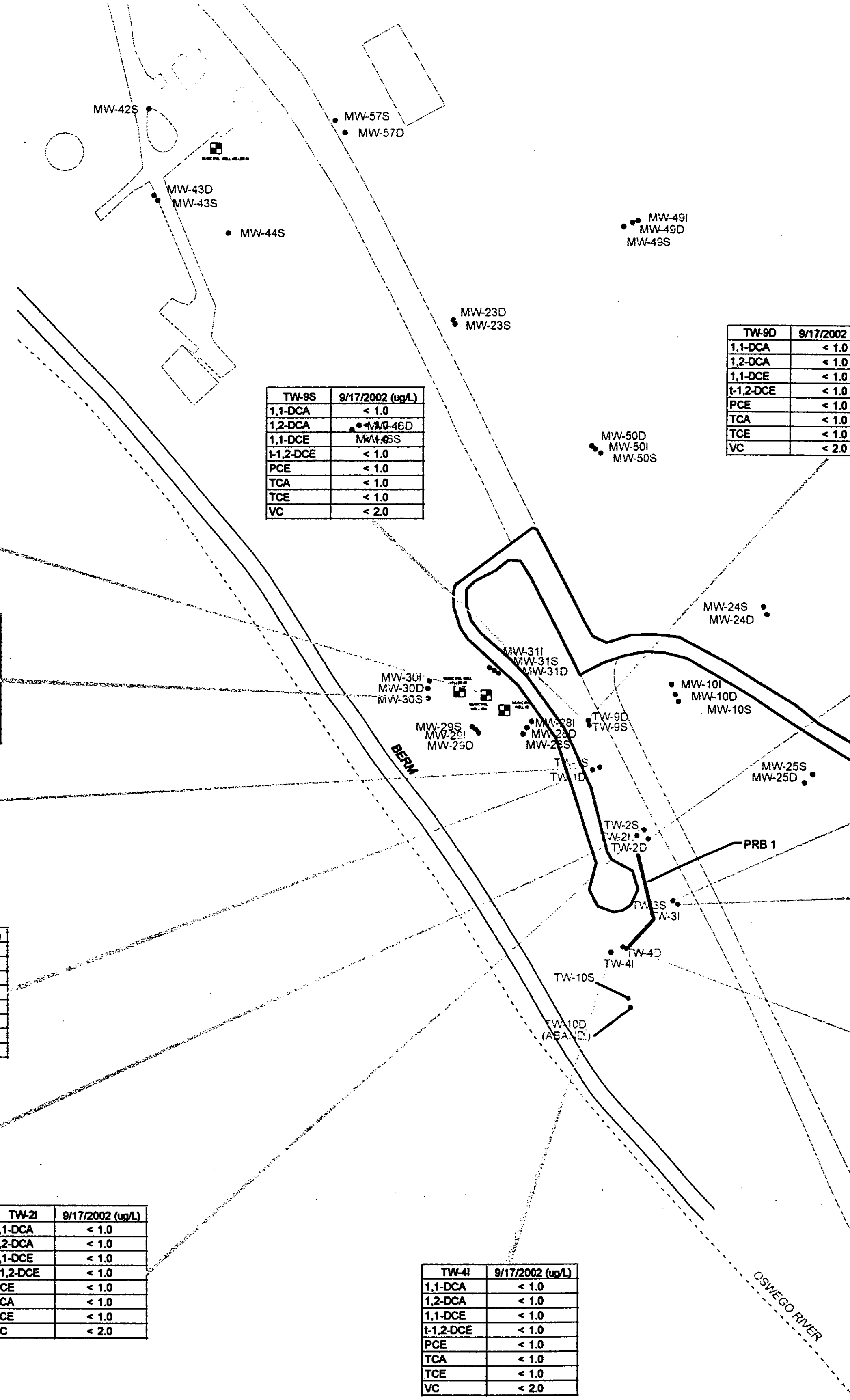
Based on concentration detected in 2002

Table 5-1

## Required Iron Thickness - PRB 1
## Former Miller Container Plant, Volney NY

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| $C_{0,PCA}$ | = | 3.8 | µg/L | $C_{0,TCA}$ | = | 5.4 | µg/L | $C_{0,1,1,DCE}$ | = | 1.5 | µg/L |
| $CP_{CA}$ | = | 0.49 | µg/L | $CP_{CA}$ | = | 0.49 | µg/L | $CP_{CA}$ | = | 0.49 | µg/L |
| $\lambda$ | = | 0.54 | 1/hr | $\lambda$ | = | 0.49 | 1/hr | $\lambda$ | = | 0.52 | 1/hr |
| $t_{ReqdResi}$ | = | 0.158 | day | $t_{ReqdResi}$ | = | 0.204 | day | $t_{ReqdResi}$ | = | 0.090 | day |
| v | = | 0.36 | ft/d | v | = | 0.36 | ft/d | v | = | 0.36 | ft/d |
| $SF_{ReactLossLT}$ | = | 2.00 | dimless | $SF_{ReactLossL}$ | = | 2.00 | dimless | $SF_{ReactLossL}$ | = | 2.00 | dimless |
| $SF_{ReactDecrease5\%}$ | = | 2.00 | dimless | $SF_{ReactDecre}$ | = | 2.00 | dimless | $SF_{ReactDecre}$ | = | 2.00 | dimless |
| **Required Thickness** | | | | **Required Thickness** | | | | **Required Thickness** | | | |
| $T_{ReqVelPRW1}$ | = | 0.68 | in | $T_{ReqVelPRW1}$ | = | 0.88 | in | $T_{ReqVelPRW1}$ | = | 0.39 | in |
| $T_{ReqdSFsApplied}$ | = | 2.72 | in | $T_{ReqdSFsAp}$ | = | 3.51 | in | $T_{ReqdSFsAp}$ | = | 1.54 | in |

$T_{provided}$ = 4.8 inches OK




| MUN 2-A | 7/25/02 (ug/L) |
|---|---|
| 1,1-DCA | < 0.5 |
| 1,1-DCE | 0.5 |
| t-1,2-DCE | < 0.5 |
| PCE | 0.92 |
| TCA | 1.6 |

| TW-9S | 9/17/2002 (ug/L) |
|---|---|
| 1,1-DCA | < 1.0 |
| 1,2-DCA | < 1.0 |
| 1,1-DCE | < 1.0 |
| t-1,2-DCE | < 1.0 |
| PCE | < 1.0 |
| TCA | < 1.0 |
| TCE | < 1.0 |
| VC | < 2.0 |

| TW-9D | 9/17/2002 (ug/L) |
|---|---|
| 1,1-DCA | < 1.0 |
| 1,2-DCA | < 1.0 |
| 1,1-DCE | < 1.0 |
| t-1,2-DCE | < 1.0 |
| PCE | < 1.0 |
| TCA | < 1.0 |
| TCE | < 1.0 |
| VC | < 2.0 |

| TW-2D | 9/17/2002 (ug/L) |
|---|---|
| 1,1-DCA | < 1.0 |
| 1,2-DCA | < 1.0 |
| 1,1-DCE | < 1.0 |
| t-1,2-DCE | < 1.0 |
| PCE | < 1.0 |
| TCA | < 1.0 |
| TCE | < 1.0 |
| VC | < 2.0 |

| MW-30S | 9/19/2002 (ug/L) |
|---|---|
| 1,1-DCA | < 1.0 |
| 1,2-DCA | < 1.0 |
| 1,1-DCE | 1.0 |
| t-1,2-DCE | < 1.0 |
| PCE | 2.2 |
| TCA | 1.8 |
| TCE | < 1.0 |
| VC | < 2.0 |

| TW-3S | 9/17/2002 (ug/L) |
|---|---|
| 1,1-DCA | < 1.0 |
| 1,2-DCA | < 1.0 |
| 1,1-DCE | < 1.0 |
| t-1,2-DCE | < 1.0 |
| PCE | 1.2 |
| TCA | 2.3 |
| TCE | < 1.0 |
| VC | < 2.0 |

| TW-1S | 9/17/2002 (ug/L) |
|---|---|
| 1,1-DCA | < 1.0 |
| 1,2-DCA | < 1.0 |
| 1,1-DCE | < 1.0 |
| t-1,2-DCE | < 1.0 |
| PCE | < 1.0 |
| TCA | < 1.0 |
| TCE | < 1.0 |
| VC | < 2.0 |

| TW-3I | 9/17/2002 (ug/L) |
|---|---|
| 1,1-DCA | < 1.0 |
| 1,2-DCA | < 1.0 |
| 1,1-DCE | 1.5 |
| t-1,2-DCE | < 1.0 |
| PCE | 3.8 |
| TCA | 5.4 |
| TCE | < 1.0 |
| VC | < 2.0 |

| TW-1D | 9/17/2002 (ug/L) |
|---|---|
| 1,1-DCA | < 1.0 |
| 1,2-DCA | < 1.0 |
| 1,1-DCE | < 1.0 |
| t-1,2-DCE | < 1.0 |
| PCE | < 1.0 |
| TCA | < 1.0 |
| TCE | < 1.0 |
| VC | < 2.0 |

| TW-2S | 9/17/2002 (ug/L) |
|---|---|
| 1,1-DCA | < 1.0 |
| 1,2-DCA | < 1.0 |
| 1,1-DCE | < 1.0 |
| t-1,2-DCE | < 1.0 |
| PCE | < 1.0 |
| TCA | < 1.0 |
| TCE | < 1.0 |
| VC | < 2.0 |

| TW-2I | 9/17/2002 (ug/L) |
|---|---|
| 1,1-DCA | < 1.0 |
| 1,2-DCA | < 1.0 |
| 1,1-DCE | < 1.0 |
| t-1,2-DCE | < 1.0 |
| PCE | < 1.0 |
| TCA | < 1.0 |
| TCE | < 1.0 |
| VC | < 2.0 |

| TW-4I | 9/17/2002 (ug/L) |
|---|---|
| 1,1-DCA | < 1.0 |
| 1,2-DCA | < 1.0 |
| 1,1-DCE | < 1.0 |
| t-1,2-DCE | < 1.0 |
| PCE | < 1.0 |
| TCA | < 1.0 |
| TCE | < 1.0 |
| VC | < 2.0 |

| TW-4D | 9/17/2002 (ug/L) |
|---|---|
| 1,1-DCA | < 1.0 |
| 1,2-DCA | < 1.0 |
| 1,1-DCE | < 1.0 |
| t-1,2-DCE | < 1.0 |
| PCE | < 1.0 |
| TCA | < 1.0 |
| TCE | < 1.0 |
| VC | < 2.0 |

## LEGEND

- MONITORING WELLS
- RECOVERY WELLS
- TEMPORARY WELLS
- PROPOSED PRB LAYOUT
- < 1 NON-DETECT

NOTE:

BASED ON SUPPLEMENTAL DESIGN INVESTIGATION AND PERIODIC SITE-WIDE MONITORING RESULTS FROM 2002.

0 120 240
SCALE IN FEET

MILLER BREWING COMPANY
FORMER CONTAINER PLANT
VOLNEY, NEW YORK

| | | |
|---|---|---|
| SCALE | AS SHOWN | |
| DESIGNED BY | JI | 10/28/02 |
| DRAWN BY | RF | 07/25/03 |
| CHECKED BY | JI | 07/25/03 |
| APPROVED BY | JI | 07/25/03 |

URS

GROUNDWATER ANALYTICAL RESULTS
PRB-1 (2002)

| CONTRACT NO. | DRAWING NO. | REV NO. |
|---|---|---|
| 81002401 | PRB1 2003 | - |

# Design Basis PRB 2

Former Miller Container Plant
Fulton, NY

Table 2-2
Hydraulic Conductivity Evaluation

Note: Kh based on RI by Malcolm Pirnie

## Overall Geometric Mean (Kh) PRB-1

| WELL ID | DEPTH | ID | NOTES | K (cm/s) |
|---|---|---|---|---|
| MW-10S | Shallow | S | | 9.E-04 |
| MW-14S | Shallow | S | | 2.E-04 |
| MW-25S | Shallow | S | | 4.E-03 |
| MW-28S | Shallow | G | | 5.E-03 |
| MW-33S | Shallow | G | | 4.E-04 |
| MW-28I | Intermediate | G | | 1.E-01 |
| MW-10D | Deep | G | | 4.E-03 |
| MW-14D | Deep | G | | 4.E-03 |
| MW-25D | Deep | G | | 2.E-02 |
| MW-28D | Deep | G | + | 2.E-02 |
| MW-32D | Deep | G | | 5.E-03 |
| MW-34D | Deep | G | | 1.E-03 |
| MW-35D | Deep | G | | 1.E-01 |
| | | | | **5.E-03** |

## Kh per Geologic Unit PRB-1

| WELL ID | DEPTH | ID | NOTES | K (cm/s) |
|---|---|---|---|---|
| PRB 1 - S | | | | |
| MW-10S | Shallow | S | | 9.E-04 |
| MW-14S | Shallow | S | | 2.E-04 |
| MW-25S | Shallow | S | | 4.E-03 |
| | | | | **8.96E-04** |
| PRB 1 - G | | | | |
| MW-28S | Shallow | G | | 5.E-03 |
| MW-33S | Shallow | G | | 4.E-04 |
| MW-28I | Intermediate | G | | 1.E-01 |
| MW-10D | Deep | G | | 4.E-03 |
| MW-14D | Deep | G | | 4.E-03 |
| MW-25D | Deep | G | | 2.E-02 |
| MW-28D | Deep | G | + | 2.E-02 |
| MW-32D | Deep | G | | 5.E-03 |
| MW-34D | Deep | G | | 1.E-03 |
| MW-35D | Deep | G | | 1.E-01 |
| | | | | **7.60E-03** |

## Overall Geometric Mean (Kh) PRB-2

| WELL ID | DEPTH | ID | NOTES | K (cm/s) |
|---|---|---|---|---|
| MW-3S | Shallow | S | | 2.E-04 |
| MW-4S | Shallow | S | | 2.E-04 |
| MW-6S | Shallow | S | | 1.E-04 |
| MW-7S | Shallow | S | | 7.E-03 |
| MW-11S | Shallow | S | | 3.E-04 |
| MW-12S | Shallow | S | + | 9.E-05 |
| MW-26S | Shallow | S | | 8.E-04 |
| MW-37S | Shallow | S | | 4.E-06 |
| MW-53S | Shallow | S | | 1.E-04 |
| MW-54S | Shallow | S | | 4.E-06 |
| MW-6I | Intermediate | S | | 2.E-04 |
| MW-37I | Intermediate | S | | 2.E-04 |
| MW-53I | Intermediate | G | | 1.E-02 |
| MW-54I | Intermediate | S | | 4.E-03 |
| MW-3D | Deep | S | | 3.E-04 |
| MW-4D | Deep | G | | 5.E-04 |
| MW-6D | Deep | G | | 7.E-04 |
| MW-7D | Deep | G | | 2.E-03 |
| MW-11D | Deep | G | | 6.E-03 |
| MW-12D | Deep | G | | 6.E-03 |
| MW-16D | Deep | G | | 9.E-04 |
| MW-20D | Deep | S | | 2.E-04 |
| MW-26D | Deep | G | | 1.E-01 |
| MW-37D | Deep | S | | 4.E-05 |
| MW-53D | Deep | S | | 3.E-05 |
| MW-54D | Deep | S | | 5.E-06 |
| | | | | **3.49E-04** |

## Kh per Geologic Unit PRB-2

| WELL ID | DEPTH | ID | NOTES | K (cm/s) |
|---|---|---|---|---|
| PRB 2 - S | | | | |
| MW-3S | Shallow | S | | 2.E-04 |
| MW-3D | Deep | S | | 3.E-04 |
| MW-4S | Shallow | S | | 2.E-04 |
| MW-6S | Shallow | S | | 1.E-04 |
| MW-6I | Intermediate | S | | 2.E-04 |
| MW-7S | Shallow | S | | 7.E-03 |
| MW-11S | Shallow | S | | 3.E-04 |
| MW-12S | Shallow | S | + | 9.E-05 |
| MW-20D | Deep | S | | 2.E-04 |
| MW-26S | Shallow | S | | 8.E-04 |
| MW-37S | Shallow | S | | 4.E-06 |
| MW-37I | Intermediate | S | | 2.E-04 |
| MW-37D | Deep | S | | 4.E-05 |
| MW-53S | Shallow | S | | 1.E-04 |
| MW-53D | Deep | S | | 3.E-05 |
| MW-54S | Shallow | S | | 4.E-06 |
| MW-54I | Intermediate | S | | 4.E-03 |
| MW-54D | Deep | S | | 5.E-06 |
| | | | | **1.25E-04** |
| PRB 2 - G | | | | |
| MW-4D | Deep | G | | 5.E-04 |
| MW-6D | Deep | G | | 7.E-04 |
| MW-7D | Deep | G | | 2.E-03 |
| MW-11D | Deep | G | | 6.E-03 |
| MW-12D | Deep | G | | 6.E-03 |
| MW-16D | Deep | G | | 9.E-04 |
| MW-26D | Deep | G | | 1.E-01 |
| MW-53I | Intermediate | G | | 1.E-02 |
| | | | | **3.50E-03** |

