



AI#2

**Subsurface Evaluation Update &
Remedial Action Plan**

**Pollock Street Sewer
Philadelphia Refinery
Point Breeze Processing Area
Philadelphia, PA**

12 August 2003

**Prepared for:
SUNOCO, INC. (R&M)
Philadelphia Refinery
3144 Passyunk Avenue
Philadelphia, PA**

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Site Background

Sunoco, Inc. (R&M) is the current owner and operator of a petroleum refinery on 3144 Passyunk Avenue in Philadelphia, PA. The City of Philadelphia owns and maintains several sewers that traverse Sunoco's Philadelphia Refinery. Concerns regarding the subsurface environmental conditions proximal to the Pollock Street sewer initiated investigations.

The South Yard of the Philadelphia Refinery is situated on the east bank of the Schuylkill River, approximately 2.5 miles north of its confluence with the Delaware River. The refinery is located within the Atlantic Coastal Plain Physiographic Province. The topography along the Pollock Street sewer decreases towards the Schuylkill River. The Pollock Street sewer is a combined sanitary/storm sewer traversing the South Yard of the refinery from the east to west, entering the refinery property along 26th Street and discharging at the Schuylkill River (Figure 1).

Previous Investigations

In 1993, environmental investigative work was performed by Groundwater and Environmental Services (GES) along the Pollock Street sewer. Eight existing wells (S-46, 47, 48, 53, 62, 63, 64 and 65) were used in this study. Work performed during this investigation included the installation of 45 borings along the sewer trace and three monitoring wells (S-91, 92 and 93). In addition, bail down, slug and groundwater pumping tests were performed.

In 2002, Aquaterra performed characterization activities including historic data review, site reconnaissance, and the installation of seventeen monitoring wells (PS-1 through PS-17). PS-18 was drilled in August 2002.

Several areas of significant concern were identified in this investigation, specifically the former 14 Pump House, and the area proximal to RW 101. Additionally, it was recommended in the report that an up to date video survey be performed prior to any additional well drilling so that exact locations of LNAPL seep points could be identified from the surface. Wells could then be placed at these locations to determine whether additional LNAPL recovery methods were warranted.

Operation of a temporary recovery system at the former 14 Pump House during September and October 2002 indicated that the shallow saturated thickness of fluid producing sediments, above the clay layer, at the base of the sewer, would necessitate vertical recovery wells on a minimum of 25 foot centers to effectively prevent LNAPL entry to the sewer.

Current Hydraulic Control Measures

Discharge Control

To prevent potential discharge of LNAPL to the Schuylkill River, the outfall was modified in 1993. Tide gates were installed and a skimmer is operated within a weir at the outfall. LNAPL and mixed water on the surface is removed with the skimmer pump and piped to the Bio Plant.

Recovery Well Operation

Sunoco operates a recovery system along the trace of the westernmost section of the Pollock Street sewer. The locations of the current recovery wells, as noted RW-100 through RW-107 (100 series) are shown on Figure 1.

The 100 series recovery wells have continuously operated throughout the first and second Quarter of 2003 with the exception of RWs 101, 103, 104, and 105 during the first quarter. LNAPL recovery is difficult to quantify as many recovery wells are run as total fluid recovery wells.

The 14 Pump House recovery system was removed from service in December 2002 and replaced by periodic vac truck events throughout the first half of 2003. This area will be incorporated into a long-term, comprehensive recovery system along the entirety of the impact to the Pollock Street Sewer.

Additional Site Investigations, 2003

Video Sewer Inspection

On 3-11 February 2003, Aquaterra and Video Pipe Services performed an inspection of the interior of the sewer with a video camera to precisely locate points of hydrocarbon infiltration. The inspection proceeded from 26th street, and continued to the outfall at the River.

The locations of the seeps, with references to apparent severity and the occurrence north or south of the sewer are depicted on Figure 2A and 2B.

Additional Monitoring Well Installation

During May 2003, an additional 23 monitoring wells were installed in the locations of concern determined from the video investigation, and plotted on the ground surface with the surveyors. Locations of these wells are shown on Figure 3. Drill logs are attached as Appendix A.

Current Liquid Levels

Liquid levels were measured in the monitoring wells and recovery wells proximal to the sewer on a monthly basis. The most recent levels were measured on 8 July 2003 by Aquaterra personnel (Table 1). Figure 4 depicts LNAPL thickness on this date.

Planned Additional Remediation Measures

Horizontal Recovery Wells

Total fluid recovery from horizontal recovery wells is proposed as the remediation measure to eliminate oil infiltration to the sewer. Oil infiltration will be eliminated by controlling oil entry to the sewer at the joints and lift holes as noted during the video inspection. Investigations to date have provided definition of subsurface LNAPL plumes to determine where recovery efforts are best focused.

Other Options Considered:

- External sealing of joints
- Internal slip lining of sewer
- Vertical well recovery system at seep points

Horizontal Recovery Wells were selected based on the following:

- External and internal sealing would not eliminate source, possibility of more seeps occurring in 75+ year-old sewer.
- A vertical well recovery system would require hundreds of recovery wells and pumping systems, due to limited saturated thickness of the oil bearing zone. This vertical well network would require significant excavation for plumbing and electric utilities. This is not practical through operating process units.
- Horizontal wells will require only four pumping wells and 2 remediation trailers to address impact to approximately 2000' of sewer.
- Excavation for utilities in active process areas would be minimized.
- Horizontal wells will accomplish both sewer joint protection and source removal.

Execution Plan:

The complete project proposed herein involves the installation of 4 horizontal fluids recovery wells as shown on Figure 5. One well will be installed and tested for effectiveness prior to installation of the remaining three wells. This approach is recommended as subsurface interference of unknown structures at depth may preclude effective well installation.

The project has been broken down into discrete tasks to develop the timeline as presented. These tasks are as follows:

- Completion of System Design - September 2003
- Horizontal Well Installation and Development - October 2003
- Remediation System Installation and Testing - October- November 2003
- System Operation and Maintenance - December 2003-February 2004
- Reporting - March 2004

Completion of System Design

This task includes final design of the horizontal wells including screen pattern, well lengths, pumping point configuration and entry and exit point locations.

The conceptual design of the proposed test well is shown on Figure 6. This design utilizes a dual well technology which will allow consolidation of treatment trailers to one trailer for both sumps, and limit the piping runs at the ground surface.

Preliminary recovery system design is currently being finalized, and the pumping and water treatment trailer specifications will be submitted to the equipment manufacturer.

Horizontal Well Installation

This phase includes final contracting, coordination with Refinery Operations, and horizontal drilling operations along the Pollock Street sewer immediately east and west of RW101, (shown as Phase 1 on Figure 5). Once completed, the well will be developed by flushing and pumping to ensure optimum pumping characteristics.

Remediation System Installation and Testing

Installation of the remediation trailer pumping and treatment system, including setup of the trailer, installation of electrical power drop, and water discharge plumbing to a Benzene NESHAP compliant process sewer will be completed subsequent to horizontal well installation. The remediation trailer will include an air compressor, an oil/water separator and a transfer pump. System startup and shakedown will be performed as part of this task. This test will continue for five weeks. LNAPL recovery rates, volume of water discharged, and effective radius of influence will be monitored.

System Operation and Maintenance

The system will be operated and maintained for ten weeks to determine the effectiveness of the well in protecting the sewer. Operational system data, maintenance of system components, liquid levels in surrounding monitoring wells, and adjustments to pumping rates to optimize recovery well operations will be performed on a daily basis for one week, and weekly thereafter for the duration of the test.

Remediation Update Report

At the completion of the testing phase, a second videotape run of the sewer between manholes nine and eleven will be performed to determine if the observed points of oil entry have been eliminated by operation of the horizontal well. A system operation report will be generated based on the 5 week test, the 10 weeks of O&M and the follow up video tape. Based on the results of the above, the next steps in the remediation will be detailed.

Outfall Control System Modifications

The current system consists of a series of oil control booms deployed inside two tide gates. A continuously operating skimmer pump is deployed within this containment apparatus to intercept LNAPL as it enters the outfall at low tides.

Two operational difficulties exist with the current arrangement. Primarily, floating solids (trash and debris) from the City storm sewers will not allow the tide gate's gaskets to seal properly. Secondly, siltation behind the tide gates interferes with the operation of the floating skimmer pump. This problem requires frequent dredging of the control area to allow the skimmer to float.

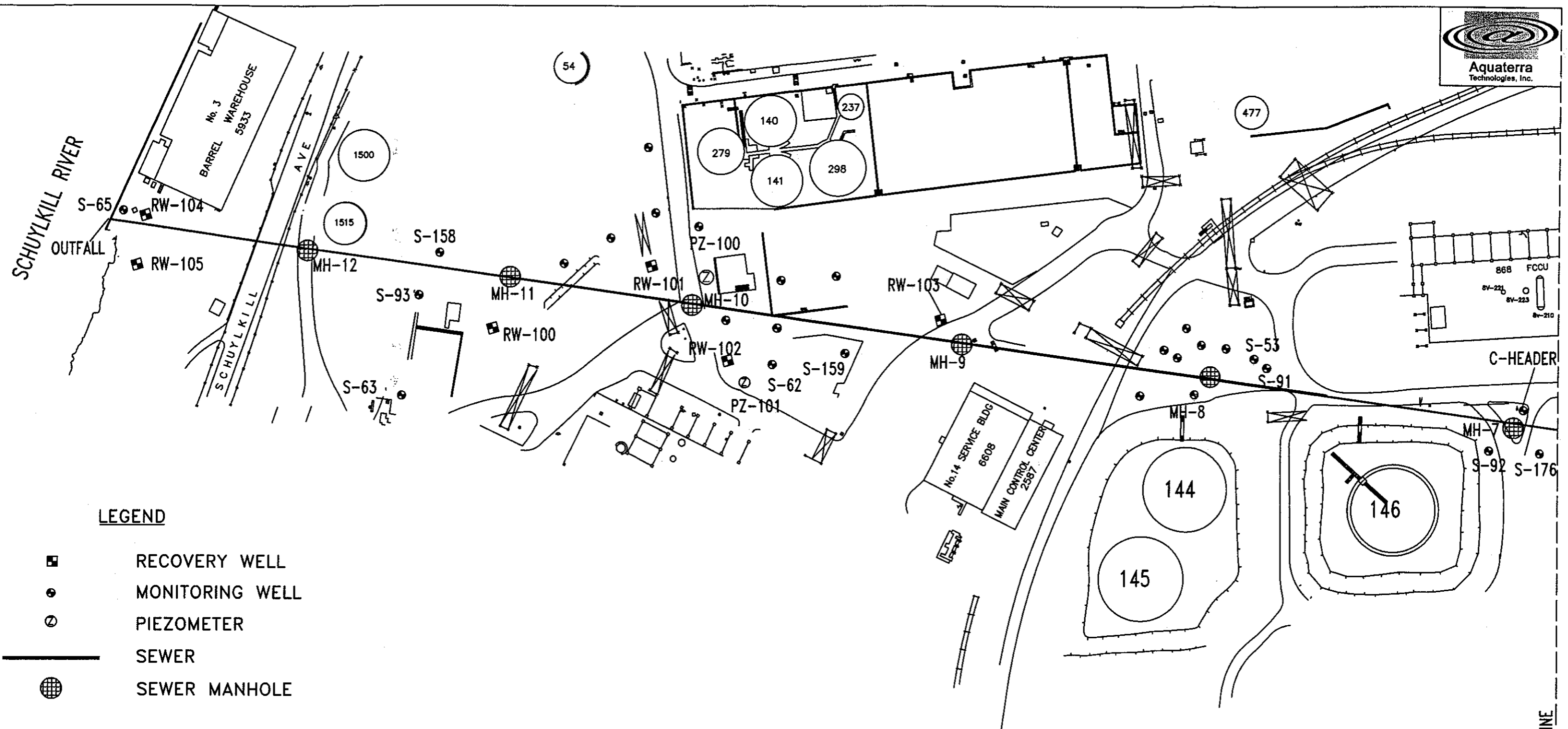
Investigations into methods to upgrade the Pollock Street CSO outfall control systems are ongoing. The options currently under consideration include:

- Floating product only skimmer installed in protective well screen
- Belt type skimmer
- Modification to tide gates
- Installation of an underflow weir

Current plans for this investigation include a pilot study of the belt type skimmer for a one month period to determine its effectiveness and/or potential maintenance drawbacks. Any modification to the tide gate or plans for an underflow weir would need to be discussed with the PWD.

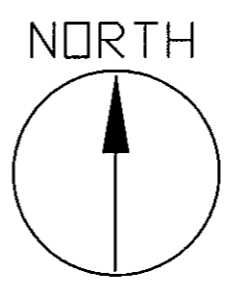
An update of CSO outfall control modification plans will be included in the above referenced Remediation Update Report.

FIGURES



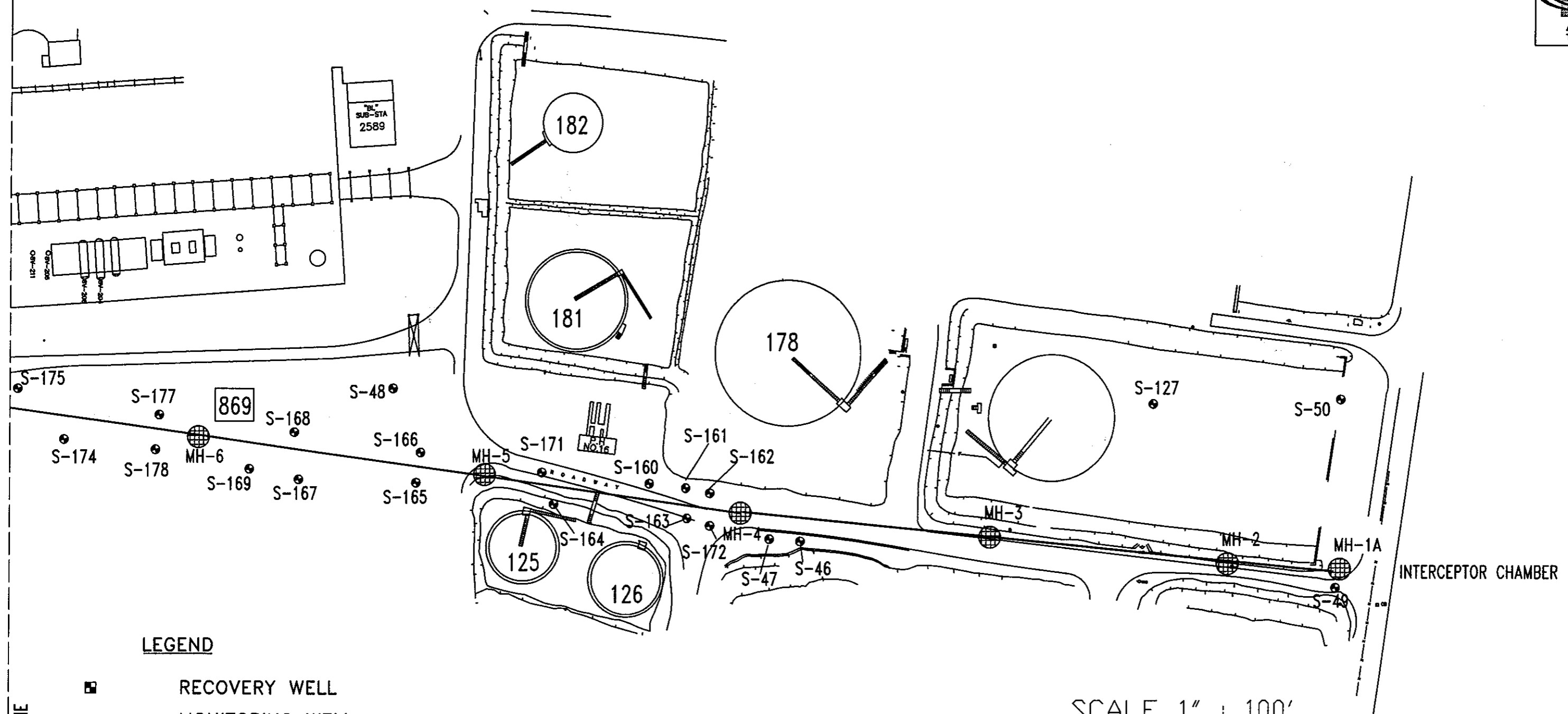
LEGEND

- RECOVERY WELL
- MONITORING WELL
- PIEZOMETER
- SEWER
- SEWER MANHOLE








SCALE 1" : 100'

FIGURE 1A
GENERALIZED SITE PLAN
POLLACK STREET SEWER
SUNOCO POINT BREEZE REFINERY
PHILADELPHIA, PENNSYLVANIA



LEGEND

-  RECOVERY WELL
-  MONITORING WELL
-  PIEZOMETER
-  SEWER
-  SEWER MANHOLE

SCALE 1" : 100'