*Table 2-3*

**Summary of Groundwater Model Parameters**

Former Miller Container Plant, Volney, NY

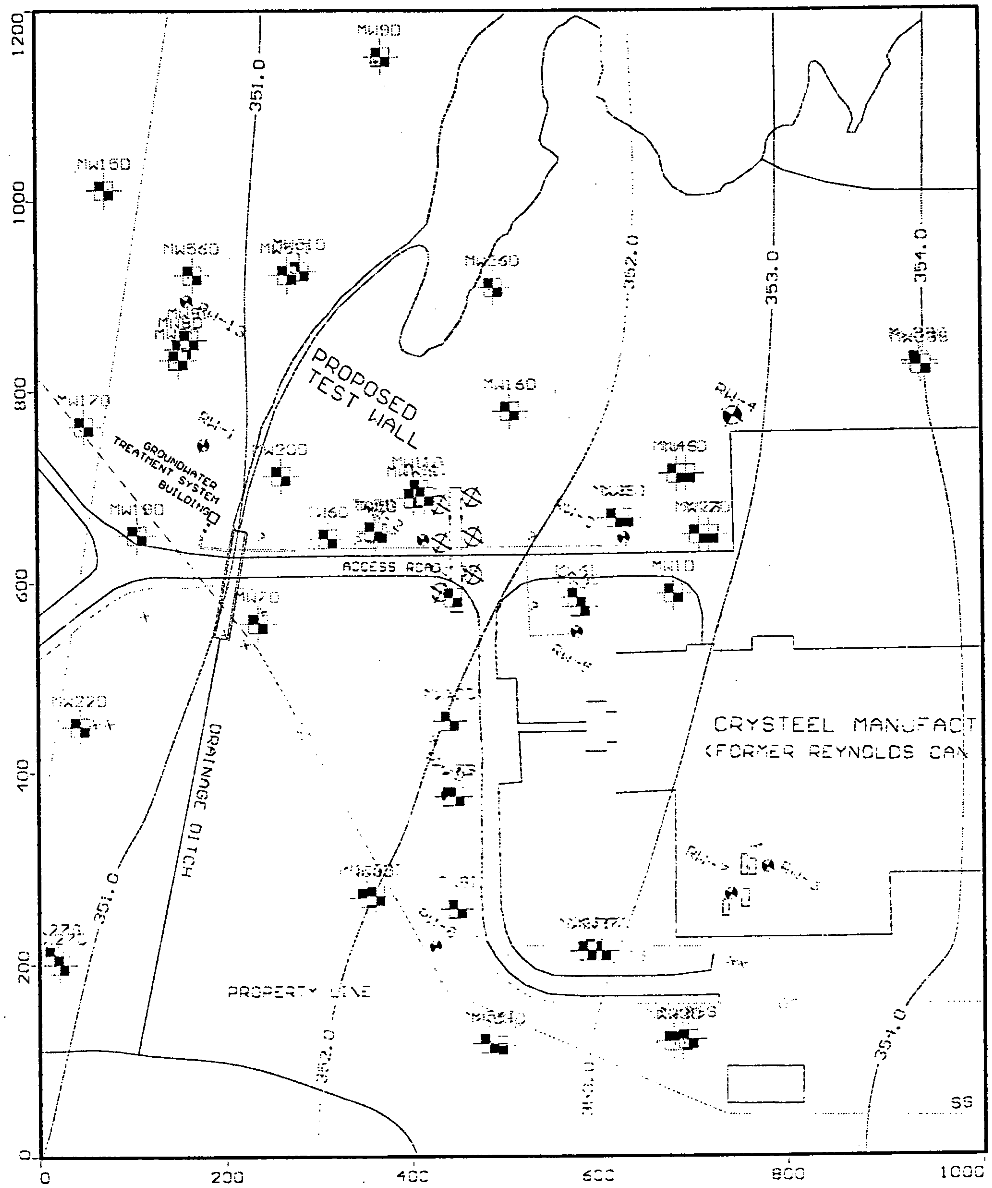
Note: Model calibrated to heads from supplemental investigation (see Figure 1 for conceptual model)

| Description | Variable | Value | Comments |
|---|---|---|---|
| Model Domain Length (N-S) | L (ft) | 1200 | Length is measured parallel to PRB-1 |
| Model Domain Width (E-W) | L (ft) | 1000 | Length is measured perpendicular to PRB-1 |
| Potentiametric Surface (t = 0) | H (ft) | Varies | Measured groundwater elevation without groundwater pump & treat system operating in September 2002 (see spreadsheet 'All Wells-Data Entry Sheet' this file). |
| Recharge Boundary | in/yr | 0.7 | Annual rainfall 40, low permeability soils 10% or less typical |
| Constant Head Boundary, West | CHB (ft) | 351.0 - 349.7 | Based on non-pumping conditions, Sept 2002 |
| Constant Head Boundary, East | CHB (ft) | 354.6-354.4 | South to north along east boundary, based on non-pumping conditions, Sept 2002 |
| Hydraulic Conductivity of Sand/Silt Layer | K (cm/s) | 1.25E-04 | Based on geometric mean of wells within 400 feet of PRB-2 (see spreadsheet 'Hydraulic Conductivity' this file). Lithology interpreted from boring logs from RI and subsequent field activities. |
| Effective Porosity of Sand/Silt Layer | ne | 0.22 | Based on RI report by Malcolm Pirnie. Total porosity est. 0.25 - 0.30. |
| Hydraulic Conductivity of Sand/Gravel Layer | K (cm/s) | 3.50E-03 | Based on geometric mean of wells within 400 feet of PRB-2 (see spreadsheet 'Hydraulic Conductivity' this file). Lithology interpreted from boring logs from RI and subsequent field activities. |
| Effective Porosity of Sand/Gravel Layer | ne | 0.22 | Based on RI report by Malcolm Pirnie. Total porosity is 0.25 - 0.30. |
| Hydraulic Conductivity of Till Layer | K (cm/s) | 1.00E-07 | Based on geometric mean of wells within 400 feet of PRB-2 (see spreadsheet 'Hydraulic Conductivity' this file). Lithology interpreted from boring logs from RI and subsequent field activities. |
| Effective Porosity of Till Layer | ne | 0.30 | Estimated based on range of values of porosity from Freeze & Cherry |
| Hydraulic Conductivity of PRB Gate | K (cm/s) | 3.50E-02 | Based on ETI data |
| Effective Porosity of PRB Gate | ne | 0.35 | Assumed based on experience |
| Hydraulic Conductivity of Funnel | K (cm/s) | 5.00E-07 | Based on mix test data |
| Effective Porosity of Funnel | ne | 0.25 | Assumed based on experience |
| Specific Yield | Sy | 0.2 | Based on Freeze & Cherry, value is between 0.1-0.3 |
| Specific Storage | Ss | 0.07 | Based on RI Report by Malcolm Pirnie |
| **Parameters Calculated from Model** | | | |
| Velocity, Gate 1 Shallow/Deep | ft/day | 0.009 / 0.18 | Northern gate, based on 7.16.03 block model |
| Velocity, Gate 2 Shallow/Deep | ft/day | 0.025 / 0.36 | Central gate, based on 7.16.03 block model |
| Velocity, Gate 3 Shallow/Deep | ft/day | 0.028 / 0.042 | Southern gate, based on 7.16.03 block model |

Baseline GW Model + Calibration - PRB2
MBCo, Fulton NY



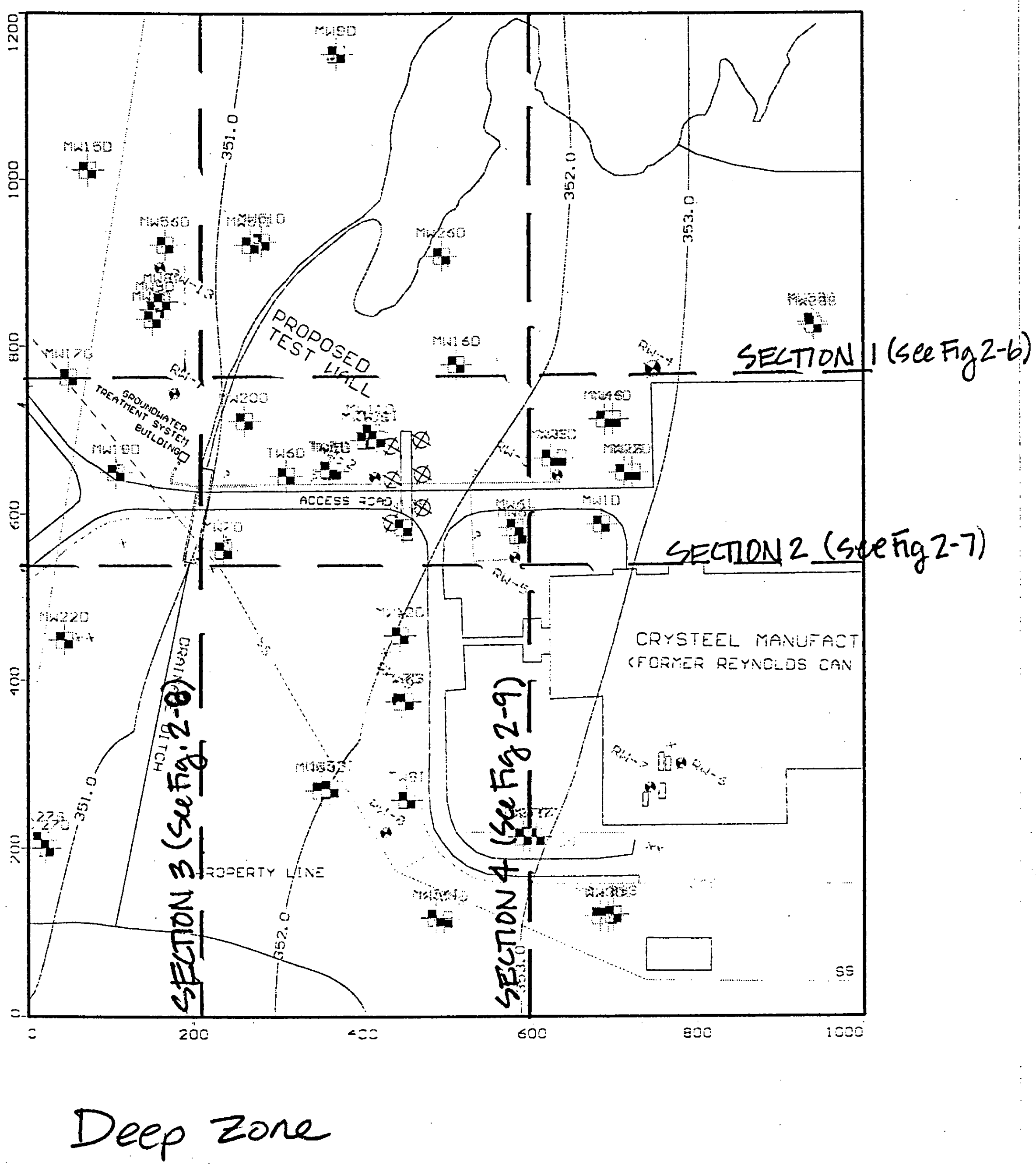
Figure 2-3




Shallow Zone

| | |
|---|---|
| URS Corp<br>Project: .7infl, 0 infl bldg pond<br>Description: Pnchout Hole Pond.001<br>Modeller: 351-349.7 354.6-354.4<br>16 Jul 03 | Visual MODFLOW v.2.8.2, (C) 1995-1999<br>Waterloo Hydrogeologic, Inc.<br>NC: 200 NR: 240 NL: 3<br>Current Layer: 1 |

Figure 2-4




URS Corp
Project: .7infl, 0 infl bldg pond
Description: Pnchout Hole Pond.001
Modeller: 351–349.7 354.6–354.4
16 Jul 03

Visual MODFLOW v.2.8.2, (C) 1995–1999
Waterloo Hydrogeologic, Inc.
NC: 200 NR: 240 NL: 3
Current Layer: 2

Figure 2-5

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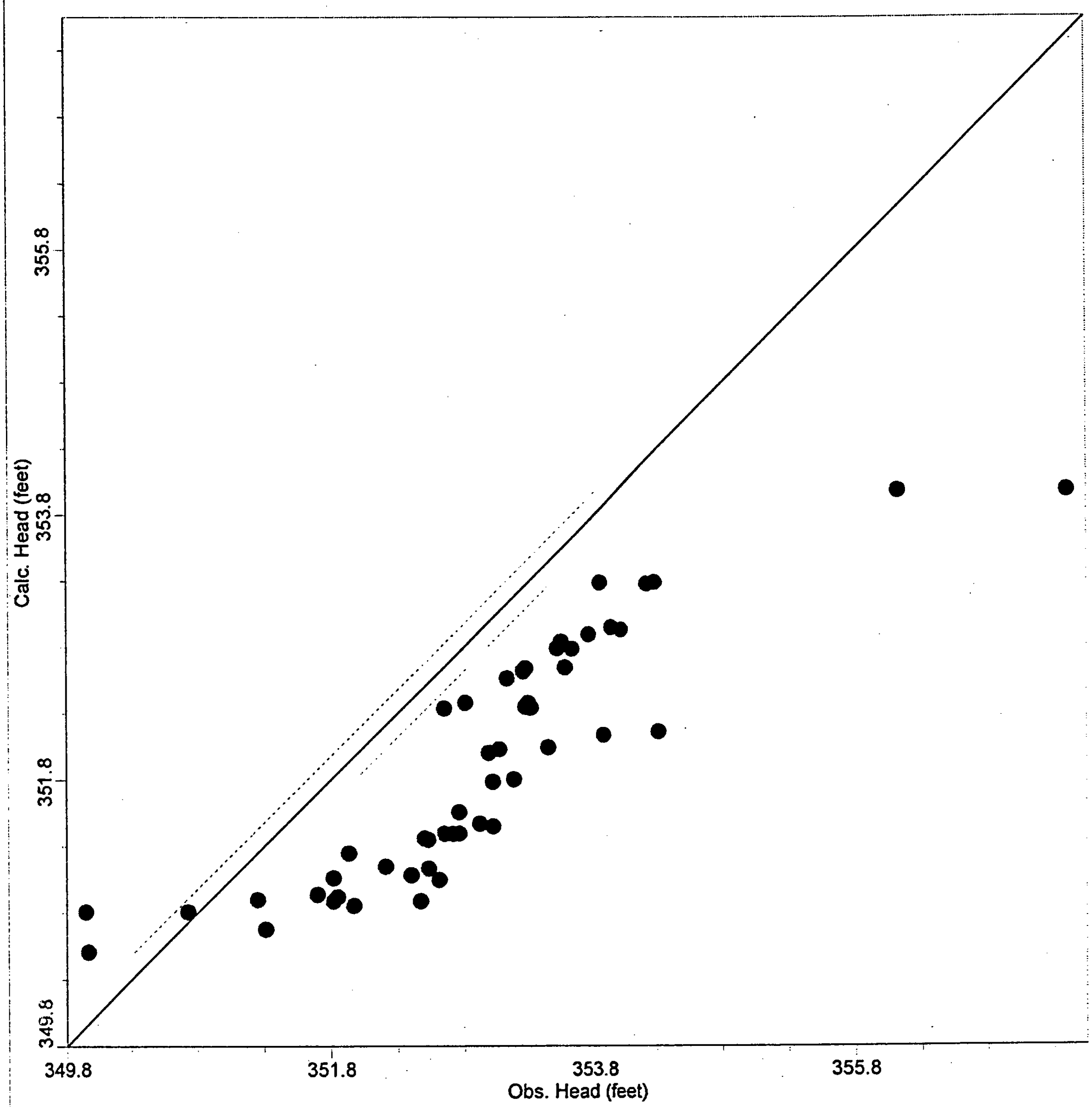
## Calculated vs. Observed Head : Steady state




Num.Points : 51
Mean Error : -1.009646 (feet)
Mean Absolute : 1.06751 (feet)
Standard Error of the Estimate : 0.09002495 (feet)
Root mean squared : 1.19357 (feet)
Normalized RMS : 16.02107 ( % )