NORTH

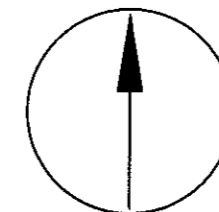


FIGURE 1B
GENERALIZED SITE PLAN
POLLACK STREET SEWER
SUNOCO POINT BREEZE REFINERY
PHILADELPHIA, PENNSYLVANIA

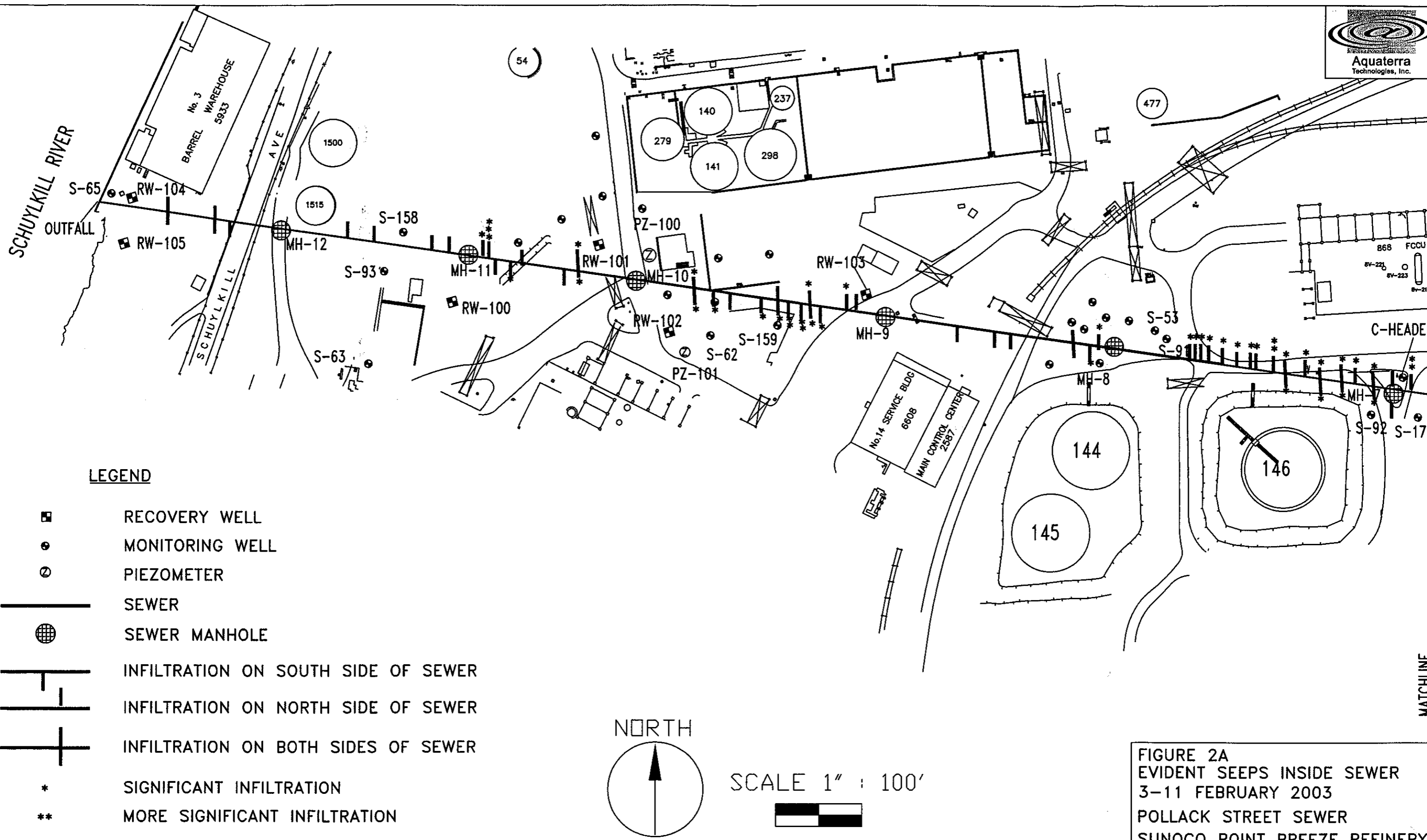
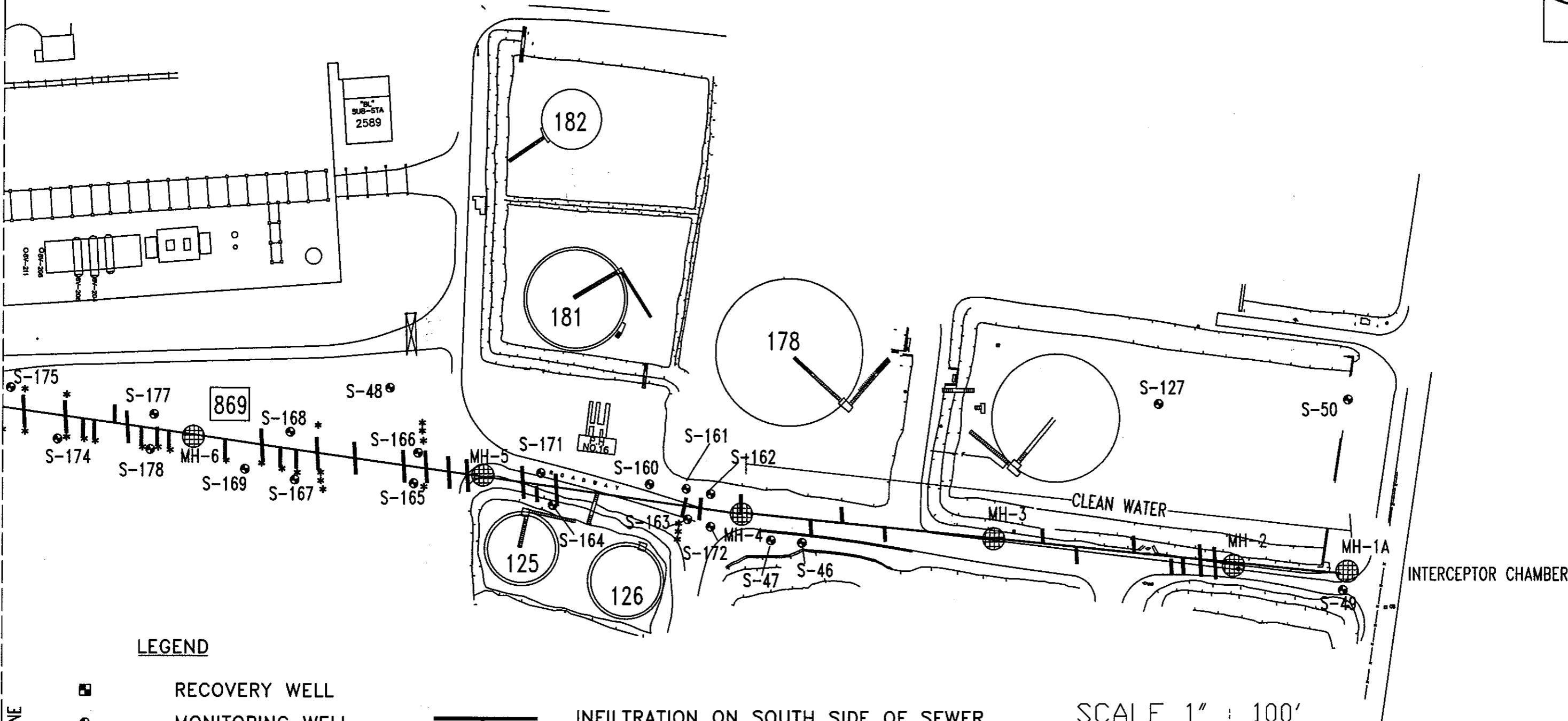













FIGURE 2A
EVIDENT SEEPS INSIDE SEWER
3-11 FEBRUARY 2003
POLLACK STREET SEWER
SUNOCO POINT BREEZE REFINERY
PHILADELPHIA, PENNSYLVANIA



LEGEND

-  RECOVERY WELL
-  MONITORING WELL
-  PIEZOMETER
-  SEWER
-  SEWER MANHOLE

-  INFILTRATION ON SOUTH SIDE OF SEWER
-  INFILTRATION ON NORTH SIDE OF SEWER
-  INFILTRATION ON BOTH SIDES OF SEWER
-  SIGNIFICANT INFILTRATION
-  MORE SIGNIFICANT INFILTRATION
-  MOST SIGNIFICANT INFILTRATION

SCALE 1" = 100'



NORTH

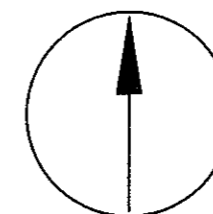
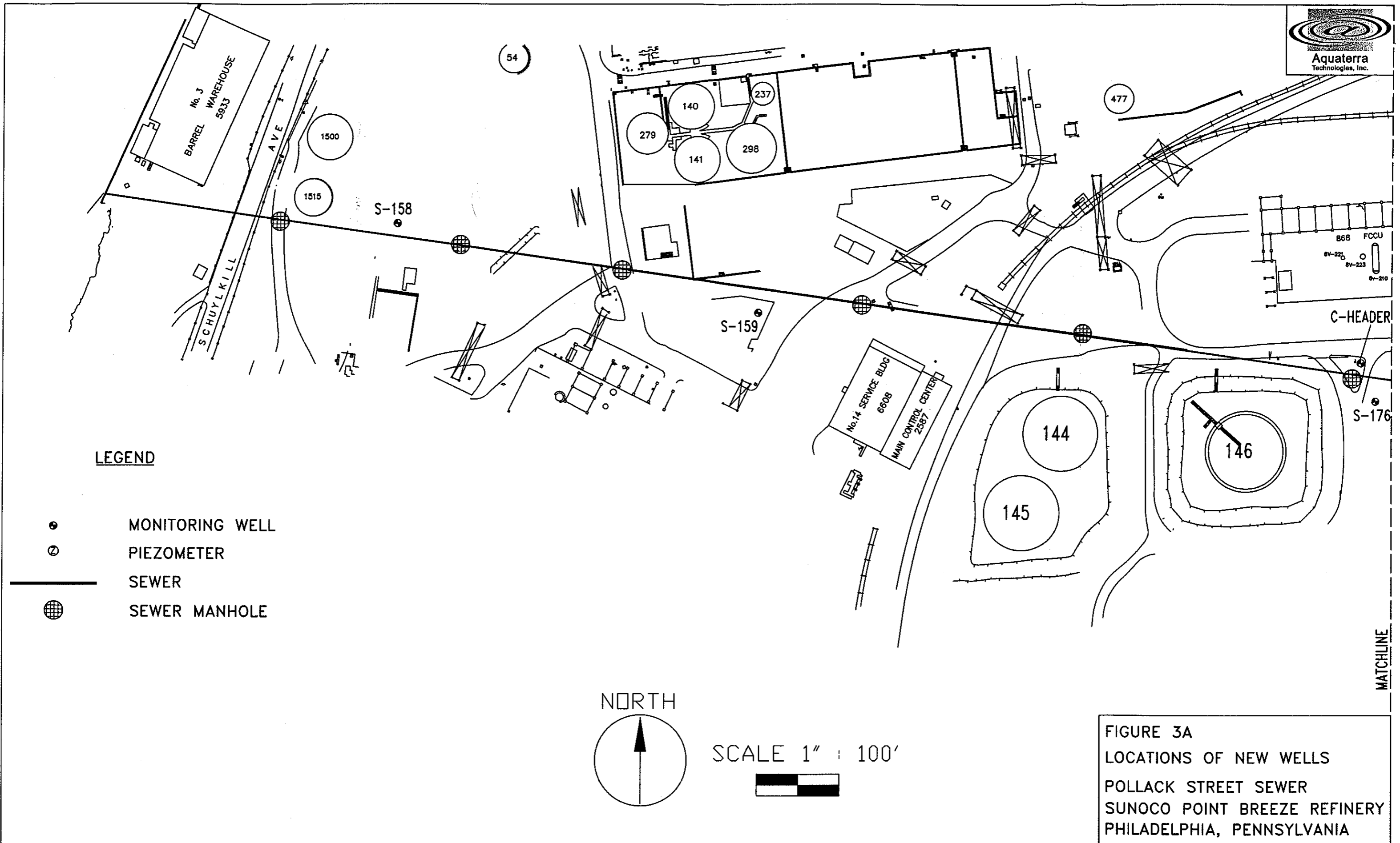


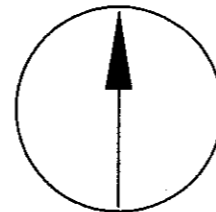
FIGURE 2B
EVIDENT SEEPS INSIDE SEWER
3-11 FEBRUARY 2003
POLLACK STREET SEWER
SUNOCO POINT BREEZE REFINERY
PHILADELPHIA, PENNSYLVANIA



LEGEND

- MONITORING WELL
- ⊙ PIEZOMETER
- SEWER
- ⊗ SEWER MANHOLE

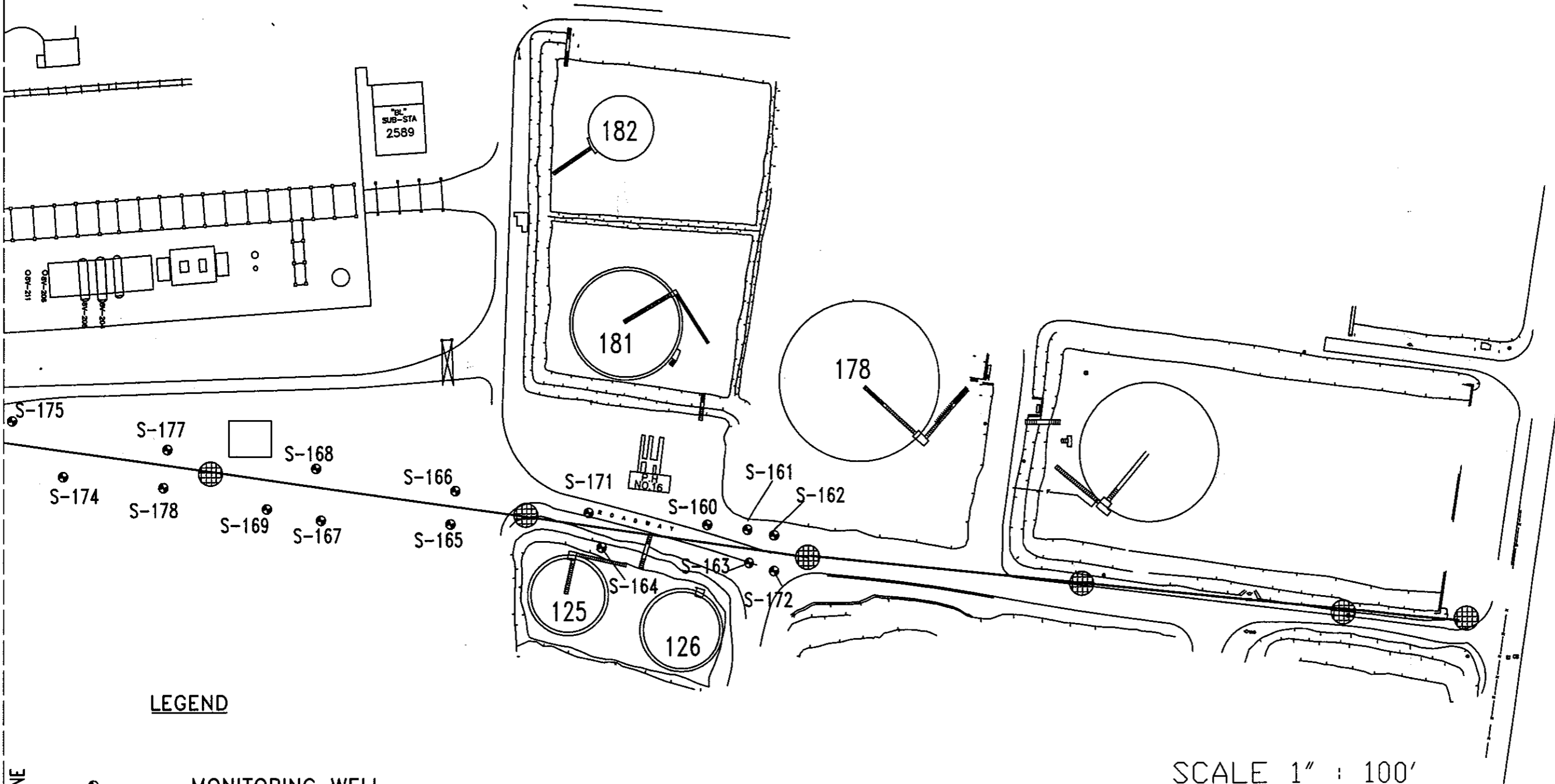
NORTH



SCALE 1" = 100'



FIGURE 3A
LOCATIONS OF NEW WELLS
POLLACK STREET SEWER
SUNOCO POINT BREEZE REFINERY
PHILADELPHIA, PENNSYLVANIA



LEGEND

- MATCHLINE**
- MONITORING WELL
 - ⊙ PIEZOMETER
 - SEWER
 - ⊗ SEWER MANHOLE

SCALE 1" : 100'