Project: 2003.07.16.MillerModel_5x5_0ftpinchout_pond_0
7/16/2003 11:38:47 AM

Figure 2-6
SECTION 1

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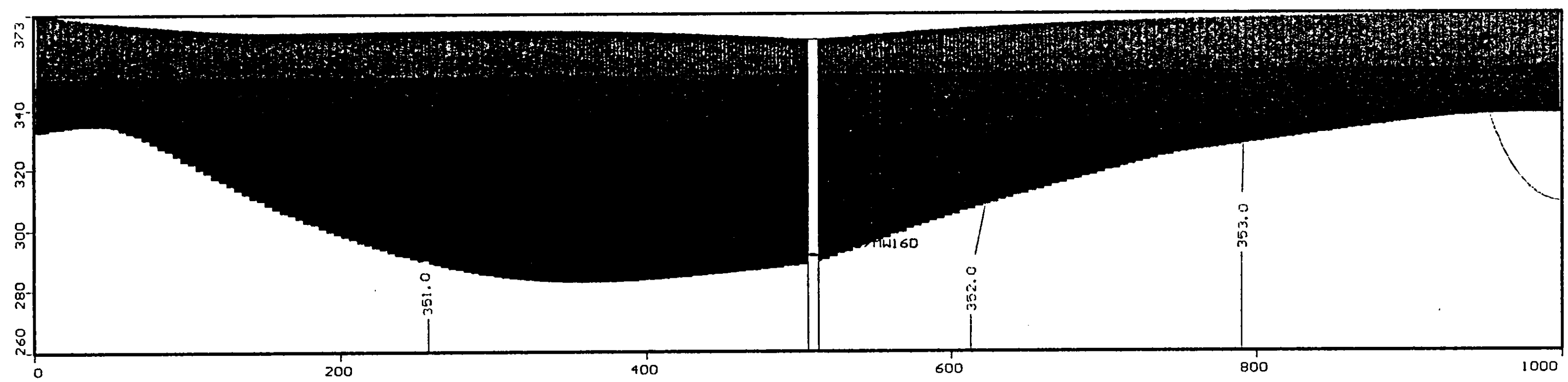
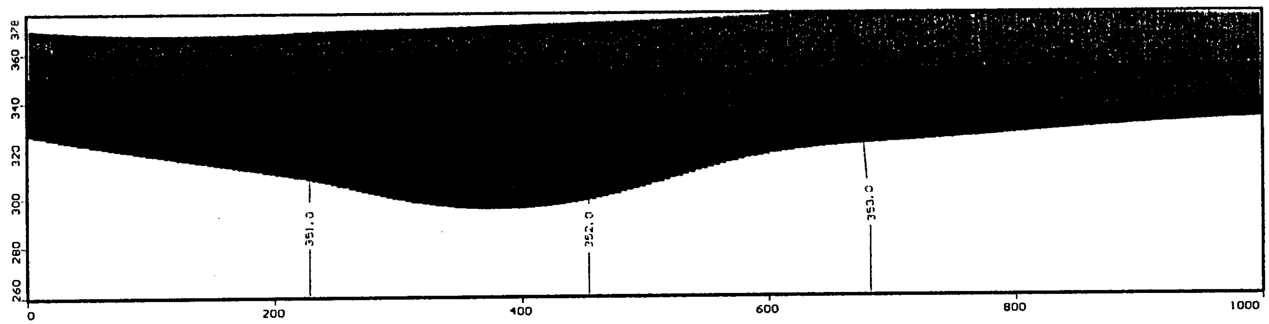



| | |
|---|---|
| URS Corp<br>Project: Miller<br>Description: PRB, Vert Exg x2<br>Modeller: Row 84, Y=782.5'<br>25 Jul 03 | Visual MODFLOW v.2.8.2, (C) 1995–1999<br>Waterloo Hydrogeologic, Inc.<br>NC: 264 NR: 240 NL: 3<br>Current Row: 84 |

Figure 2-7
SECTION 2



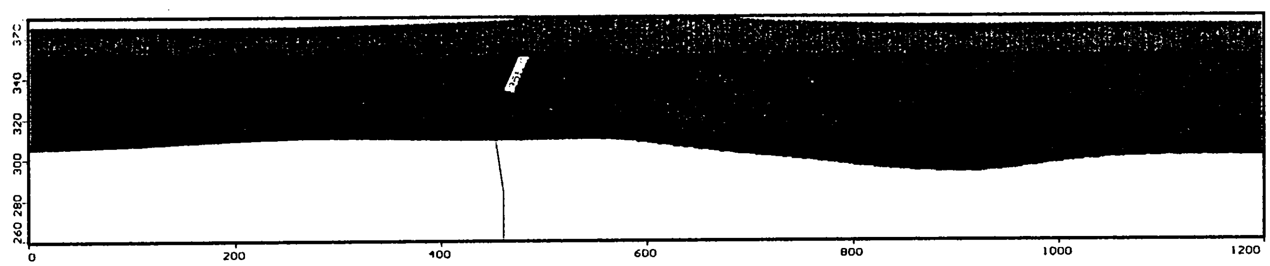



URS Corp
Project: Miller
Description: PRB, Vert Exg x2
Modeller: Row 133, Y=535'
25 Jul 03

Visual MODFLOW v.2.8.2, (C) 1995–1999
Waterloo Hydrogeologic, Inc.
NC: 264 NR: 240 NL: 3
Current Row: 133

Figure 2-8
SECTION 3

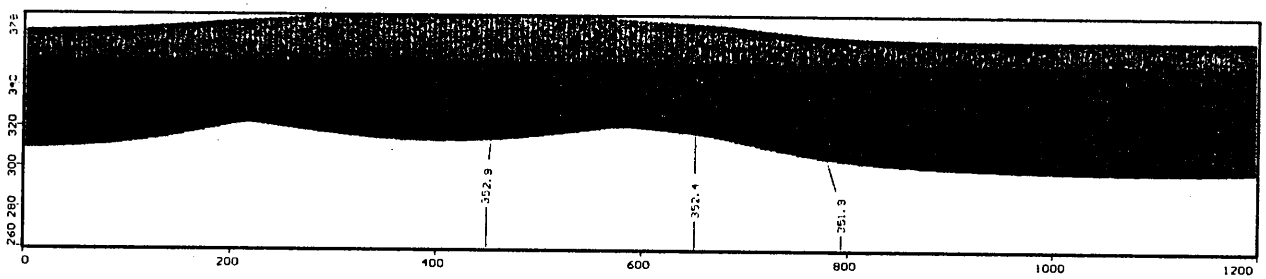
6/7




URS Corp
Project: Miller
Description: PRB, Vert Exg x2
Modeller: Col 41, X = 201'
25 Jul 03

Visual MODFLOW v.2.8.2, (C) 1995–1999
Waterloo Hydrogeologic, Inc.
NC: 264 NR: 240 NL: 3
Current Column: 41

Figure 2-9
SECTION 4

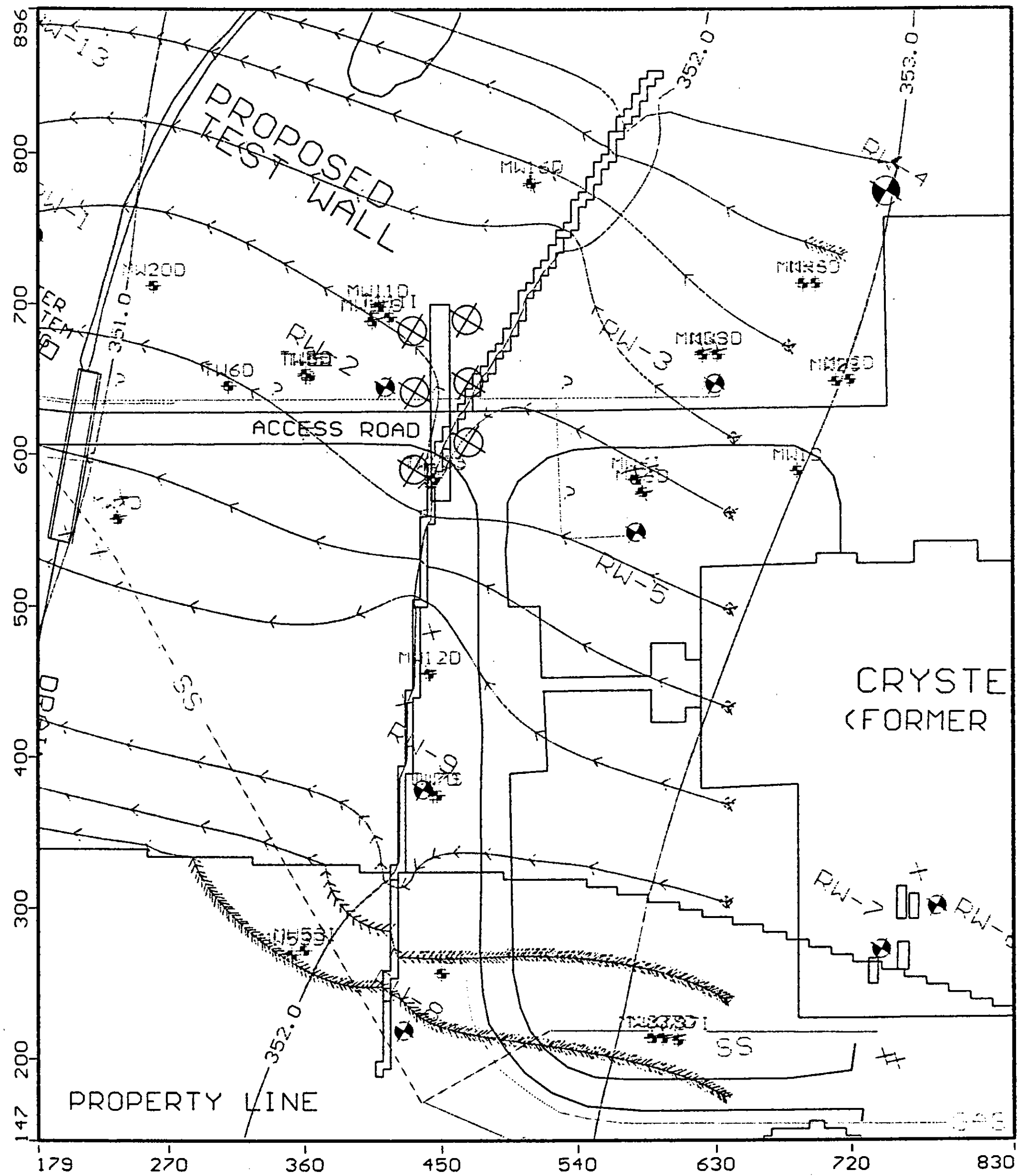



| | |
|---|---|
| URS Corp<br>Project: Miller<br>Description: PRB, Vert Exg x2<br>Modeller: Col 171, X = 599'<br>25 Jul 03 | Visual MODFLOW v.2.8.2, (C) 1995–1999<br>Waterloo Hydrogeologic, Inc.<br>NC: 264 NR: 240 NL: 3<br>Current Column: 171 |

7/.

GW Flow Paths – PRB 2
MBCo, Fulton NY

Figure 2-10



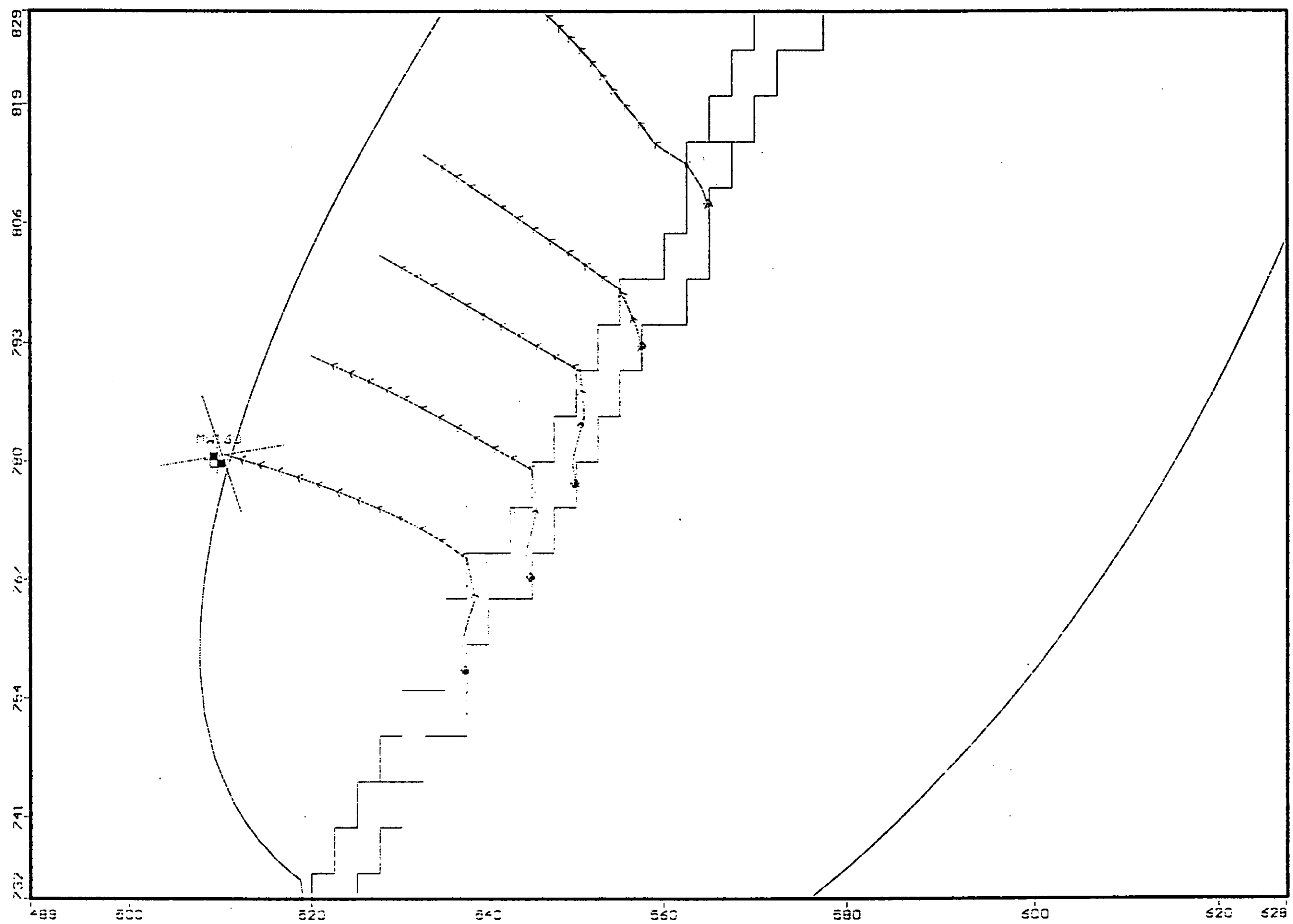

Shallow and deep zone

| | |
|---|---|
| URS Corp<br>Project: Miller, NY<br>Description: PRB<br>Modeller: 365 Days b/w Arrow Heads<br>25 Jul 03 | Visual MODFLOW v.2.8.2, (C) 1995–1999<br>Waterloo Hydrogeologic, Inc.<br>NC: 200 NR: 240 NL: 3<br>Current Layer: 2 |

Design Velocity - PRB 2
MBCo, Fulton NY



Figure 3-1



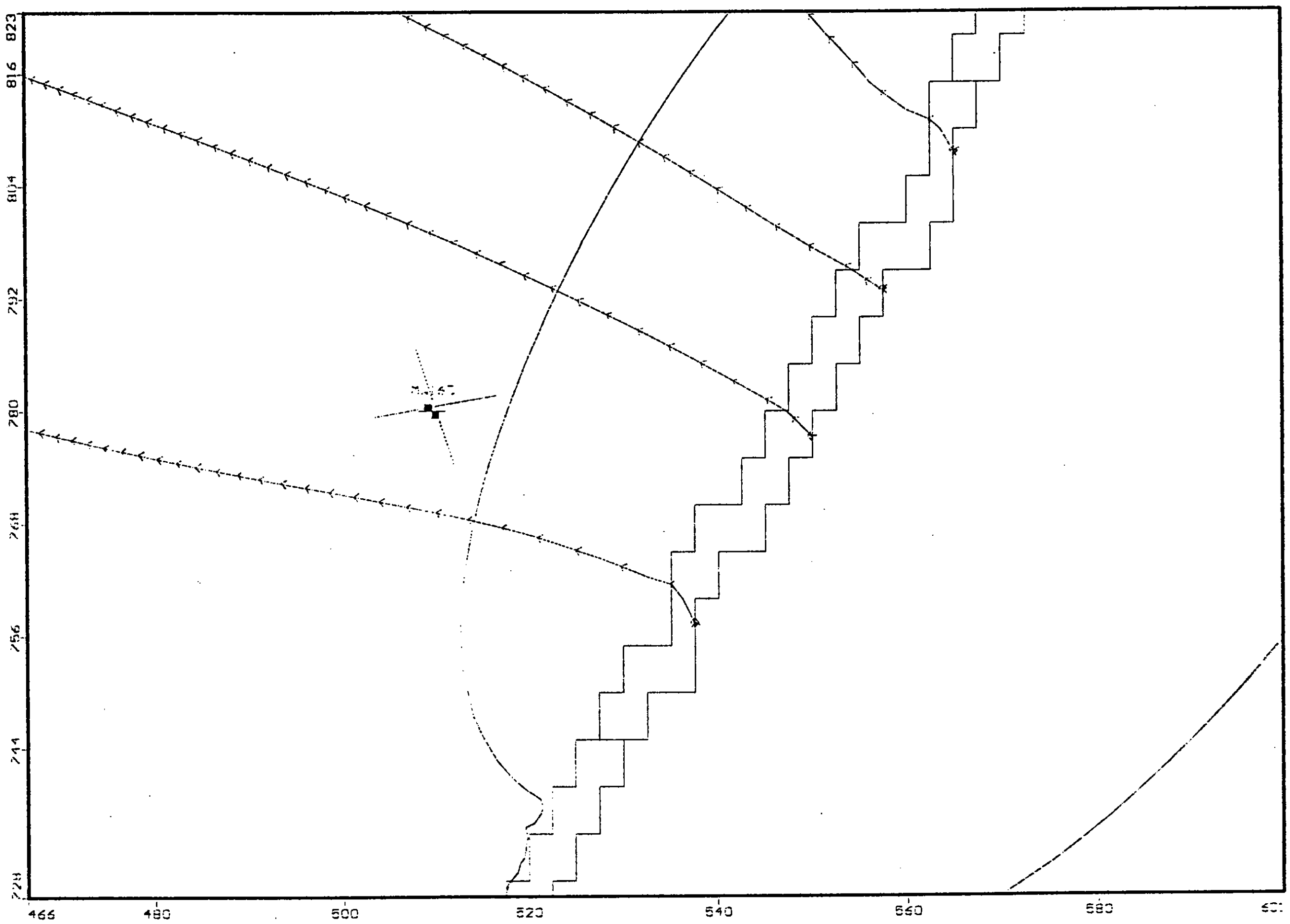

Gate 1: Shallow zone vel ≅ 0.009 ft/d

| | |
|---|---|
| URS Corp<br>Project: Gate 1<br>Description: 290 days b/w Arrow Hds<br>Modeller: 351−349.7 354.6−354.4<br>24 Jul 03 | Visual MODFLOW v.2.8.2, (C) 1995−1999<br>Waterloo Hydrogeologic, Inc.<br>NC: 264 NR: 240 NL: 3<br>Current Layer: 1 |

Design Velocity - PRB 2
MBCo, Fulton NY



Figure 3-2



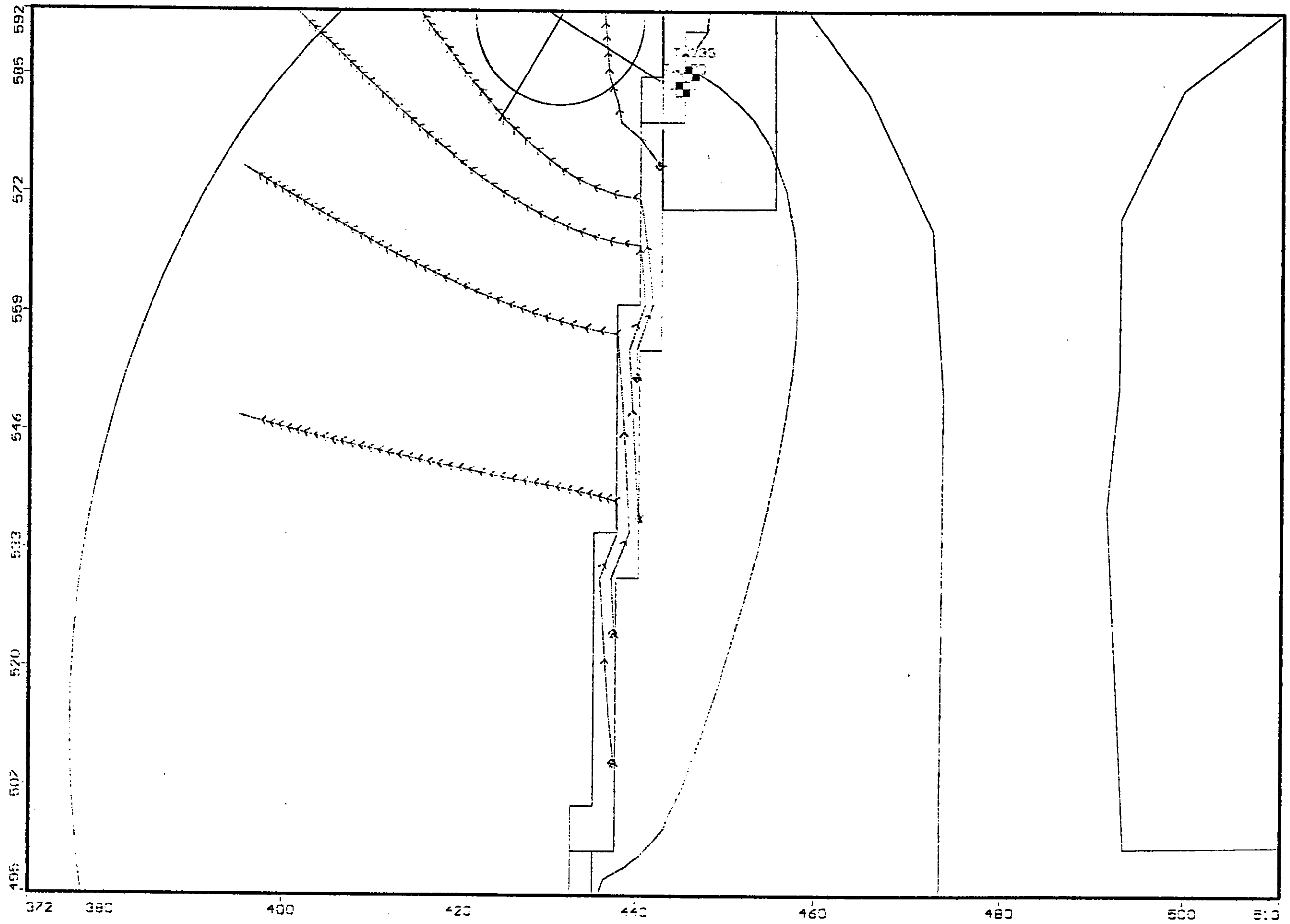
Gate 1: Deep zone vel ≅ 0.18 ft/d

| | |
|---|---|
| URS Corp<br>Project: Gate 1<br>Description: 14 days b/w Arrow Hds<br>Modeller: 351–349.7 354.6–354.4<br>23 Jul 03 | Visual MODFLOW v.2.8.2. (C) 1995–1999<br>Waterloo Hydrogeologic, Inc.<br>NC: 264 NR: 240 NL: 3<br>Current Layer: 2 |

Design Velocity - PRB 2
MBCo, Fulton NY

3/6

Figure 3-3




Gate 2: Shallow zone vel ≅ 0.025 ft/d

| | |
|---|---|
| URS Corp<br>Project: Gate 2<br>Description: 100 days b/w Arrow Hds<br>Modeller: 351–349.7 354.6–354.4<br>24 Jul 03 | Visual MODFLOW v.2.8.2, (C) 1995–1999<br>Waterloo Hydrogeologic, Inc.<br>NC: 264 NR: 240 NL: 3<br>Current Layer: 1 |

Design Velocity – PRB 2
MBCo, Fulton NY

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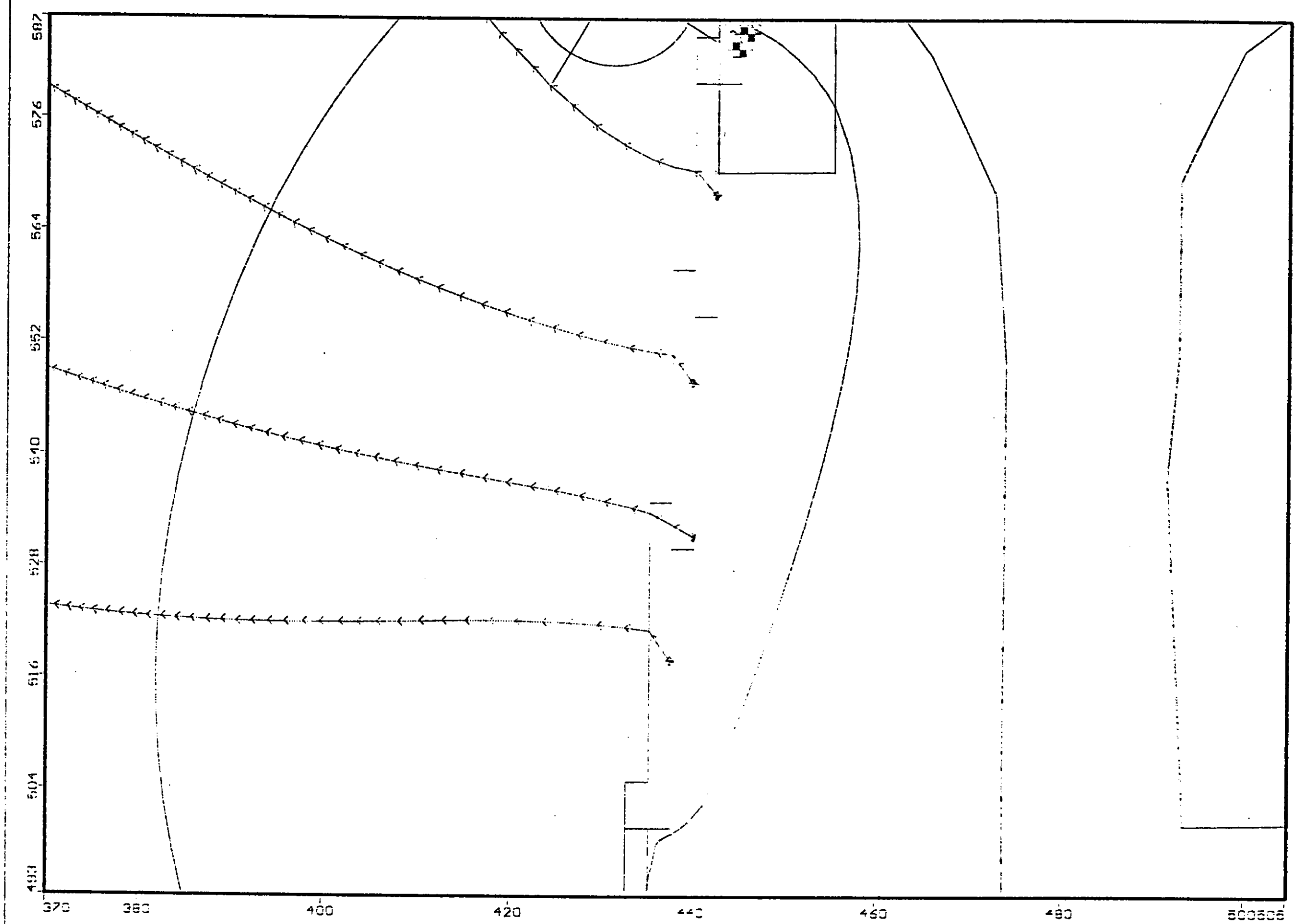
Figure 3-4




Gate 2: Design zone vel ≅ 0.36 ft/d

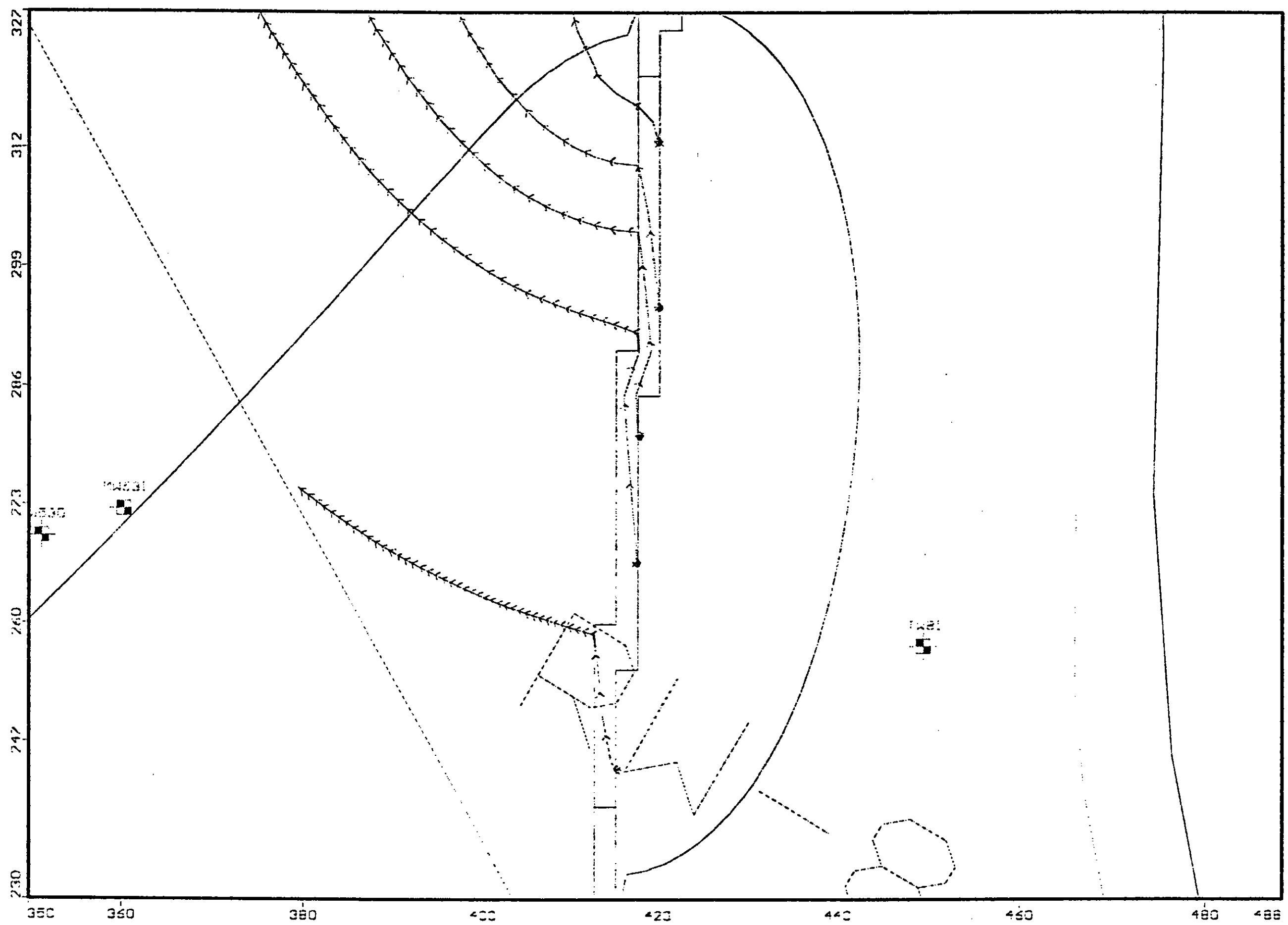
URS Corp
Project: Gate 2
Description: 7 days b/w Arrow Hds
Modeller: 351–349.7 354.6–354.4
23 Jul 03

Visual MODFLOW v.2.8.2, (C) 1995–1999
Waterloo Hydrogeologic, Inc.
NC: 264 NR: 240 NL: 3
Current Layer: 2

Design Velocity - PRB 2
MBCo, Fulton NY

5/6

Figure 3-5




Gate 3: Shallow vel ≅ 0.028 ft/d

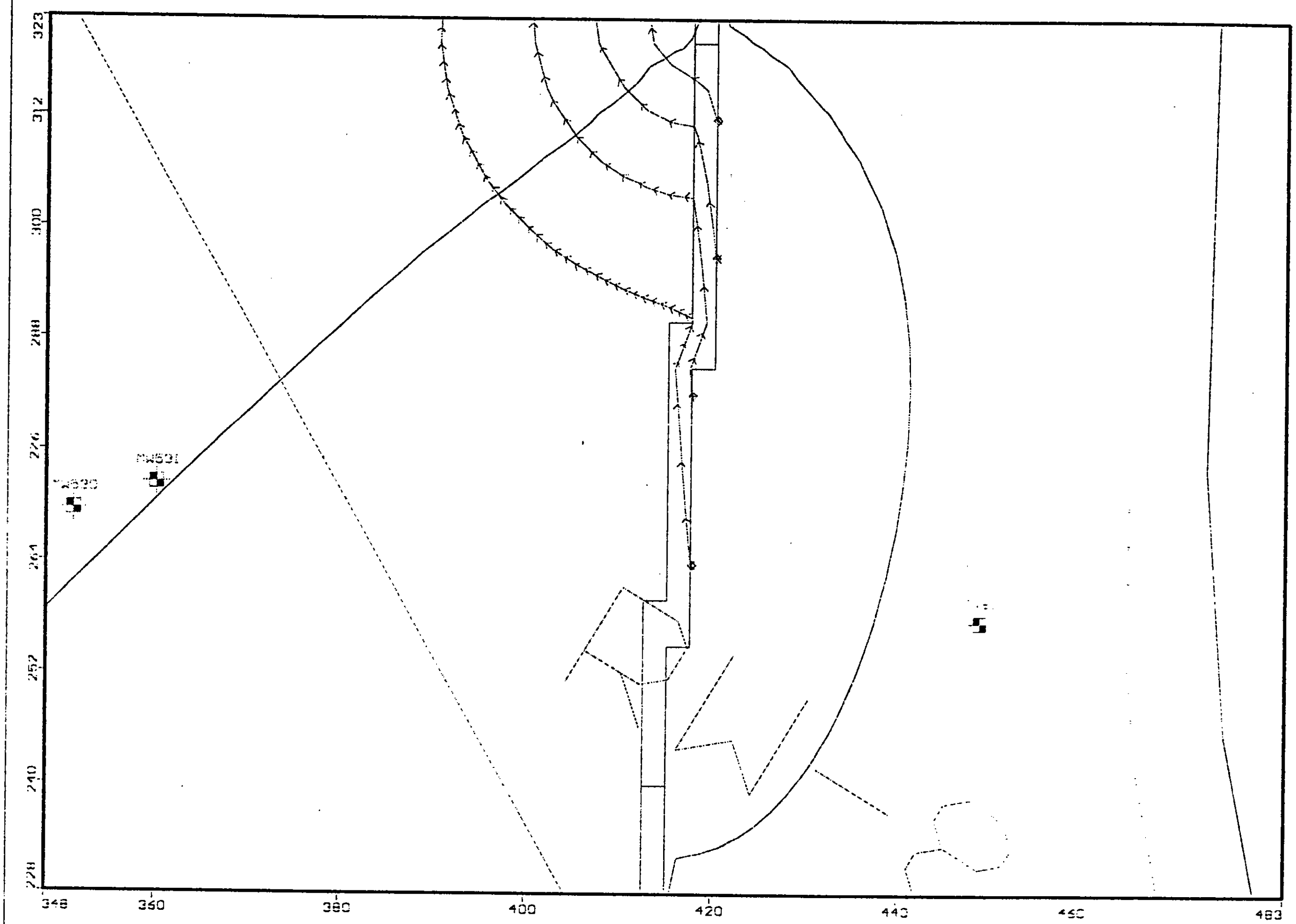
URS Corp
Project: Gate 3
Description: 90 days b/w Arrow Hds
Modeller: 351-349.7 354.6-354.4
24 Jul 03

Visual MODFLOW v.2.8.2, (C) 1995-1999
Waterloo Hydrogeologic, Inc.
NC: 264 NR: 240 NL: 3
Current Layer: 1