NORTH

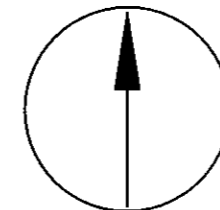


FIGURE 3B
LOCATIONS OF NEW WELLS
POLLACK STREET SEWER
SUNOCO POINT BREEZE REFINERY
PHILADELPHIA, PENNSYLVANIA

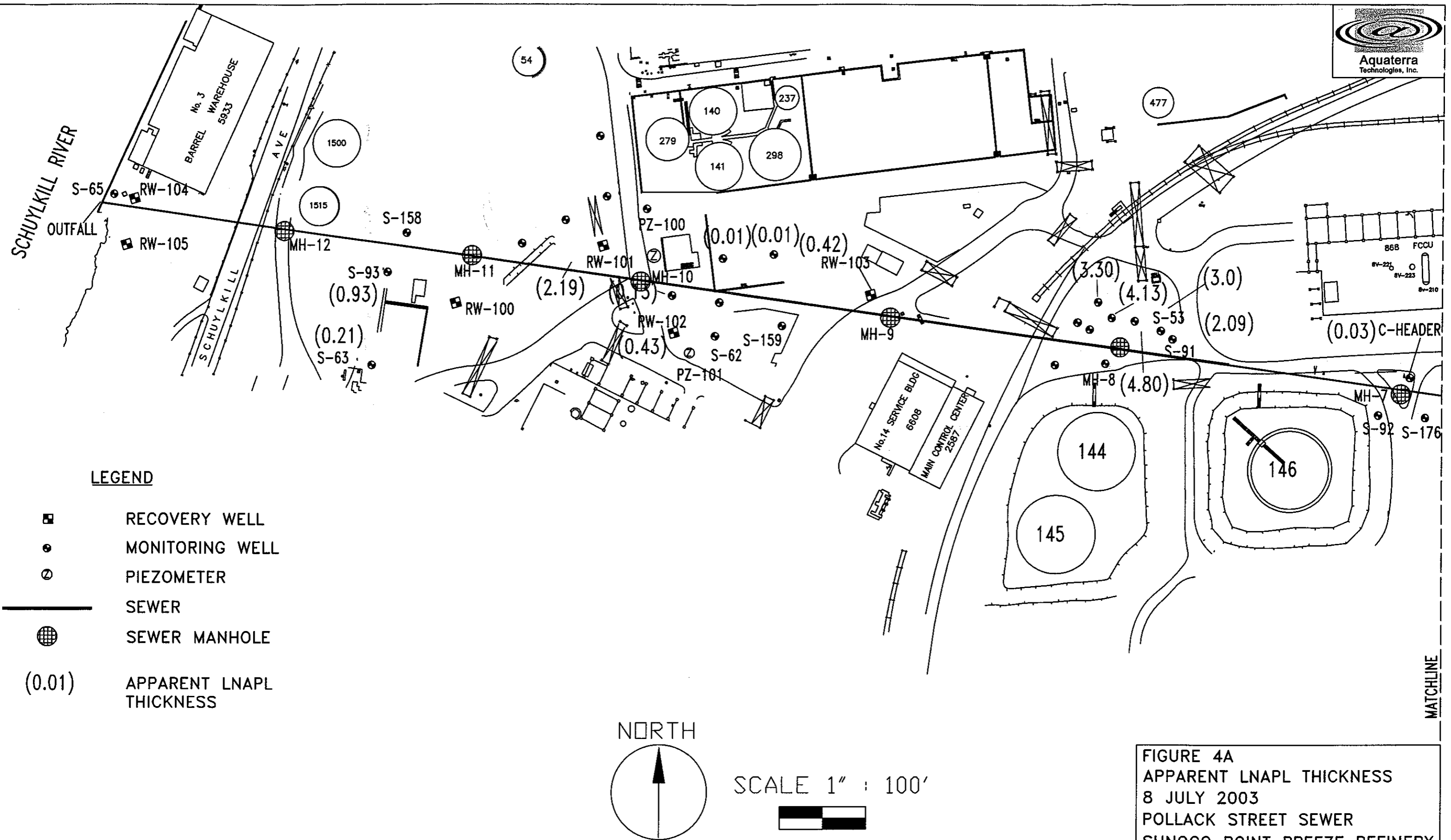
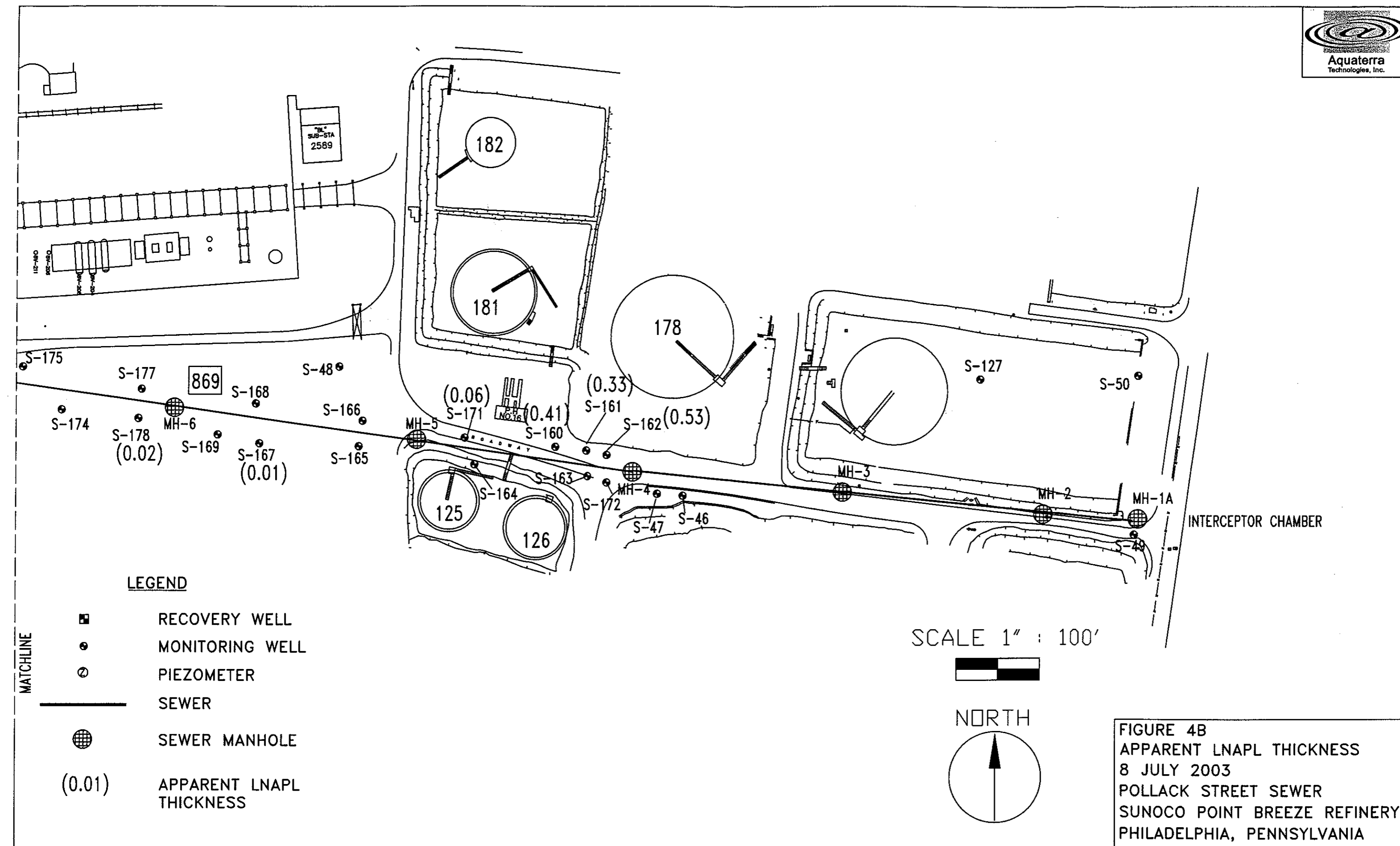
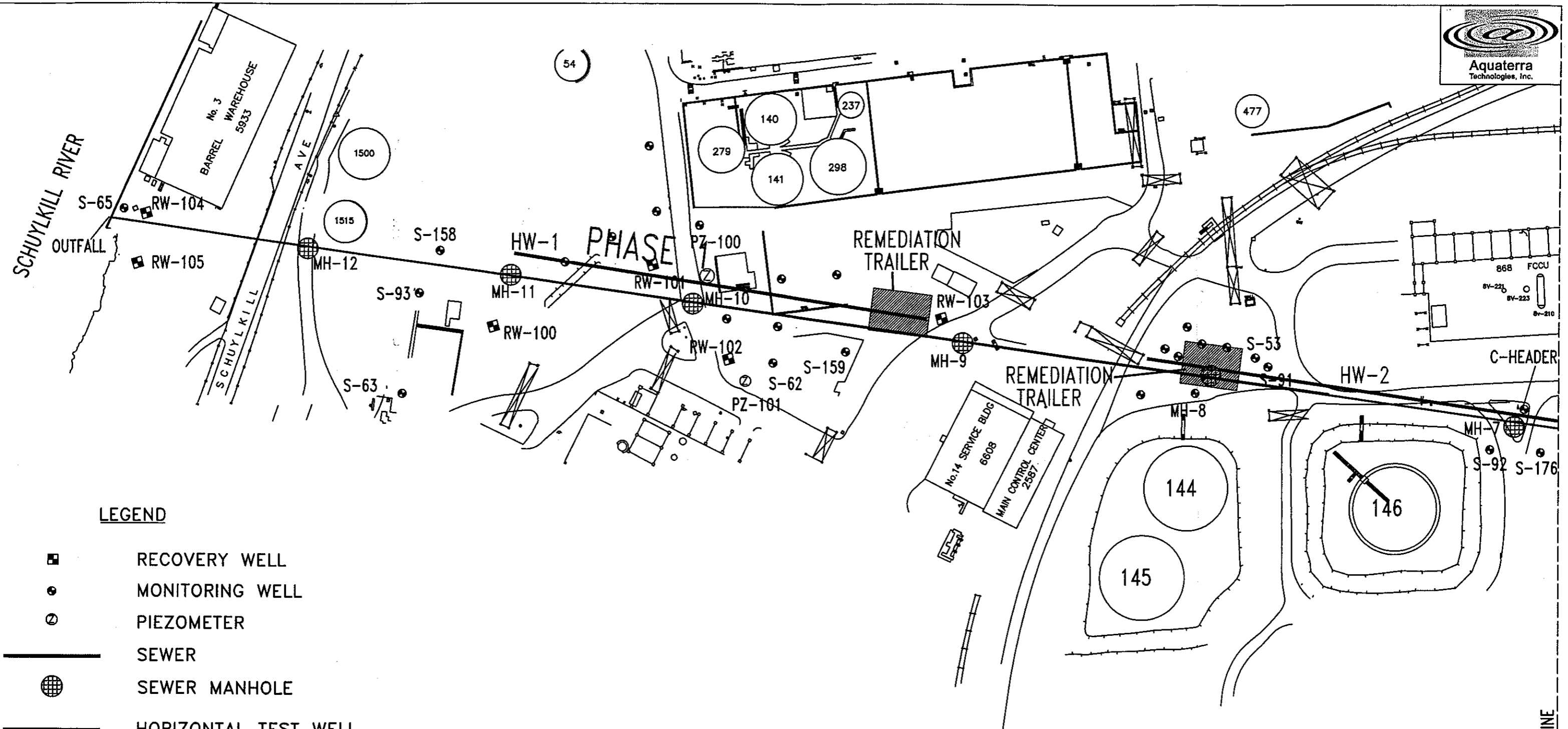