Design Velocity - PRB 2
MBG, Fulton NY

6/6

Figure 3-6




Gate 3: Deep vel ≅ 0.042

| | |
|---|---|
| URS Corp<br>Project: Gate 3<br>Description: 60 days b/w Arrow Hds<br>Modeller: 351-349.7 354.6-354.4<br>23 Jul 03 | Visual MODFLOW v.2.8.2 (C) 1995-1999<br>Waterloo Hydrogeologic Inc.<br>NC: 264 NR: 240 NL: 3<br>Current Layer: 2 |

Table 4-2

**Groundwater Concentrations versus NYSDEC Criteria - PRB 2 - Gate 1**
**Former Miller Container Plant, Volney, NY**

| | | | Shallow Zone Wells | | | | | Deep Zone Wells | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Constituent | NYSDEC Generic Criteria (ug/L) | EPA MCLs (ug/L) | MW-11S | TW-11I | RW-4 | RW-3 | MW-2S | MW-11D | MW-3D | MW-16D |
| 1,1 DCA | 5 | - | <1 | <1 | 3.1 | 100 | 77 | <1 | 14 | <5 |
| 1,1 DCE | 5 | 7 | <1 | 1 | 2.5 | 62 | 66 | <1 | 13 | 9.4 |
| 1,2 DCE | 5 | 70 | <1 | <1 | 1.1 | 200 | 210 | <1 | 11 | <5 |
| PCE | 5 | 5 | <1 | 14 | 65 | 650 | 200 | 8.1 | 190 | 51 |
| 1,1,1 TCA | 5 | 200 | <1 | 3.5 | 12 | 130 | 97 | 1 | 63 | 28 |
| TCE | 5 | 5 | <1 | 1.4 | 1.7 | 3 | 14 | <1 | 6 | <5 |
| VC | 5 | 5 | <2 | <2 | <0.5 | <5 | 12 | <2 | <5 | <5 |

Based on concentration detected in 2002

Table 4-3

## Groundwater Concentrations versus NYSDEC Criteria - PRB 2 - Gate 2
### Former Miller Container Plant, Volney, NY

| | | | Shallow Zone Wells | | | Deep Zone Wells | | | |
|---|---|---|---|---|---|---|---|---|---|
| Constituent | NYSDEC Generic Criteria (ug/L) | EPA MCLs (ug/L) | TW-13S | RW-9 | TW-12I | RW-5 | TW-13D | TW-7D | MW-12D |
| 1,1 DCA | 5 | - | <1 | 47 | 11 | 22 | 8.4 | 31 | 4.9 |
| 1,2 DCA | 5 | | <1 | - | <5 | - | <2 | <5 | <1 |
| 1,1 DCE | 5 | 7 | <1 | 390 | 73 | 43 | 28 | 41 | 3.3 |
| 1,2 DCE | 5 | 70 | <1 | 98 | <5 | 44 | <2 | <5 | 1.2 |
| PCE | 5 | 5 | <1 | 2200 | 435 | 660 | 21 | <5 | 4.2 |
| 1,1,1 TCA | 5 | 200 | <1 | 1300 | 106 | 210 | 27 | 85 | 13 |
| TCE | 5 | 5 | <1 | 47 | <5 | 88 | 8.8 | <5 | 4 |
| VC | 5 | 5 | <2 | <20 | <10 | <5 | <4 | <10 | <2 |

Based on concentration detected in 2002

Table 4-4

## Groundwater Concentrations versus NYSDEC Criteria - PRB 3 - Gate 3

### Former Miller Container Plant, Volney, NY

| | | | Shallow Zone Wells | | | | | |
|---|---|---|---|---|---|---|---|---|
| Constituent | NYSDEC Generic Criteria (ug/L) | EPA MCLs (ug/L) | MW-37I | TW-8I | MW-54I | TW-7S | RW-8 | RW-9 |
| 1,1 DCA | 5 | - | 530 | <1 | <0.5 | <1 | 17 | 47 |
| 1,1 DCE | 5 | 7 | 400 | <1 | <0.5 | <1 | 49 | 390 |
| 1,2 DCE | 5 | 70 | 3900 | <1 | <0.5 | <1 | 88 | 98 |
| PCE | 5 | 5 | 1300 | <1 | <0.5 | <1 | 110 | 2200 |
| 1,1,1 TCA | 5 | 200 | 1400 | <1 | <0.5 | <1 | 120 | 1500 |
| TCE | 5 | 5 | <100 | <1 | <0.5 | <1 | <5 | 47 |
| VC | 5 | 5 | 1.2 | <2 | <0.5 | <2 | <5 | <20 |

Based on concentration detected in 2002

Table 5-2

**Required Wall Thickness - PRB 2 - Gate 1- Shallow Zone**
**Former Miller Container Plant, Volney NY**

Note:
1. Groundwater velocities from groundwater model 6/03

[shaded box] Below Detection Limits

| | | | |
|---|---|---|---|
| $C_{0,PCE}$ | = | 650 | µg/L |
| $CP_{CA}$ | = | 5 | µg/L |
| $\lambda$ | = | 0.5155 | 1/hr |
| $t_{ReqdResi}$ | = | 0.393 | day |
| $v$ | = | 0.009 | ft/d |
| $SF_{ReactLossLT}$ | = | 2.00 | dimless |
| $SF_{ReactDecrease5\%}$ | = | 2.00 | dimless |

**Required Thickness**

| | | | |
|---|---|---|---|
| $T_{ReqVelPRB2}$ | = | 0.04 | in |
| $T_{ReqdSFsApplied}$ | = | 0.17 | in |

| | | | |
|---|---|---|---|
| $C_{0,TCA}$ | = | 130 | µg/L |
| $CP_{CA}$ | = | 5 | µg/L |
| $\lambda$ | = | 0.8339 | 1/hr |
| $t_{ReqdResi}$ | = | 0.163 | day |
| $v$ | = | 0.009 | ft/d |
| $SF_{ReactLossLT}$ | = | 2.00 | dimless |
| $SF_{ReactDecrease5\%}$ | = | 2.00 | dimless |

**Required Thickness**

| | | | |
|---|---|---|---|
| $T_{ReqVelPRB2}$ | = | 0.02 | in |
| $T_{ReqdSFsApplied}$ | = | 0.07 | in |

| | | | |
|---|---|---|---|
| $C_{0,1,2\ DCE}$ | = | 200 | µg/L |
| $CP_{CA}$ | = | 5 | µg/L |
| $\lambda$ | = | 0.4241 | 1/hr |
| $t_{ReqdResi}$ | = | 0.362 | day |
| $v$ | = | 0.009 | ft/d |
| $SF_{ReactLossLT}$ | = | 2.00 | dimless |
| $SF_{ReactDecrease5\%}$ | = | 2.00 | dimless |

**Required Thickness**

| | | | |
|---|---|---|---|
| $T_{ReqVelPRB2}$ | = | 0.04 | in |
| $T_{ReqdSFsApplied}$ | = | 0.16 | in |

| | | | |
|---|---|---|---|
| $C_{0,\ 1,1\ DCE}$ | = | 62 | µg/L |
| $CP_{CA}$ | = | 5 | µg/L |
| $\lambda$ | = | 0.3254 | 1/hr |
| $t_{ReqdResi}$ | = | 0.322 | day |
| $v$ | = | 0.009 | ft/d |
| $SF_{ReactLossLT}$ | = | 2.00 | dimless |
| $SF_{ReactDecrease5\%}$ | = | 2.00 | dimless |

**Required Thickness**

| | | | |
|---|---|---|---|
| $T_{ReqVelPRB2}$ | = | 0.03 | in |
| $T_{ReqdSFsApplied}$ | = | 0.14 | in |

| | | | |
|---|---|---|---|
| $C_{0,VC}$ | = | 2.5 | µg/L |
| $CP_{CA}$ | = | 5 | µg/L |
| $\lambda$ | = | 0.146 | 1/hr |
| $t_{ReqdResi}$ | = | -0.198 | day |
| $v$ | = | 0.009 | ft/d |
| $SF_{ReactLossLT}$ | = | 2.00 | dimless |
| $SF_{ReactDecrease5\%}$ | = | 2.00 | dimless |

**Required Thickness**

| | | | |
|---|---|---|---|
| $T_{ReqVelPRB2}$ | = | -0.02 | in |
| $T_{ReqdSFsApplied}$ | = | -0.09 | in |

| | | | |
|---|---|---|---|
| $C_{0,1,1\ DCA}$ | = | 100 | µg/L |
| $CP_{CA}$ | = | 5 | µg/L |
| $\lambda$ | = | 0.146 | 1/hr |
| $t_{ReqdResi}$ | = | 0.855 | day |
| $v$ | = | 0.009 | ft/d |
| $SF_{ReactLossLT}$ | = | 2.00 | dimless |
| $SF_{ReactDecrease5\%}$ | = | 2.00 | dimless |

**Required Thickness**

| | | | |
|---|---|---|---|
| $T_{ReqVelPRB2}$ | = | 0.09 | in |
| $T_{ReqdSFsApplied}$ | = | 0.37 | in |

$T_{provided}$ = 5 inches OK

Req'd Thick Gate 1 Shallow
Miller Data Decay Calculations 7.28.03

Table 5-3

**Required Wall Thickness - PRB 2 - Gate 1- Deep Zone**
**Former Miller Container Plant, Volney NY**

Note:
1. Groundwater velocities from groundwater model 6/03

[ ] Below Detection Limits

| | | | |
|---|---|---|---|
| $C_{0,PCE}$ | = | 650 | µg/L |
| $CP_{CA}$ | = | 5 | µg/L |
| $\lambda$ | = | 0.5155 | 1/hr |
| $t_{ReqdResi}$ | = | 0.393 | day |
| v | = | 0.180 | ft/d |
| $SF_{ReactLossLT}$ | = | 2.00 | dimless |
| $SF_{ReactDecrease5\%}$ | = | 2.00 | dimless |
| **Required Thickness** | | | |
| $T_{ReqVelPRB2}$ | = | 0.85 | in |
| $T_{ReqdSFsApplied}$ | = | 3.40 | in |

| | | | |
|---|---|---|---|
| $C_{0,TCA}$ | = | 130 | µg/L |
| $CP_{CA}$ | = | 5 | µg/L |
| $\lambda$ | = | 0.8339 | 1/hr |
| $t_{ReqdResi}$ | = | 0.163 | day |
| v | = | 0.180 | ft/d |
| $SF_{ReactLossLT}$ | = | 2.00 | dimless |
| $SF_{ReactDecrease5\%}$ | = | 2.00 | dimless |
| **Required Thickness** | | | |
| $T_{ReqVelPRB2}$ | = | 0.35 | in |
| $T_{ReqdSFsApplied}$ | = | 1.41 | in |

| | | | |
|---|---|---|---|
| $C_{0,1,2\ DCE}$ | = | 200 | µg/L |
| $CP_{CA}$ | = | 5 | µg/L |
| $\lambda$ | = | 0.4241 | 1/hr |
| $t_{ReqdResi}$ | = | 0.362 | day |
| v | = | 0.180 | ft/d |
| $SF_{ReactLossLT}$ | = | 2.00 | dimless |
| $SF_{ReactDecrease5\%}$ | = | 2.00 | dimless |
| **Required Thickness** | | | |
| $T_{ReqVelPRB2}$ | = | 0.78 | in |
| $T_{ReqdSFsApplied}$ | = | 3.13 | in |

| | | | |
|---|---|---|---|
| $C_{0,1,1\ DCE}$ | = | 62 | µg/L |
| $CP_{CA}$ | = | 5 | µg/L |
| $\lambda$ | = | 0.3254 | 1/hr |
| $t_{ReqdResi}$ | = | 0.322 | day |
| v | = | 0.180 | ft/d |
| $SF_{ReactLossLT}$ | = | 2.00 | dimless |
| $SF_{ReactDecrease5\%}$ | = | 2.00 | dimless |
| **Required Thickness** | | | |
| $T_{ReqVelPRB2}$ | = | 0.70 | in |
| $T_{ReqdSFsApplied}$ | = | 2.79 | in |

| | | | |
|---|---|---|---|
| $C_{0,VC}$ | = | 2.5 | µg/L |
| $CP_{CA}$ | = | 5 | µg/L |
| $\lambda$ | = | 0.146 | 1/hr |
| $t_{ReqdResi}$ | = | -0.198 | day |
| v | = | 0.180 | ft/d |
| $SF_{ReactLossLT}$ | = | 2.00 | dimless |
| $SF_{ReactDecrease5\%}$ | = | 2.00 | dimless |
| **Required Thickness** | | | |
| $T_{ReqVelPRB2}$ | = | -0.43 | in |
| $T_{ReqdSFsApplied}$ | = | -1.71 | in |

| | | | |
|---|---|---|---|
| $C_{0,1,1\ DCA}$ | = | 100 | µg/L |
| $CP_{CA}$ | = | 5 | µg/L |
| $\lambda$ | = | 0.146 | 1/hr |
| $t_{ReqdResi}$ | = | 0.855 | day |
| v | = | 0.180 | ft/d |
| $SF_{ReactLossLT}$ | = | 2.00 | dimless |
| $SF_{ReactDecrease5\%}$ | = | 2.00 | dimless |
| **Required Thickness** | | | |
| $T_{ReqVelPRB2}$ | = | 1.85 | in |
| $T_{ReqdSFsApplied}$ | = | 7.39 | in |

T provided OK

Table 5-4

# Required Wall Thickness - PRB-2 - Gate 2 - Shallow Zone
## Former Miller Container Plant, Volney NY

Note:
1. Groundwater velocities from groundwater model 6/03

[shaded box] Below Detection Limits

| | | | |
|---|---|---|---|
| $C_{0,PCE}$ | = | 2200 | µg/L |
| $CP_{CA}$ | = | 5 | µg/L |
| $\lambda$ | = | 0.5155 | 1/hr |
| $t_{ReqdResi}$ | = | 0.492 | day |
| v | = | 0.025 | ft/d |
| $SF_{ReactLossLT}$ | = | 2.00 | dimless |
| $SF_{ReactDecrease5\%}$ | = | 2.00 | dimless |
| **Required Thickness** | | | |
| $T_{ReqVelPRB2}$ | = | 0.15 | in |
| $T_{ReqdSFsApplied}$ | = | 0.59 | in |

| | | | |
|---|---|---|---|
| $C_{0,TCA}$ | = | 1300 | µg/L |
| $CP_{CA}$ | = | 5 | µg/L |
| $\lambda$ | = | 0.8339 | 1/hr |
| $t_{ReqdResi}$ | = | 0.278 | day |
| v | = | 0.025 | ft/d |
| $SF_{ReactLossLT}$ | = | 2.00 | dimless |
| $SF_{ReactDecrease5\%}$ | = | 2.00 | dimless |
| **Required Thickness** | | | |
| $T_{ReqVelPRB2}$ | = | 0.08 | in |
| $T_{ReqdSFsApplied}$ | = | 0.33 | in |

| | | | |
|---|---|---|---|
| $C_{0,1,2\ DCE}$ | = | 98 | µg/L |
| $CP_{CA}$ | = | 5 | µg/L |
| $\lambda$ | = | 0.4241 | 1/hr |
| $t_{ReqdResi}$ | = | 0.292 | day |
| v | = | 0.025 | ft/d |
| $SF_{ReactLossLT}$ | = | 2.00 | dimless |
| $SF_{ReactDecrease5\%}$ | = | 2.00 | dimless |
| **Required Thickness** | | | |
| $T_{ReqVelPRB2}$ | = | 0.09 | in |
| $T_{ReqdSFsApplied}$ | = | 0.35 | in |

| | | | |
|---|---|---|---|
| $C_{0,\ 1,1\ DCE}$ | = | 390 | µg/L |
| $CP_{CA}$ | = | 5 | µg/L |
| $\lambda$ | = | 0.3254 | 1/hr |
| $t_{ReqdResi}$ | = | 0.558 | day |
| v | = | 0.025 | ft/d |
| $SF_{ReactLossLT}$ | = | 2.00 | dimless |
| $SF_{ReactDecrease5\%}$ | = | 2.00 | dimless |
| **Required Thickness** | | | |
| $T_{ReqVelPRB2}$ | = | 0.17 | in |
| $T_{ReqdSFsApplied}$ | = | 0.67 | in |

| | | | |
|---|---|---|---|
| $C_{0,VC}$ | = | 10 | µg/L |
| $CP_{CA}$ | = | 5 | µg/L |
| $\lambda$ | = | 0.146 | 1/hr |
| $t_{ReqdResi}$ | = | 0.198 | day |
| v | = | 0.025 | ft/d |
| $SF_{ReactLossLT}$ | = | 2.00 | dimless |
| $SF_{ReactDecrease5\%}$ | = | 2.00 | dimless |
| **Required Thickness** | | | |
| $T_{ReqVelPRB2}$ | = | 0.06 | in |
| $T_{ReqdSFsApplied}$ | = | 0.24 | in |

| | | | |
|---|---|---|---|
| $C_{0,1,1\ DCA}$ | = | 47 | µg/L |
| $CP_{CA}$ | = | 5 | µg/L |
| $\lambda$ | = | 0.146 | 1/hr |
| $t_{ReqdResi}$ | = | 0.639 | day |
| v | = | 0.025 | ft/d |
| $SF_{ReactLossLT}$ | = | 2.00 | dimless |
| $SF_{ReactDecrease5\%}$ | = | 2.00 | dimless |
| **Required Thickness** | | | |
| $T_{ReqVelPRB2}$ | = | 0.19 | in |
| $T_{ReqdSFsApplied}$ | = | 0.77 | in |

$T_{provided}$ = 5 inches ok

Req'd Thick Gate 2 Shallow
Miller Data Decay Calculations 7.28.03

Table 5-5

**Required Wall Thickness - PRB-2 - Gate 2 - Deep Zone**
**Former Miller Container Plant, Volney NY**

Note:
1. Groundwater velocities from groundwater model 6/03

[shaded box] Below Detection Limits

| | | | |
|---|---|---|---|
| $C_{0,PCE}$ | = | 2200 | µg/L |
| $CP_{CA}$ | = | 5 | µg/L |
| λ | = | 0.5155 | 1/hr |
| $t_{ReqdResi}$ | = | 0.492 | day |
| v | = | 0.360 | ft/d |
| $SF_{ReactLossLT}$ | = | 2.00 | dimless |
| $SF_{ReactDecrease5\%}$ | = | 2.00 | dimless |
| **Required Thickness** | | | |
| $T_{ReqVelPRB2}$ | = | 2.13 | in |
| $T_{ReqdSFsApplied}$ | = | 8.50 | in |

| | | | |
|---|---|---|---|
| $C_{0,TCA}$ | = | 1300 | µg/L |
| $CP_{CA}$ | = | 5 | µg/L |
| λ | = | 0.8339 | 1/hr |
| $t_{ReqdResi}$ | = | 0.278 | day |
| v | = | 0.360 | ft/d |
| $SF_{ReactLossLT}$ | = | 2.00 | dimless |
| $SF_{ReactDecrease5\%}$ | = | 2.00 | dimless |
| **Required Thickness** | | | |
| $T_{ReqVelPRB2}$ | = | 1.20 | in |
| $T_{ReqdSFsApplied}$ | = | 4.80 | in |

| | | | |
|---|---|---|---|
| $C_{0,1,2\ DCE}$ | = | 98 | µg/L |
| $CP_{CA}$ | = | 5 | µg/L |
| λ | = | 0.4241 | 1/hr |
| $t_{ReqdResi}$ | = | 0.292 | day |
| v | = | 0.360 | ft/d |
| $SF_{ReactLossLT}$ | = | 2.00 | dimless |
| $SF_{ReactDecrease5\%}$ | = | 2.00 | dimless |
| **Required Thickness** | | | |
| $T_{ReqVelPRB2}$ | = | 1.26 | in |
| $T_{ReqdSFsApplied}$ | = | 5.05 | in |

| | | | |
|---|---|---|---|
| $C_{0,\ 1,1\ DCE}$ | = | 390 | µg/L |
| $CP_{CA}$ | = | 5 | µg/L |
| λ | = | 0.3254 | 1/hr |
| $t_{ReqdResi}$ | = | 0.558 | day |
| v | = | 0.360 | ft/d |
| $SF_{ReactLossLT}$ | = | 2.00 | dimless |
| $SF_{ReactDecrease5\%}$ | = | 2.00 | dimless |
| **Required Thickness** | | | |
| $T_{ReqVelPRB2}$ | = | 2.41 | in |
| $T_{ReqdSFsApplied}$ | = | 9.64 | in |

| | | | |
|---|---|---|---|
| $C_{0,VC}$ | = | 10 | µg/L |
| $CP_{CA}$ | = | 5 | µg/L |
| λ | = | 0.146 | 1/hr |
| $t_{ReqdResi}$ | = | 0.198 | day |
| v | = | 0.360 | ft/d |
| $SF_{ReactLossLT}$ | = | 2.00 | dimless |
| $SF_{ReactDecrease5\%}$ | = | 2.00 | dimless |
| **Required Thickness** | | | |
| $T_{ReqVelPRB2}$ | = | 0.85 | in |
| $T_{ReqdSFsApplied}$ | = | 3.42 | in |

| | | | |
|---|---|---|---|
| $C_{0,1,1\ DCA}$ | = | 47 | µg/L |
| $CP_{CA}$ | = | 5 | µg/L |
| λ | = | 0.146 | 1/hr |
| $t_{ReqdResi}$ | = | 0.639 | day |
| v | = | 0.360 | ft/d |
| $SF_{ReactLossLT}$ | = | 2.00 | dimless |
| $SF_{ReactDecrease5\%}$ | = | 2.00 | dimless |
| **Required Thickness** | | | |
| $T_{ReqVelPRB2}$ | = | 2.76 | in |
| $T_{ReqdSFsApplied}$ | = | 11.05 | in |

T provided ok

Table 5-6

## Required Wall Thickness - PRB-2 - Gate 3
## Former Miller Container Plant, Volney NY

Note:
1. Groundwater velocities from groundwater model 6/03

[ ] Below Detection Limits

| | | | |
|---|---|---|---|
| $C_{0,PCE}$ | = | 1300 | µg/L |
| $CP_{CA}$ | = | 5 | µg/L |
| λ | = | 0.5155 | 1/hr |
| $t_{ReqdResi}$ | = | 0.449 | day |
| v | = | 0.042 | ft/d |
| $SF_{ReactLossLT}$ | = | 2.00 | dimless |
| $SF_{ReactDecrease5\%}$ | = | 2.00 | dimless |

**Required Thickness**

| | | | |
|---|---|---|---|
| $T_{ReqVelPRB2}$ | = | 0.23 | in |
| $T_{ReqdSFsApplied}$ | = | 0.91 | in |

| | | | |
|---|---|---|---|
| $C_{0,TCA}$ | = | 1400 | µg/L |
| $CP_{CA}$ | = | 5 | µg/L |
| λ | = | 0.8339 | 1/hr |
| $t_{ReqdResi}$ | = | 0.282 | day |
| v | = | 0.042 | ft/d |
| $SF_{ReactLossLT}$ | = | 2.00 | dimless |
| $SF_{ReactDecrease5\%}$ | = | 2.00 | dimless |

**Required Thickness**

| | | | |
|---|---|---|---|
| $T_{ReqVelPRB2}$ | = | 0.14 | in |
| $T_{ReqdSFsApplied}$ | = | 0.57 | in |

| | | | |
|---|---|---|---|
| $C_{0,1,2\ DCE}$ | = | 3900 | µg/L |
| $CP_{CA}$ | = | 5 | µg/L |
| λ | = | 0.4241 | 1/hr |
| $t_{ReqdResi}$ | = | 0.654 | day |
| v | = | 0.042 | ft/d |
| $SF_{ReactLossLT}$ | = | 2.00 | dimless |
| $SF_{ReactDecrease5\%}$ | = | 2.00 | dimless |

**Required Thickness**

| | | | |
|---|---|---|---|
| $T_{ReqVelPRB2}$ | = | 0.33 | in |
| $T_{ReqdSFsApplied}$ | = | 1.32 | in |

| | | | |
|---|---|---|---|
| $C_{0,\ 1,1\ DCE}$ | = | 400 | µg/L |
| $CP_{CA}$ | = | 5 | µg/L |
| λ | = | 0.3254 | 1/hr |
| $t_{ReqdResi}$ | = | 0.561 | day |
| v | = | 0.042 | ft/d |
| $SF_{ReactLossLT}$ | = | 2.00 | dimless |
| $SF_{ReactDecrease5\%}$ | = | 2.00 | dimless |

**Required Thickness**

| | | | |
|---|---|---|---|
| $T_{ReqVelPRB2}$ | = | 0.28 | in |
| $T_{ReqdSFsApplied}$ | = | 1.13 | in |

| | | | |
|---|---|---|---|
| $C_{0,VC}$ | = | 10 | µg/L |
| $CP_{CA}$ | = | 5 | µg/L |
| λ | = | 0.146 | 1/hr |
| $t_{ReqdResi}$ | = | 0.198 | day |
| v | = | 0.042 | ft/d |
| $SF_{ReactLossLT}$ | = | 2.00 | dimless |
| $SF_{ReactDecrease5\%}$ | = | 2.00 | dimless |

**Required Thickness**

| | | | |
|---|---|---|---|
| $T_{ReqVelPRB2}$ | = | 0.10 | in |
| $T_{ReqdSFsApplied}$ | = | 0.40 | in |

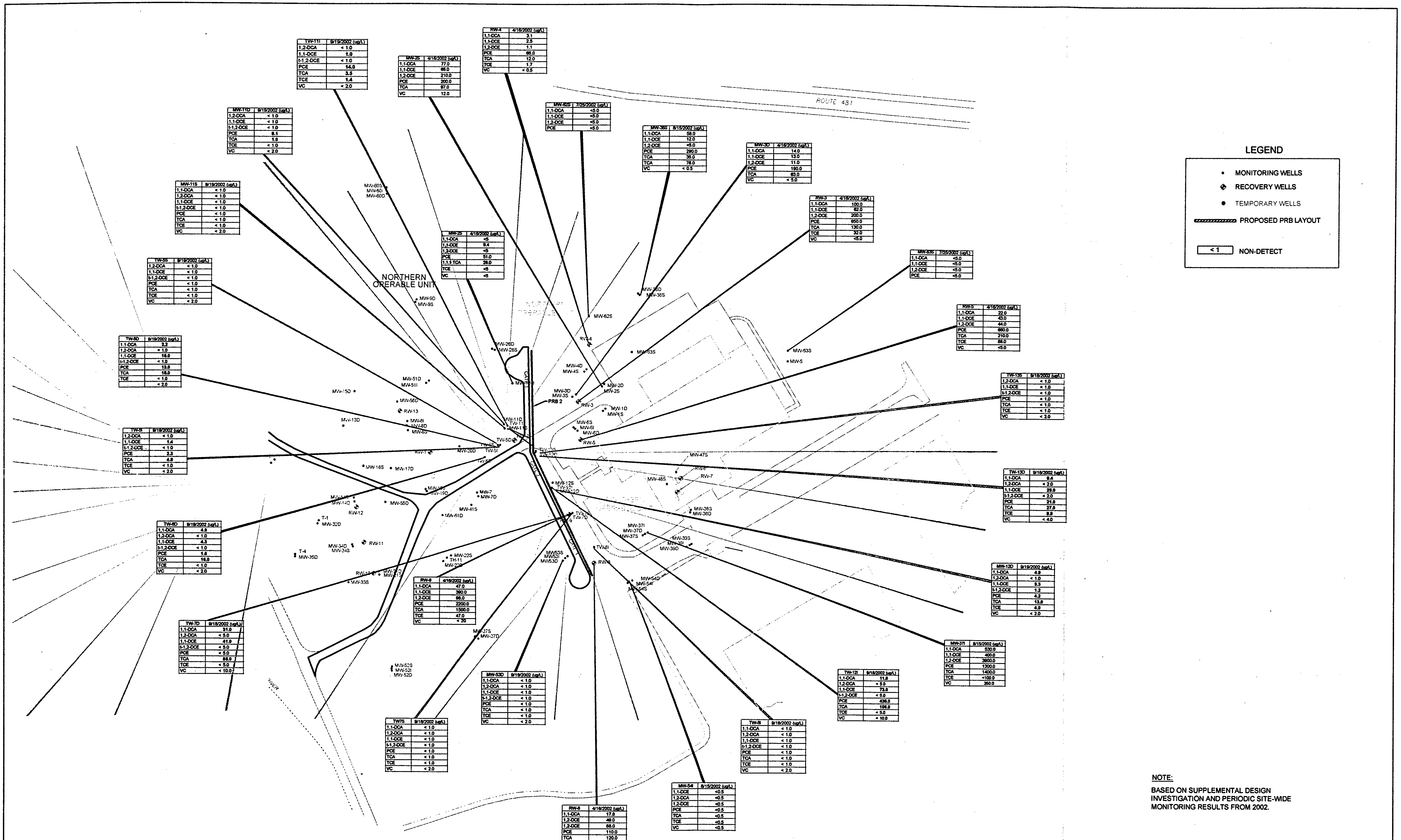
| | | | |
|---|---|---|---|
| $C_{0,1,1\ DCA}$ | = | 530 | µg/L |
| $CP_{CA}$ | = | 5 | µg/L |
| λ | = | 0.146 | 1/hr |
| $t_{ReqdResi}$ | = | 1.331 | day |
| v | = | 0.042 | ft/d |
| $SF_{ReactLossLT}$ | = | 2.00 | dimless |
| $SF_{ReactDecrease5\%}$ | = | 2.00 | dimless |

**Required Thickness**

| | | | |
|---|---|---|---|
| $T_{ReqVelPRB2}$ | = | 0.67 | in |
| $T_{ReqdSFsApplied}$ | = | 2.68 | in |

$T_{provided}$ = 5 inches OK

Req'd Thick Gate 3
Miller Data Decay Calculations 7.28.03




| TW-11I | 9/19/2002 (ug/L) |
|---|---|
| 1,2-DCA | < 1.0 |
| 1,1-DCE | 1.0 |
| t-1,2-DCE | < 1.0 |
| PCE | 14.0 |
| TCA | 3.5 |
| TCE | 1.4 |
| VC | < 2.0 |

| MW-2S | 4/16/2002 (ug/L) |
|---|---|
| 1,1-DCA | 77.0 |
| 1,1-DCE | 66.0 |
| 1,2-DCE | 210.0 |
| PCE | 200.0 |
| TCA | 97.0 |
| VC | 12.0 |

| RW-4 | 4/16/2002 (ug/L) |
|---|---|
| 1,1-DCA | 3.1 |
| 1,1-DCE | 2.5 |
| 1,2-DCE | 1.1 |
| PCE | 65.0 |
| TCA | 12.0 |
| TCE | 1.7 |
| VC | < 0.5 |

| MW-62S | 7/25/2002 (ug/L) |
|---|---|
| 1,1-DCA | <5.0 |
| 1,1-DCE | <5.0 |
| 1,2-DCE | <5.0 |
| PCE | <5.0 |

| MW-38S | 8/15/2002 (ug/L) |
|---|---|
| 1,1-DCA | 58.0 |
| 1,1-DCE | 12.0 |
| 1,2-DCE | <5.0 |
| PCE | 290.0 |
| TCA | 35.0 |
| TCA | 78.0 |
| VC | < 0.5 |

| MW-3D | 4/16/2002 (ug/L) |
|---|---|
| 1,1-DCA | 14.0 |
| 1,1-DCE | 13.0 |
| 1,2-DCE | 11.0 |
| PCE | 190.0 |
| TCA | 63.0 |
| VC | < 5.0 |

| MW-11D | 9/19/2002 (ug/L) |
|---|---|
| 1,2-DCA | < 1.0 |
| 1,1-DCE | < 1.0 |
| t-1,2-DCE | < 1.0 |
| PCE | 8.1 |
| TCA | 1.0 |
| TCE | < 1.0 |
| VC | < 2.0 |

| RW-3 | 4/16/2002 (ug/L) |
|---|---|
| 1,1-DCA | 100.0 |
| 1,1-DCE | 62.0 |
| 1,2-DCE | 200.0 |
| PCE | 650.0 |
| TCA | 130.0 |
| TCE | 32.0 |
| VC | <5.0 |

| MW-11S | 9/19/2002 (ug/L) |
|---|---|
| 1,1-DCA | < 1.0 |
| 1,2-DCA | < 1.0 |
| 1,1-DCE | < 1.0 |
| t-1,2-DCE | < 1.0 |
| PCE | < 1.0 |
| TCA | < 1.0 |
| TCE | < 1.0 |
| VC | < 2.0 |

| MW-2S | 4/16/2002 (ug/L) |
|---|---|
| 1,1-DCA | <5 |
| 1,1-DCE | 9.4 |
| 1,2-DCE | <5 |
| PCE | 51.0 |
| 1,1,1 TCA | 28.0 |
| TCE | <5 |
| VC | <5 |

| MW-63S | 7/25/2002 (ug/L) |
|---|---|
| 1,1-DCA | <5.0 |
| 1,1-DCE | <5.0 |
| 1,2-DCE | <5.0 |
| PCE | <5.0 |

| TW-5S | 9/19/2002 (ug/L) |
|---|---|
| 1,2-DCA | < 1.0 |
| 1,1-DCE | < 1.0 |
| t-1,2-DCE | < 1.0 |
| PCE | < 1.0 |
| TCA | < 1.0 |
| TCE | < 1.0 |
| VC | < 2.0 |

| RW-5 | 4/16/2002 (ug/L) |
|---|---|
| 1,1-DCA | 22.0 |
| 1,1-DCE | 43.0 |
| 1,2-DCE | 44.0 |
| PCE | 660.0 |
| TCA | 210.0 |
| TCE | 88.0 |
| VC | <5.0 |

| TW-5D | 9/19/2002 (ug/L) |
|---|---|
| 1,1-DCA | 2.2 |
| 1,2-DCA | < 1.0 |
| 1,1-DCE | 16.0 |
| t-1,2-DCE | < 1.0 |
| PCE | 13.0 |
| TCA | 18.0 |
| TCE | < 1.0 |
| | < 2.0 |

| TW-13S | 9/18/2002 (ug/L) |
|---|---|
| 1,2-DCA | < 1.0 |
| 1,1-DCE | < 1.0 |
| t-1,2-DCE | < 1.0 |
| PCE | < 1.0 |
| TCA | < 1.0 |
| TCE | < 1.0 |
| VC | < 2.0 |

| TW-5I | 9/19/2002 (ug/L) |
|---|---|
| 1,2-DCA | < 1.0 |
| 1,1-DCE | 1.4 |
| t-1,2-DCE | < 1.0 |
| PCE | 2.3 |
| TCA | 4.8 |
| TCE | < 1.0 |
| VC | < 2.0 |