FIGURE 4A
APPARENT LNAPL THICKNESS
8 JULY 2003
POLLACK STREET SEWER
SUNOCO POINT BREEZE REFINERY
PHILADELPHIA, PENNSYLVANIA

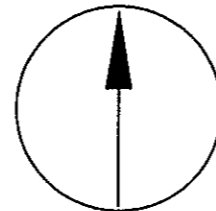




LEGEND

-  RECOVERY WELL
-  MONITORING WELL
-  PIEZOMETER
-  SEWER
-  SEWER MANHOLE
-  HORIZONTAL TEST WELL

NORTH

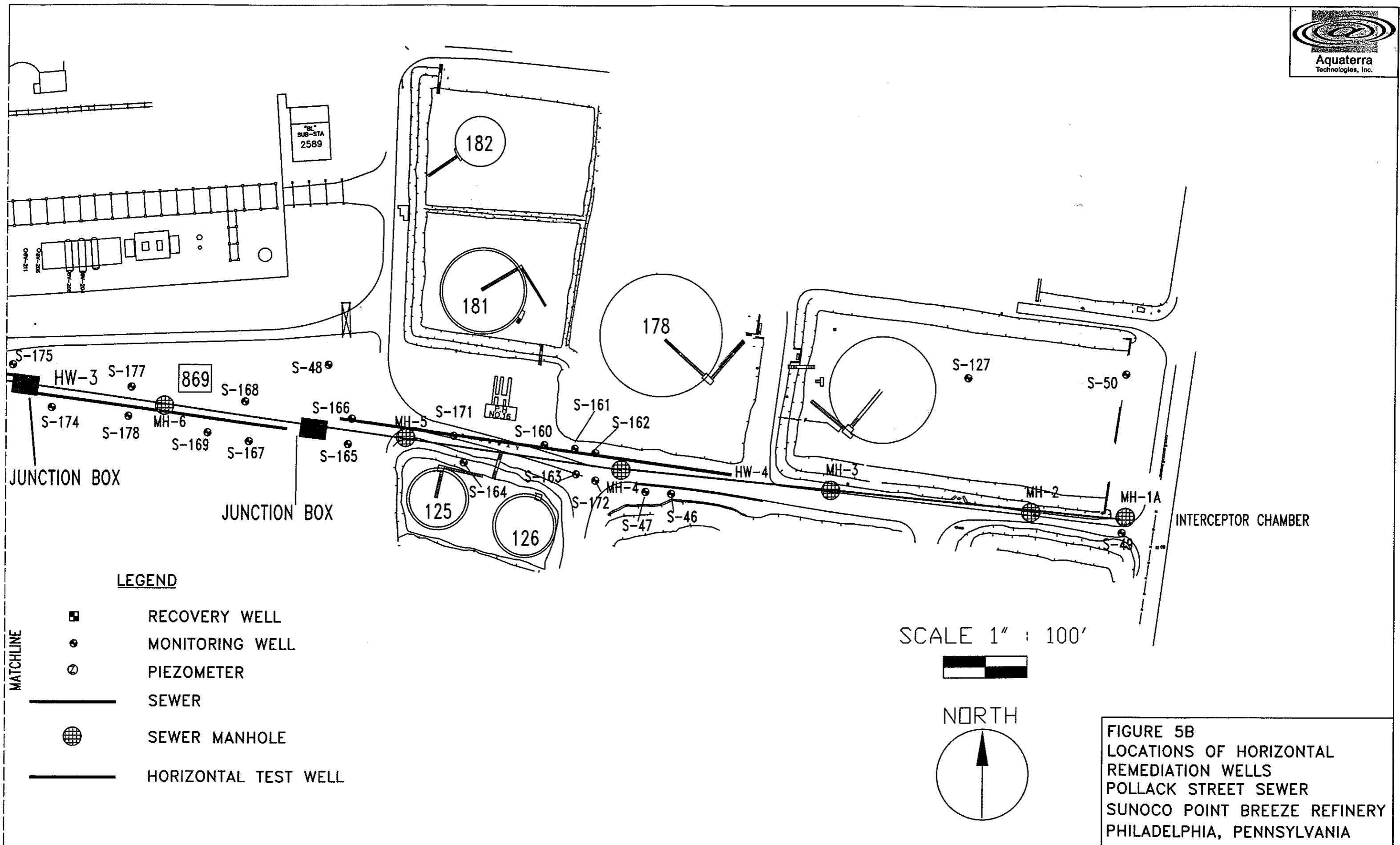


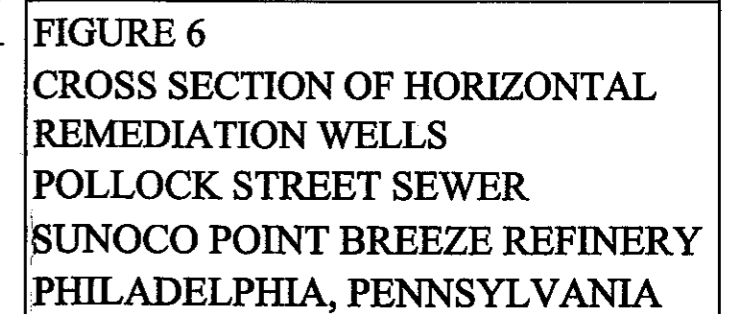
SCALE 1" = 100'



FIGURE 5A
LOCATIONS OF HORIZONTAL
REMEDATION WELLS
POLLACK STREET SEWER
SUNOCO POINT BREEZE REFINERY
PHILADELPHIA, PENNSYLVANIA