| TW-13D | 9/18/2002 (ug/L) |
|---|---|
| 1,1-DCA | 8.4 |
| 1,2-DCA | < 2.0 |
| 1,1-DCE | 29.0 |
| t-1,2-DCE | < 2.0 |
| PCE | 21.0 |
| TCA | 27.0 |
| TCE | 8.8 |
| VC | < 4.0 |

| TW-6D | 9/19/2002 (ug/L) |
|---|---|
| 1,1-DCA | 4.9 |
| 1,2-DCA | < 1.0 |
| 1,1-DCE | 4.3 |
| t-1,2-DCE | < 1.0 |
| PCE | 1.8 |
| TCA | 16.0 |
| TCE | < 1.0 |
| VC | < 2.0 |

| MW-12D | 9/19/2002 (ug/L) |
|---|---|
| 1,1-DCA | 4.9 |
| 1,2-DCA | < 1.0 |
| 1,1-DCE | 3.3 |
| t-1,2-DCE | 1.2 |
| PCE | 4.2 |
| TCA | 13.0 |
| TCE | 4.0 |
| VC | < 2.0 |

| RW-9 | 4/16/2002 (ug/L) |
|---|---|
| 1,1-DCA | 47.0 |
| 1,1-DCE | 380.0 |
| 1,2-DCE | 98.0 |
| PCE | 2200.0 |
| TCA | 1500.0 |
| TCE | 47.0 |
| VC | < 20 |

| TW-7D | 9/18/2002 (ug/L) |
|---|---|
| 1,1-DCA | 31.0 |
| 1,2-DCA | < 5.0 |
| 1,1-DCE | 41.0 |
| t-1,2-DCE | < 5.0 |
| PCE | < 5.0 |
| TCA | 86.0 |
| TCE | < 5.0 |
| VC | < 10.0 |

| MW-37I | 8/15/2002 (ug/L) |
|---|---|
| 1,1-DCA | 530.0 |
| 1,1-DCE | 400.0 |
| 1,2-DCE | 3900.0 |
| PCE | 1300.0 |
| TCA | 1400.0 |
| TCE | <100.0 |
| VC | 350.0 |

| MW-53D | 9/19/2002 (ug/L) |
|---|---|
| 1,1-DCA | < 1.0 |
| 1,2-DCA | < 1.0 |
| 1,1-DCE | < 1.0 |
| t-1,2-DCE | < 1.0 |
| PCE | < 1.0 |
| TCA | < 1.0 |
| TCE | < 1.0 |
| VC | < 2.0 |

| TW-12I | 9/18/2002 (ug/L) |
|---|---|
| 1,1-DCA | 11.0 |
| 1,2-DCA | < 5.0 |
| 1,1-DCE | 73.0 |
| t-1,2-DCE | < 5.0 |
| PCE | 436.0 |
| TCA | 106.0 |
| TCE | < 5.0 |
| VC | < 10.0 |

| TW7S | 9/18/2002 (ug/L) |
|---|---|
| 1,1-DCA | < 1.0 |
| 1,2-DCA | < 1.0 |
| 1,1-DCE | < 1.0 |
| t-1,2-DCE | < 1.0 |
| PCE | < 1.0 |
| TCA | < 1.0 |
| TCE | < 1.0 |
| VC | < 2.0 |

| TW-8I | 9/18/2002 (ug/L) |
|---|---|
| 1,1-DCA | < 1.0 |
| 1,2-DCA | < 1.0 |
| 1,1-DCE | < 1.0 |
| t-1,2-DCE | < 1.0 |
| PCE | < 1.0 |
| TCA | < 1.0 |
| TCE | < 1.0 |
| VC | < 2.0 |

| MW-54I | 8/15/2002 (ug/L) |
|---|---|
| 1,1-DCE | <0.5 |
| 1,2-DCA | <0.5 |
| 1,2-DCE | <0.5 |
| PCE | <0.5 |
| TCA | <0.5 |
| TCE | <0.5 |
| VC | <0.5 |

| RW-8 | 4/16/2002 (ug/L) |
|---|---|
| 1,1-DCA | 17.0 |
| 1,2-DCE | 49.0 |
| 1,2-DCE | 88.0 |
| PCE | 110.0 |
| TCA | 120.0 |
| TCE | < 5.0 |
| VC | < 5.0 |

NOTE:

BASED ON SUPPLEMENTAL DESIGN INVESTIGATION AND PERIODIC SITE-WIDE MONITORING RESULTS FROM 2002.

MILLER BREWING COMPANY
FORMER CONTAINER PLANT
VOLNEY, NEW YORK

| | | | |
|---|---|---|---|
| SCALE | AS SHOWN | | |
| DESIGNED BY | JI | DATE | 10/28/02 |
| DRAWN BY | RF | DATE | 07/25/03 |
| CHECKED BY | JI | DATE | 07/25/03 |
| APPROVED BY | JI | DATE | 07/25/03 |

URS

GROUNDWATER ANALYTICAL RESULTS
PRB-2 2002

CONTRACT NO. 81002401 | DRAWING NO. PRB2 2003

# PRB 2 Soil Cement Bentonite Backfill Permeability and Strength Testing

Former Miller Container Plant

Fulton, NY

# SOIL CEMENT BENTONITE BACKFILL PERMEABILITY AND STRENGTH TESTING

## Permeable Reactive Barrier Construction
## Fulton, NY

## 1.0 INTRODUCTION

This report presents the results of laboratory tests performed on potential soil-cement-bentonite slurry wall materials for the funnels of the PRB funnel and gate installation at the Former Container Plant site located in Fulton, New York.

The objective of this design mix study was to develop a site-specific soil-cement-bentonite slurry wall mixture for use as a funnel for directing groundwater flow at the subject site. An ideal slurry wall backfill mixture should demonstrate the following properties:

- Acceptability of the available on-site materials for use in the construction of a soil-cement-bentonite slurry wall.
- Minimum use of off-site borrows.
- Adequate workability of the bentonite-water slurry and the soil-cement-bentonite to permit efficient mixing and placement for a slurry wall.
- Minimum generation of excess materials and wastes from the materials used in the construction.
- A low permeability (or hydraulic conductivity) of $1 \times 10^{-6}$ cm/sec or less for the soil-cement-bentonite mixture.
- An acceptable strength to allow installation of gate sections.
- Minimum cost.

The following activities were all carried out in the laboratories of GAI Inc. of Pittsburgh, PA:

- Soil sample characterization. Soil samples from the auger borings were visually classified and tested in the laboratory.
- Soil-bentonite mix testing. Trial soil-cement-bentonite (SCB) mixtures were formulated and tested for permeability and unconfined compressive strength (UCS).

The source of materials used in the laboratory testing program were as follows:

| Material | Source |
|---|---|
| Mix Water | Tap Water |
| On-site soil | Auger boring 0'to76'(Combined split spoon samples) |
| Bentonite Clay | 90 bbl yield Hydrogel, manufactured by WyoBen |
| Cement | Portland Type I |
| Clay Pond Material | Borrow Operator |
| Red Clay Material | Borrow Operator |

All of the site soil samples were collected by URS personnel and delivered to the testing lab

## 2.0 LABORATORY TESTING

All tests were performed in accordance with current ASTM and API standards.

The soils obtained from the auger borings were delivered to the laboratory, tested, and classified. Results are attached.

Soils from the site can be classified as ML. Although the percentage of fines was found to be high, in the range of 69%, the low of plasticity of these fines will not be very helpful in further reducing the permeability.

A standard bentonite slurry (about 5% bentonite) was made from the bentonite and the tap water. The resultant slurry had a viscosity of approximately 40 Seconds-marsh and was used for mixing with the site soils and cement grout to make the soil-cement-bentonite backfill mix samples. A standard 90 bbl yield bentonite was used.

The cement grout consisted of a mixture of Portland Type I cement and tap water. A water to cement ratio of 1.2/1 was used. The grout had a density of approximately 90 pcf.

Soil-cement-bentonite mixtures were made in the laboratory to simulate field-mixing methods. The soil-cement-bentonite backfill was composed of bentonite slurry; local soil and cement grout, as required. The ingredients were mixed together with a spatula until visually homogeneous. The slump of the mixtures (about 4 to 6 inches) was estimated based on our experience.

Proportions of bentonite and cement added are expressed as the dry weight of material divided by the dry weight of the soil blend. We tested cement addition rates of 5,6,7,8, and 9 percent. Slurry was added as necessary to bring the mixture to the correct consistency.

Unconfined compression strength and flexible wall permeability tests were performed on all of the mixtures. Flexible wall permeability tests were performed in accordance with ASTM D-5084 at an effective confining stress of 6.25 psi.

## 3.0 PERMEABILITY RESULTS

The results of the permeability tests for each of the backfill blends are presented in the graphs attached along with detailed lab sheets.

All of the mixes tested met the project permeability requirements (1 x 10-6 cm/sec) as well as other likely specification requirements.

## 4.0 UNCONFINED COMPRESIVE STRENGTH RESULTS

The results of the UCS testing for each of the backfill blends are attached. All of the mixes except for mix 1 attained acceptable strength values.

## 5.0 ADDITIONAL MIXES WITH BORROW MATERIAL

Based on the testing data of the original 5 mixes, specifically permeability results, it was decided to run additional mixes using an imported borrow material to supplement site soils and add additional plastic fines. URS provided 4 differing borrow samples. Based on a geotechnical analysis, the samples designated as clay pond and red clay materials were used for trial mixes 6,7,8, and 9. These mixes contained 15% and 30% addition rates of the borrow. The same test program was run on the additional mixes as was performed on the original 5 mixes.

## 6.0 DISCUSSION OF RESULTS AND RECOMMENDATIONS

Impermeability and strength are generally recognized as the most critical parameters for soil-cement-bentonite slurry walls.

For this project, a maximum permeability of 1X10-6 cm/sec was the target. All of the mixes achieved this value. After review of the initial 5 mixes, it was decided to attempt to improve the permeability even more with the addition of borrow material containing a reasonable amount of plastic fines. Four samples were sent to the lab and analyzed. Two of the samples contained sufficient plastic fines. These borrow samples were included in mixes 6 through 9 at varying addition rates and tested. The borrow addition, however, did not significantly improve the permeability.

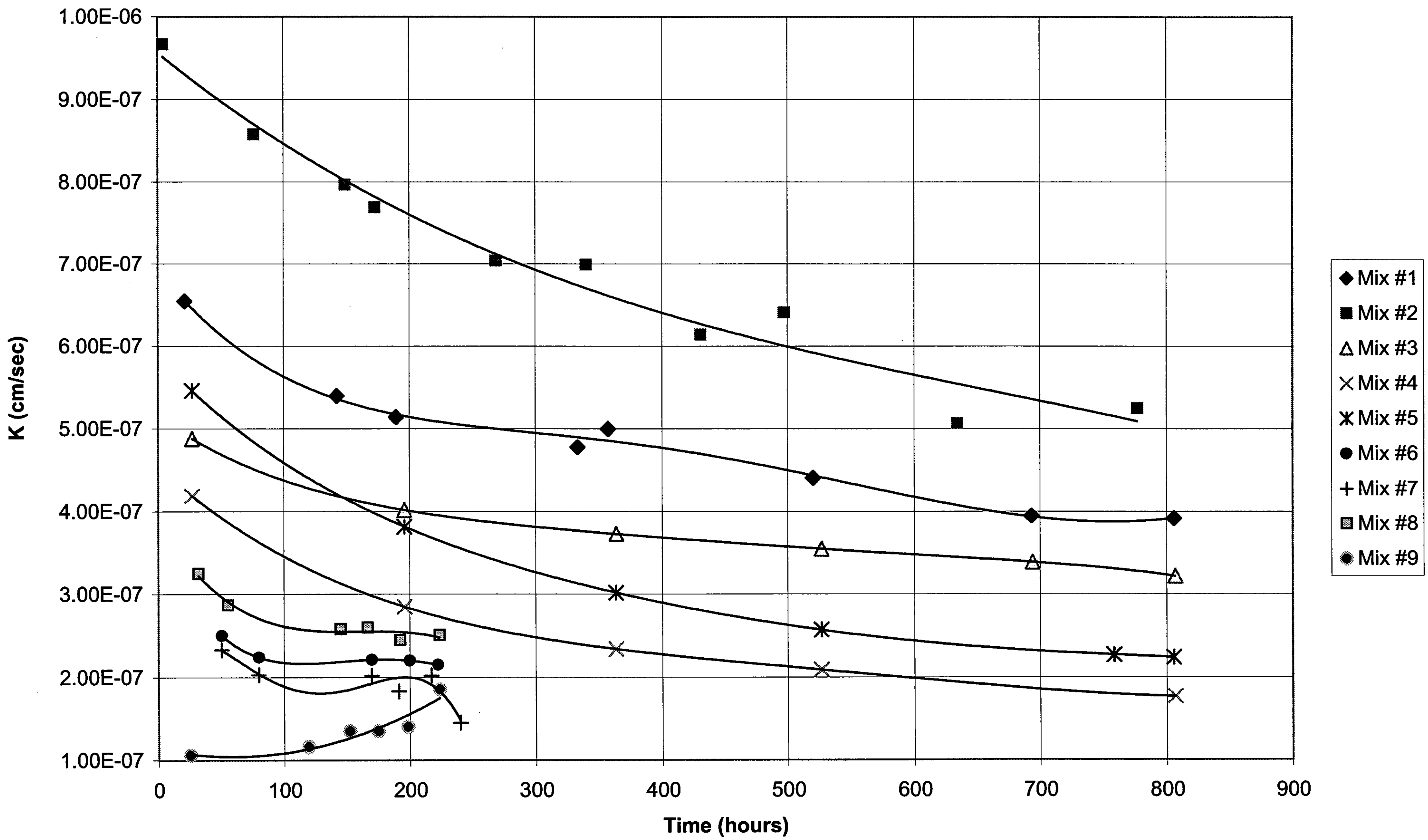
All of the mixes except for Mix 1 achieved sufficient UCS values. The strength is important during construction of the gates only and is unrelated to the performance of the

SCB walls as funnels. During excavation of the gates using the biopolymer slurry trenching technique adjacent to the SCB walls, the SCB walls must have sufficient strength to stand supported by the slurry. A target of 20 psi would be acceptable.

It is recommended Mix 4 be used. This mix consists of 0.50% bentonite via slurry, 8% cement, and the composite site soils. All addition rates are based on dry weights. This mix achieved a permeability of 1.8X10-7 cm/sec and a 28 day UCS value of 59.3 psi. These properties exceed the target values for this project.

**Geo-Solutions, Inc.**
**Miller Brewing Company**
**Fulton, New York**

## SCB Hydraulic Conductivity




Note : Test specimens were moist cured for 7 days prior to hydraulic conductivity testing.

**Mix 1**

| K (cm/sec) | t min | t hours | t days |
|---|---|---|---|
| 6.55E-07 | 1286 | 21.43 | 0.9 |
| 5.40E-07 | 7233 | 141.98 | 5.9 |
| 5.14E-07 | 2832 | 189.18 | 7.9 |
| 4.78E-07 | 8632 | 333.05 | 13.9 |
| 5.00E-07 | 1438 | 357.02 | 14.9 |
| 4.41E-07 | 9781 | 520.03 | 21.7 |
| 3.95E-07 | 10389 | 693.18 | 28.9 |
| 3.92E-07 | 6746 | 805.62 | 33.6 |
| **Total Mean** | **.25Mean** | **Steady State Range** | |
| 4.89E-07 | 1.22E-07 | 6.12E-07 | 3.67E-07 |
| **First 4 - Mean** | | | |
| 5.47E-07 | 1.37E-07 | 6.83E-07 | 4.10E-07 |
| **Last 4 - Mean** | | | |
| 4.32E-07 | 1.08E-07 | 5.40E-07 | 3.24E-07 |

**Mix 2**

| K (cm/sec) | t min | t hours | t days |
|---|---|---|---|
| 9.67E-07 | 243 | 4.05 | 0.2 |
| 8.58E-07 | 4352 | 76.58 | 3.2 |
| 7.97E-07 | 4316 | 148.52 | 6.2 |
| 7.69E-07 | 1423 | 172.23 | 7.2 |
| 7.04E-07 | 5789 | 268.72 | 11.2 |
| 6.99E-07 | 4277 | 340.00 | 14.2 |
| 6.14E-07 | 5433 | 430.55 | 17.9 |
| 6.41E-07 | 4002 | 497.25 | 20.7 |
| 5.07E-07 | 8223 | 634.30 | 26.4 |
| 5.25E-07 | 8564 | 777.03 | 32.4 |
| **Total Mean** | **.25Mean** | **Steady State Range** | |
| 7.08E-07 | 1.77E-07 | 8.85E-07 | 5.31E-07 |
| **First 5 - Mean** | | | |
| 8.19E-07 | 2.05E-07 | 1.02E-06 | 6.14E-07 |
| **Last 5 - Mean** | | | |
| 5.97E-07 | 1.49E-07 | 7.47E-07 | 4.48E-07 |

**Mix 3**

| K (cm/sec) | t min | t hours | t days |
|---|---|---|---|
| 4.88E-07 | 1639 | 27.32 | 1.1 |
| 4.02E-07 | 10100 | 195.65 | 8.2 |
| 3.73E-07 | 10064 | 363.38 | 15.1 |
| 3.55E-07 | 9791 | 526.57 | 21.9 |
| 3.39E-07 | 10053 | 694.12 | 28.9 |
| 3.22E-07 | 6742 | 806.48 | 33.6 |
| **Total Mean** | **.25Mean** | **Steady State Range** | |
| 3.80E-07 | 9.50E-08 | 4.75E-07 | 2.85E-07 |
| **First 4 - Mean** | | | |
| 4.05E-07 | 1.01E-07 | 5.06E-07 | 3.03E-07 |
| **Last 4 - Mean** | | | |
| 3.47E-07 | 8.68E-08 | 4.34E-07 | 2.60E-07 |

**Mix 5**

| K (cm/sec) | t min | t hours | t days |
|---|---|---|---|
| 5.46E-07 | 1633 | 27.22 | 1.1 |
| 3.82E-07 | 10103 | 195.60 | 8.2 |
| 3.02E-07 | 10061 | 363.28 | 15.1 |
| 2.57E-07 | 9789 | 526.43 | 21.9 |
| 2.27E-07 | 13907 | 758.22 | 31.6 |
| 2.24E-07 | 2827 | 805.33 | 33.6 |
| **Total Mean** | **.25Mean** | **Steady State Range** | |
| 3.23E-07 | 8.08E-08 | 4.04E-07 | 2.42E-07 |
| **First 4 - Mean** | | | |
| 3.72E-07 | 9.29E-08 | 4.65E-07 | 2.79E-07 |
| **Last 4 - Mean** | | | |
| 2.53E-07 | 6.31E-08 | 3.16E-07 | 1.89E-07 |

**Mix 6**

| K (cm/sec) | t min | t hours | t days |
|---|---|---|---|
| 2.50E-07 | 3034 | 50.57 | 2.1 |
| 2.24E-07 | 1763 | 79.95 | 3.3 |
| 2.21E-07 | 5374 | 169.52 | 7.1 |
| 2.20E-07 | 1817 | 199.80 | 8.3 |
| 2.15E-07 | 1349 | 222.28 | 9.3 |
| **Total Mean** | **.25Mean** | **Steady State Range** | |
| 2.26E-07 | 5.65E-08 | 2.83E-07 | 1.70E-07 |
| **First 4 - Mean** | | | |
| 2.29E-07 | 5.72E-08 | 2.86E-07 | 1.72E-07 |
| **Last 4 - Mean** | | | |
| 2.20E-07 | 5.50E-08 | 2.75E-07 | 1.65E-07 |

**Mix 7**

| K (cm/sec) | t min | t hours | t days |
|---|---|---|---|
| 2.33E-07 | 3026 | 50.43 | 2.1 |
| 2.03E-07 | 1765 | 79.85 | 3.3 |
| 2.02E-07 | 5376 | 169.45 | 7.1 |
| 1.83E-07 | 1297 | 191.07 | 8.0 |
| 2.02E-07 | 1553 | 216.95 | 9.0 |
| 1.45E-07 | 1382 | 239.98 | 10.0 |
| **Total Mean** | **.25Mean** | **Steady State Range** | |
| 1.95E-07 | 4.87E-08 | 2.43E-07 | 1.46E-07 |
| **First 4 - Mean** | | | |
| 2.05E-07 | 5.13E-08 | 2.57E-07 | 1.54E-07 |
| **Last 4 - Mean** | | | |
| 1.83E-07 | 4.58E-08 | 2.29E-07 | 1.37E-07 |

| Mix 4 | | | | Mix 8 | | | |
|---|---|---|---|---|---|---|---|
| K (cm/sec) | t min | t hours | t days | K (cm/sec) | t min | t hours | t days |
| 4.19E-07 | 1634 | 27.23 | 1.1 | 3.25E-07 | 1923 | 32.05 | 1.3 |
| 2.85E-07 | 10101 | 195.58 | 8.1 | 2.87E-07 | 1401 | 55.40 | 2.3 |
| 2.34E-07 | 10062 | 363.28 | 15.1 | 2.58E-07 | 5351 | 144.58 | 6.0 |
| 2.09E-07 | 9791 | 526.47 | 21.9 | 2.60E-07 | 1298 | 166.22 | 6.9 |
| 1.77E-07 | 16803 | 806.52 | 33.6 | 2.45E-07 | 1554 | 192.12 | 8.0 |
| | | | | 2.51E-07 | 1887 | 223.57 | 9.3 |
| **Total Mean** | **.25Mean** | **Steady State Range** | | **Total Mean** | **.25Mean** | **Steady State Range** | |
| 2.65E-07 | 6.62E-08 | 3.31E-07 | 1.99E-07 | 2.71E-07 | 6.775E-08 | 3.3875E-07 | 2.0325E-07 |
| **First 4 - Mean** | | | | **First 4 - Mean** | | | |
| 2.87E-07 | 7.17E-08 | 3.58E-07 | 2.15E-07 | 2.825E-07 | 7.0625E-08 | 3.53125E-07 | 2.11875E-07 |
| **Last 4 - Mean** | | | | **Last 4 - Mean** | | | |
| 2.26E-07 | 5.66E-08 | 2.83E-07 | 1.70E-07 | 2.54E-07 | 6.34E-08 | 3.17E-07 | 1.90E-07 |

| [illegible] | | | |
|---|---|---|---|
| K (cm/sec) | t min | t hours | t days |
| 1.06E-07 | 1543 | 25.72 | 1.1 |
| 1.16E-07 | 5616 | 119.32 | 5.0 |
| 1.35E-07 | 1959 | 151.97 | 6.3 |
| 1.35E-07 | 1377 | 174.92 | 7.3 |
| 1.40E-07 | 1408 | 198.38 | 8.3 |
| 1.85E-07 | 1516 | 223.65 | 9.3 |
| | | | |
| **Total Mean** | **.25Mean** | **Steady State Range** | |
| 1.36E-07 | 3.40E-08 | 1.70E-07 | 1.02E-07 |
| **First 4 - Mean** | | | |
| 1.23E-07 | 3.08E-08 | 1.54E-07 | 9.23E-08 |
| **Last 4 - Mean** | | | |
| 1.49E-07 | 3.72E-08 | 1.86E-07 | 1.12E-07 |

# LABORATORY TESTING SUMMARY
# GEO - SOLUTIONS, INC.
# MILLER BREWING COMPANY – FULTON NEW YORK

## BENTONITE
## SUSPENSION PROPERTIES

| IDENTIFICATION | API SPECIFICATIONS FOR DRILLING FLUIDS 13A | TEST VALUES | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **Date Tested** | | 4/24/03 | 4/25/03 | 4/25/03 | 4/28/03 | 4/28/03 | 6/6/03 | 6/9/03 |
| WYO-BEN, HYDROGEL | Slurry Identification | Immediate | 20 hr. hydration | Bentonite adjust Immediate | 72 hr. hydration | Dilution Immediate | Immediate | 72 hr. hydration |
| | Concentration (as received / oven dry) | 6.04% / 5.75% | | 6.51% / 5.98% | | ---% / 5.69% | 6.04% / 5.66% | ---% / 5.68% |
| | Marsh Funnel (sec) | 33.9 | 38 | 42 | 46.8 | 42.2 | 38.8 | 43.2 |
| | Viscometer 600rpm, (30 Minimum) | 17 cps | | 40 cps | | 39 cps | 29.5 cps | 38.0 cps |
| | Yield Point/Plastic Viscosity Ratio, (3 Maximum) | .43 | | 1.08 | | 1.25 | 1.1 | 1.04 |
| | Filtrate Volume ($15.0 cm^3$, Maximum) | $19.0 cm^3$ | | $15.2 cm^3$ | | $14.0 cm^3$ | $16.0 cm^3$ | $14.0 cm^3$ |
| | Residue > 75 Micrometer (4.0 wt.% Maximum) | -- | -- | -- | -- | -- | -- | -- |
| | Moisture, (10.0 wt. % Maximum) | 6.53 % | | | | | 7.15 % | |
| | Mud Balance, (density / density ratio) | 64pcf / 1.025 | | 64.3pcf / 1.03 | | 64.2pcf / 1.028 | 64.2pcf / 1.028 | 64.3pcf / 1.03 |
| | pH | 9.20 | | 9.11 | | 9.17 | 9.23 | 9.08 |
| | Temperature ( deg. C ) | 24.5 | | 25.2 | | 25.0 | 26 | 25.8 |

# LABORATORY TESTING SUMMARY
## GEO - SOLUTIONS, INC.
## MILLER BREWING COMPANY – FULTON NEW YORK

**SOIL**

| IDENTIFICATION | DATE RECEIVED | MOISTURE CONTENT % | GRAIN SIZE % PASSING - SIEVES #4 | #40 | #200 | LIQUID LIMIT % | PLASTIC LIMIT % | PLASTIC INDEX | USCS SYMBOL |
|---|---|---|---|---|---|---|---|---|---|
| Sample # 1 (site) Sampling Tubes 1 to 19 | 4/25/03 | 18.85 | 99.7 | 98.8 | 69.2 | NP | NP | NP | ML |
| | | | | | | | | | |
| Note : Sample #1 (site) is a composite of material that was captured and retained in 19 plastic sleeves measuring 1.625 inches in diameter and 4.0 feet in length. The description is Sandy Silt. | | | | | | | | | |
| SAMPLE #1 (Septic Sand ) | 5/30/03 | 20.51 | 99.5 | 98.5 | 65.3 | 18.5 | NP | NP | ML |
| SAMPLE #2 (Clay Pond Sand ) | 5/30/03 | 30.50 | 100.0 | 99.6 | 88.3 | 37.8 | 20.3 | 17.5 | CL |
| SAMPLE #3 (Red Clay ) | 5/30/03 | 14.40 | 90.0 | 80.8 | 38.3 | 14.8 | 12.5 | 2.3 | SM |
| SAMPLE #4 (Clay Horse Corral ) | 5/30/03 | 20.55 | 100.0 | 98.2 | 67.8 | 22.7 | 16.2 | 6.5 | CL-ML |
| | | | | | | | | | |
| | | | | | | | | | |
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# Geo-Solutions, Inc
# Miller Brewing Company
# Fulton New York

## SCB LABORATORY TESTING RESULTS

**SCB Funnel**
**Miller Brewing Co.**
**Fulton, NY**

| Mix No. | Soil Type | Total Soil (gm) | Borrow Soil (gm) | Cement in Grout (gm) | Water in Grout (gm) | Grout Added (gm) | Bentonite Slurry (gm) | Bentonite in Slurry (gm) | Water in Slurry (gm) | Mini Slump (in.) | Est Slump (in.) | Mud Bal (pcf) | pH SCB | Penetration Tests (tsf) Set-Time Day 1 | Day 2 | Day 3 | Day 4 | Day 5 | Day 6 | Day 7 | UCS (psi) 7 day | UCS (psi) 14 day | UCS (psi) 28 day | Factor | (from 7 day) (%) | (from 7 day) (pcf) | Permeability (cm/sec) 7 day*** | 14 day |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | Composite | 4000 | 0 | 168.28 | 201.94 | 370.22 | 507.74 | 28.89 | 478.85 | 1.75 | 5.4 | 116.0 | 9.7 | < 0.25 | 0.25 | 0.5 | – | 1.25 | 1.5 | 1.5 | 10.2 | 13.5 | 14.7 | 1.44 | 34.5 | 116.1 | $3.9 \times 10^{7}$ | |
| 2 | Composite | 4000 | 0 | 201.94 | 242.32 | 444.26 | 496.73 | 28.26 | 468.47 | 2 | 5.9 | 115.8 | 12.5 | 0.25 | 1.20 | 2.25 | – | 3.50 | 4.5 | – | 20.5 | 24.8 | 27.7 | 1.35 | 35.0 | 116.0 | $5.3 \times 10^{7}$ | |
| 3 | Composite | 4000 | 0 | 235.59 | 282.71 | 518.30 | 322.97 | 18.38 | 304.59 | 1.5 | 4.9 | 118.0 | 12.5 | 1.20 | 3.25 | 4.50 | – | +4.50 | +4.50 | – | 34.6 | 45.4 | 52.1 | 1.51 | 30.8 | 118.9 | $3.2 \times 10^{7}$ | |
| 4 | Composite | 4000 | 0 | 269.25 | 323.10 | 592.35 | 294.35 | 16.75 | 277.60 | 1.625 | 5.1 | 118.0 | 12.5 | 1.30 | 4.25 | +4.50 | – | +4.50 | +4.50 | – | 43.4 | 54.3 | 59.3 | 1.37 | 31.1 | 118.9 | $1.8 \times 10^{7}$ | |
| 5 | Composite | 4000 | 0 | 302.90 | 363.48 | 666.38 | 240.87 | 13.71 | 227.16 | 1.75 | 5.4 | 118.5 | 12.5 | 1.75 | 4.50 | +4.50 | – | +4.50 | +4.50 | – | 42.6 | 53.1 | 69.7 | 1.64 | 30.7 | 118.9 | $2.2 \times 10^{7}$ | |
| 6 | Comp w/B [2] | 3400 | 600 | 233 | 279.6 | 512.6 | 473.96 | 26.92 | 447.04 | 1.5 | 4.9 | 115.5 | 13.0 | 0.75 | 2.25 | 4.25 | +4.50 | – | – | – | 36.6 | 52.1 [1] | 48.7 | 1.33 | 35.5 | 116.2 | $2.2 \times 10^{7}$ | |
| 7 | Comp w/B [2] | 2800 | 1200 | 230 | 276 | 506 | 733.52 | 41.66 | 691.86 | 1.5 | 4.9 | 110.0 | 13.0 | 0.70 | 1.25 | 2.50 | 3.00 | 3.50 | – | 4.25 | 29.1 | 31.9 | 35.2 | 1.21 | 44.0 | 110.7 | $2.0 \times 10^{7}$ | |
| 8 | Comp w/B [3] | 3400 | 600 | 233 | 279.6 | 512.6 | 344.86 | 19.59 | 325.27 | 1.5 | 4.9 | 120.0 | 13.0 | 0.75 | 3.25 | 4.30 | – | +4.50 | – | – | 44.4 | 52.5 | 61.4 | 1.38 | 30.2 | 119.4 | $2.7 \times 10^{7}$ | |
| 9 | Comp w/B [3] | 2800 | 1200 | 230 | 276 | 506 | 324.02 | 18.40 | 305.62 | 1.5 | 4.9 | 121.2 | 13.0 | 1.10 | 4.25 | +4.50 | – | – | – | – | 58.1 | 66.7 | 82.8 | 1.43 | 28.4 | 121.0 | $1.3 \times 10^{7}$ | |

Soil Composite Properties

| Mix No. | 1 to 5 | 6 to 9 |
|---|---|---|
| WC = | 18.9% | / 18.6% |
| Fines = | 69.2% | |
| Density = | 101 pcf | |

Borrow Properties

| Source Location | 2 S-2 clay pond | 3 S-3 red clay |
|---|---|---|
| WC | 29.1% | 11.44% |
| Fines | 88.3% | 38.30% |
| PI | 20.3 | 2.3 |

Grout Properties

| Mix No. | (1 to 5) | (6 & 7) | (8 & 9) |
|---|---|---|---|
| W/C = | 1.2 | 1.2 | 1.2 |
| Density = | 90.5 | 87 to 89 | 90.0 |
| pH = | 12.6 | 13.0 | 13.0 |

Slurry Properties

| | 1 to 5 | 6,7,8,9 |
|---|---|---|
| B/W = | 0.0638 | 0.0648 |
| % solids | 0.0569 | 0.0568 |
| MF = | 42 | 43 |
| Dens = | 64.2 | 64.3 |

| Mix No. | Soil Type | Borrow | Cement Added (pcy) Est.** | Cement Added (pcy) Actual | Cement Added (dry wt) (%) | Bento Added (dry wt) (%) | Est / Actual WC (%) | Est / Actual Total Dens (pcf) |
|---|---|---|---|---|---|---|---|---|
| 1 | Composite | 0 | 105.8 | 108.0 | 5 | 0.85 | 44.5 / 35.6 | 110.0 / 116.0 |
| 2 | Composite | 0 | 125.0 | 127.8 | 6 | 0.84 | 45.2 / 35.5 | 109.7 / 115.8 |
| 3 | Composite | 0 | 153.0 | 155.0 | 7 | 0.55 | 45.9 / 31.8 | 109.3 / 118.0 |
| 4 | Composite | 0 | 173.0 | 175.5 | 8 | 0.50 | 46.6 / 33.0 | 109.0 / 118.0 |
| 5 | Composite | 0 | 195.5 | 197.5 | 9 | 0.41 | 47.3 / 32.4 | 108.7 / 118.5 |
| 6 | Comp w/B [2] | 15% | 148.0 | 145.7 | 7 | 0.81 | / 37.0 | / 115.5 |
| 7 | Comp w/B [2] | 30% | 140.0 | 130.4 | 7 | 1.27 | / 45.7 | / 110.0 |
| 8 | Comp w/B [3] | 15% | | 155.4 | 6.84 | 0.58 | / 31.8 | / 120.0 |
| 9 | Comp w/B [3] | 30% | | 155.8 | 6.89 | 0.54 | / 29.9 | / 121.2 |

* Adjust as required for 5 to 7" est. slump
** Calculated estimate
*** 7 day cure specimen, test duration 34 days, (final)
Note: [1] Average of two tests ( 49.5 & 54.6 psi )

GAI CONSULTANTS

**Geo-Solutions**
**Miller Brewing Co.**
**Fulton, New York**

## Pittsburgh Tap Water Analysis

| | |
|---|---|
| pH | 6.87 |
| Total Hardness | 5.3 ppm Calcium |
| Total Dissolved Solids | 162.6 ppm dissolved solids |