MATCHLINE





TABLES

TABLE 1

SUNOCO, INC. PHILADELPHIA REFINERY
 POLLACK STREET SEWER
 LIQUID LEVEL DATA
 8-Jul-03

WELL	DTP	DTW	Product Thickness	COMMENTS
S-129	-	18.27	0.00	
S-130	18.96	22.02	3.06	
S-131	16.81	19.61	2.80	
S-132	-	19.81	0.00	
S-133	-	17.84	0.00	
S-134	-	20.06	0.00	
S-135	19.61	23.41	3.80	
S-136	-	20.21	0.00	
S-144	19.08	19.11	0.03	
S-156	18.67	22.80	4.13	
S-157	16.98	20.05	3.07	
S-158	-	18.92	0.00	
S-159	-	16.46	0.00	
S-160	17.25	17.67	0.42	
S-161	16.84	17.31	0.47	
S-162	17.04	17.71	0.67	
S-164	-	15.71	0.00	
S-165	-	16.92	0.00	
S-166	-	17.04	0.00	
S-167	17.93	NA	Unknown	Thick Black Product
S-168	-	18.02	0.00	
S-169	-	17.84	0.00	
S-171	15.63	15.92	0.29	
S-172	18.00	18.01	0.01	
S-173	-	17.63	0.00	
S-174	10.79	10.82	0.03	
S-175	-	17.75	0.00	
S-176	14.85	14.86	0.01	
S-177	-	18.09	0.00	
S-178	18.21	18.22	0.01	
C-Header	17.64	21.00	3.36	To bottom of well, thick black product
S-53	18.66	20.52	1.86	

Appendix A

Drill Logs

Aquaterra Technologies, Inc.

Subsurface Log: S-158

Project Name: Pollack St Sewer
Location: 14 P.H.
Boring Number: S-158
Casing Elevation: N/A
Screen Diameter: 2" **Length:** 15'
Casing Diameter: 2" **Length:** 10'
Drilling Method: Hollow Stem Auger Drilling


Owner: Sunoco, Inc. (R&M)
Permit No.: N/A
Log By: Cathy Grzybek
Driller: B.L. Meyers
Slot Size: 0.020"
Type: PVC
Sample Method: Cuttings

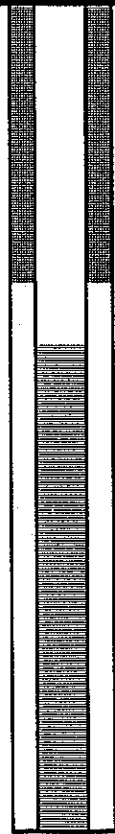
Date: 14-May-03
Borehole Dia: 6.25"
Water Level (Init): NA

Rig Type:

Total Well Depth: 25'
Screen Interval: 10'-25'
Sand Pack Interval: 8'-25'
Completion Details: Completed with 8-inch manhole cover and locking cap

Construction Details
Bentonite Interval: 1'-8'
Cement/Grout Interval: NA
Sand Pack Type: No. 2 sand


 = Backfill
 = Cement/Grout
 = Bentonite
 = Sand

Depth (ft)	Sample Depth (ft)	OVM (ppm)	Sample Number	Lithology	Well Schematic
0	0'-5'	N/A		NA, Hydroexcavated to 7' bgs.	
5	5'-10'	N/A		No cuttings available	
10	10'-15'			Rocks, hard drilling, water at 15' bgs	
15	15'-20'	0.1		Gray, silty water	
20	20'-25'			Gray sand and clay	
25				Borehole complete at 25' BGS	

NOTE: Shaded sample submitted for laboratory analysis

Aquaterra Technologies, Inc.

Subsurface Log: S-159

Project Name: Pollack St Sewer
Location: 14 P.H.

Boring Number: S-159
Casing Elevation: N/A

Screen Diameter: 2" **Length:** 15'
Casing Diameter: 2" **Length:** 5'

Drilling Method: Hollow Stem Auger Drilling

Owner: Sunoco, Inc. (R&M)
Permit No.: N/A

Log By: Cathy Grzybek
Driller: B.L. Meyers

Slot Size: 0.020"

Type: PVC

Sample Method: Cuttings

Date: 14-May-03


Borehole Dia: 6.25"

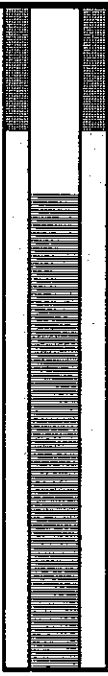
Water Level (Init): NA

Rig Type:

Total Well Depth: 20'
Screen Interval: 5'-20'
Sand Pack Interval: 3'-20'
Completion Details: Completed with 8-inch manhole cover and locking cap

Construction Details
Bentonite Interval: 1'-3'
Cement/Grout Interval: NA
Sand Pack Type: No. 2 sand


 = Backfill
 = Cement/Grout
 = Bentonite
 = Sand

Depth (ft)	Sample Depth (ft)	OVM (ppm)	Sample Number	Lithology	Well Schematic
0	0'-5'			NA, Hydroexcavated to 7' bgs.	
5	5'-10'	9.4, 10		Dark gray/black stained silt, sand, gravel, clay fill	
10	10'-15'	7.2		Black stained clay	
15	15'-20'	4.5		Moist clay stained dark gray/black, odor	
20				Borehole complete at 20' BGS	

NOTE: Shaded sample submitted for laboratory analysis

Aquaterra Technologies, Inc.

Subsurface Log: S-160

Project Name: Pollack St Sewer
Location: Tank 178

Boring Number: S-160
Casing Elevation: N/A

Screen Diameter: 2" **Length:** 20'
Casing Diameter: 2" **Length:** 3'

Drilling Method: Hollow Stem Auger Drilling

Owner: Sunoco, Inc. (R&M)
Permit No.: N/A

Log By: Cathy Grzybek
Driller: B.L. Meyers

Slot Size: 0.020"
Type: PVC

Sample Method: Cuttings

Date: 15-May-03

Borehole Dia: 6.25"


Water Level (Init): NA

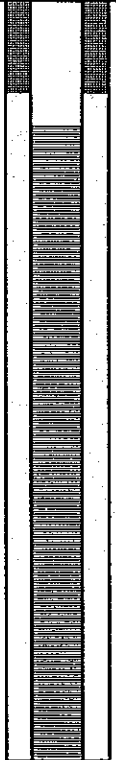
Rig Type:

Construction Details

Total Well Depth: 23'
Screen Interval: 3'-23'
Sand Pack Interval: 2'-23'
Completion Details: Completed with 8-inch manhole cover and locking cap

Bentonite Interval: 1'-2'
Cement/Grout Interval: NA
Sand Pack Type: No. 2 sand


 = Backfill
 = Cement/Grout
 = Bentonite
 = Sand

Depth (ft)	Sample Depth (ft)	OVN (ppm)	Sample Number	Lithology	Well Schematic
0	0'-5'			NA, Hydroexcavated to 7' bgs.	
5	5'-10'			No cuttings available	
10	10'-15'	0		Black/gray silt, sand, and gravel	
15	15'-20'			No cuttings available Wet at 18' bgs	
20	20'-23'			Gray, plastic clay	
23				Well set at 23' bgs	

NOTE: Shaded sample submitted for laboratory analysis

Aquaterra Technologies, Inc.

Subsurface Log: S-161

Project Name: Pollack St Sewer
Location: Tank 178
Boring Number: S-161
Casing Elevation: N/A
Screen Diameter: 2" **Length:** 15'
Casing Diameter: 2" **Length:** 5'
Drilling Method: Hollow Stem Auger Drilling


Owner: Sunoco, Inc. (R&M)
Permit No.: N/A
Log By: Cathy Grzybek
Driller: B.L. Meyers
Slot Size: 0.020"
Type: PVC
Sample Method: Cuttings


Date: 15-May-03
Borehole Dia: 6.25"
Water Level (Init): NA

Rig Type:

Total Well Depth: 21'
Screen Interval: 6'-21'
Sand Pack Interval: 4'-21'
Completion Details: Completed with 8-inch manhole cover and locking cap

Construction Details
Bentonite Interval: 1'-4'
Cement/Grout Interval: NA
Sand Pack Type: No. 2 sand


 = Backfill
 = Cement/Grout
 = Bentonite
 = Sand

Depth (ft)	Sample Depth (ft)	OVm (ppm)	Sample Number	Lithology	Well Schematic
0	0'-5'			NA, Hydroexcavated to 7' bgs.	
5	5'-10'	0.1		Silt, sand, and gravel Auger moist at 10'	
10	10'-15'			Same as above Harder drilling at 15'	
15	15'-20'	1.7		Cobbles	
20 21	20'-21'	15		Cobbles, some sandy clay, dark gray gravel and clay	
				Borehole complete at 21' BGS	

NOTE: Shaded sample submitted for laboratory analysis

Aquaterra Technologies, Inc.

Subsurface Log: S-162

Project Name: Pollack St Sewer
Location: Tank 178

Boring Number: S-162
Casing Elevation: N/A

Screen Diameter: 2" **Length:** 17'
Casing Diameter: 2" **Length:** 3'

Drilling Method: Hollow Stem Auger Drilling

Owner: Sunoco, Inc. (R&M)
Permit No.: N/A

Log By: Cathy Grzybek
Driller: B.L Meyers

Slot Size: 0.020"
Type: PVC

Sample Method: Cuttings

Date: 15-May-03

Borehole Dia: 6.25"

Water Level (Init): NA

Rig Type:

Construction Details

Total Well Depth: 22'

Screen Interval: 5'-22'

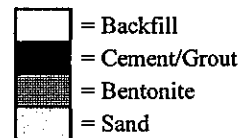
Sand Pack Interval: 3'-22'

Completion Details: Completed with 8-inch manhole cover and locking cap

Bentonite Interval: 0'-3'

Cement/Grout Interval: NA

Sand Pack Type: No. 2 sand



Depth (ft)	Sample Depth (ft)	OVN (ppm)	Sample Number	Lithology	Well Schematic
0	0'-5'			NA, Hydroexcavated to 7' bgs.	
5	5'-10'			Silt, sandy gravel, some clay	
10	10'-15'	7		Moist clay	
15	15'-20'	4,19.9		Cobbles and clay at 16'bgs	
20	20'-22'	287,333		Cobbles and clay	
22				Borehole complete at 22' BGS	

NOTE: Shaded sample submitted for laboratory analysis

Aquaterra Technologies, Inc.
Subsurface Log: S-163

Project Name: Pollack St Sewer
Location: Tank 178

Boring Number: S-163

Casing Elevation: N/A

Screen Diameter: NA **Length:** NA

Casing Diameter: NA **Length:** NA

Drilling Method: Hollow Stem Auger Drilling **Sample Method:** Cuttings

Owner: Sunoco, Inc. (R&M)
Permit No.: N/A

Log By: M. Brad Spancake

Driller: B.L. Meyers

Slot Size: 0.020"

Type: PVC

Date: 16-May-03





Borehole Dia: 6.25"

Water Level (Init): NA

Rig Type:

Total Well Depth: NA
Screen Interval: NA
Sand Pack Interval: NA
Completion Details: NA

Construction Details
Bentonite Interval: NA
Cement/Grout Interval: NA
Sand Pack Type: NA

 = Backfill
 = Cement/Grout
 = Bentonite
 = Sand

Depth (ft)	Sample Depth (ft)	OVM (ppm)	Sample Number	Lithology	Well Schematic
0	0'-5'			NA, Hydroexcavated to 7' bgs. Some gravel, silt, and clay	
5	5'-10'	15.9		Clay	
10	10'-15'			Refusal at 16' bgs Three other locations yielded refusal between 13'- 15' bgs, Well Not Constructed	

NOTE: Shaded sample submitted for laboratory analysis

Aquaterra Technologies, Inc.

Subsurface Log: S-164

Project Name: Pollack St Sewer
Location: Tank 178
Boring Number: S-164
Casing Elevation: N/A
Screen Diameter: 2" **Length:** 20'
Casing Diameter: 2" **Length:** 4'
Drilling Method: Hollow Stem Auger Drilling

Owner: Sunoco, Inc. (R&M)
Permit No.: N/A
Log By: Cathy Grzybek
Driller: B.L. Meyers
Slot Size: 0.020"
Type: PVC
Sample Method: Cuttings

Date: 16-May-03
Borehole Dia: 6.25"
Water Level (Init): NA


Rig Type:

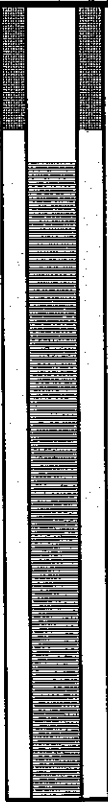
Construction Details
Total Well Depth: 24'
Screen Interval: 4'-24'
Sand Pack Interval: 3'-22'
Completion Details: Completed with 8-inch manhole cover and locking cap

Bentonite Interval: 0'-3'

Cement/Grout Interval: NA

Sand Pack Type: No. 2 sand


 = Backfill
 = Cement/Grout
 = Bentonite
 = Sand

Depth (ft)	Sample Depth (ft)	OVM (ppm)	Sample Number	Lithology	Well Schematic
0	0'-5'			NA, Hydroexcavated to 7' bgs.	
5	5'-10'	0.1		Dark brown/gray silt, sand, and clay	
10	10'-15'	6.1		Gray clay with fine sand, cobbles around 11'bgs	
15	15'-20'			Soft clay	
20	20'-25'			Soft clay to 23', cobbles	
24				Borehole complete at 24' BGS	

NOTE: Shaded sample submitted for laboratory analysis

Aquaterra Technologies, Inc.

Subsurface Log: S-165

Project Name: Pollack St Sewer
Location: 869 Unit
Boring Number: S-165
Casing Elevation: N/A
Screen Diameter: 2" **Length:** 15'
Casing Diameter: 2" **Length:** 4.5'
Drilling Method: Hollow Stem Auger Drilling

Owner: Sunoco, Inc. (R&M)
Permit No.: N/A
Log By: Cathy Grzybek
Driller: B.L Meyers
Slot Size: 0.020"
Type: PVC
Sample Method: Cuttings

Date: 16-May-03
Borehole Dia: 6.25"
Water Level (Init): NA

Rig Type:

Total Well Depth: 19.5'
Screen Interval: 4.5'-19.5'
Sand Pack Interval: 3.5'-19.5'
Completion Details: Completed with 8-inch manhole cover and locking cap

Construction Details
Bentonite Interval: 0-2.5'
Cement/Grout Interval: NA
Sand Pack Type: No. 2 sand

= Backfill
 = Cement/Grout
 = Bentonite
 = Sand

Depth (ft)	Sample Depth (ft)	OVN (ppm)	Sample Number	Lithology	Well Schematic
0	0'-5'			NA, Hydroexcavated to 7' bgs.	
5	5'-10'			Silt, sand, stone, and gravel	
10	10'-15'			Same as above	
15	15'-20'			Very moist gray clay, some sandy clay, some gravel, cobbles at 18'bgs	
19.5				Borehole complete at 19.5' BGS	

NOTE: Shaded sample submitted for laboratory analysis

Aquaterra Technologies, Inc.

Subsurface Log: S-166

Project Name: Pollack St Sewer
Location: 869 Unit

Boring Number: S-166
Casing Elevation: N/A

Screen Diameter: 2" **Length:** 15'
Casing Diameter: 2" **Length:** 5'

Drilling Method: Hollow Stem Auger Drilling

Owner: Sunoco, Inc. (R&M)
Permit No.: N/A

Log By: Cathy Grzybek
Driller: B.L Meyers

Slot Size: 0.020"
Type: PVC

Sample Method: Cuttings

Date: 16-May-03

Borehole Dia: 6.25"

Water Level (Init): NA

Rig Type:

Construction Details

Total Well Depth: 20'

Screen Interval: 5'-20'

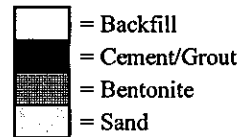
Sand Pack Interval: 4'-20'

Completion Details: Completed with 8-inch manhole cover and locking cap

Bentonite Interval: 0'-4'

Cement/Grout Interval: NA

Sand Pack Type: No. 2 sand



Depth (ft)	Sample Depth (ft)	OVN (ppm)	Sample Number	Lithology	Well Schematic
0	0'-5'			NA, Hydroexcavated to 7' bgs.	
5	5'-10'			Stones, silt, sand, and gravel	
10	10'-15'			Same as above	
15	15'-20'			Hard drilling at 18' bgs, wert, dark clay, sandy clay to 20' bgs Refusal at 20' bgs	
20				Borehole complete at 20' BGS	

NOTE: Shaded sample submitted for laboratory analysis

Aquaterra Technologies, Inc.

Subsurface Log: S-167

Project Name: Pollack St Sewer
Location: 869 Unit
Boring Number: S-167
Casing Elevation: N/A
Screen Diameter: 2" **Length:** 17'
Casing Diameter: 2" **Length:** 5'
Drilling Method: Hollow Stem Auger Drilling

Owner: Sunoco, Inc. (R&M)
Permit No.: N/A
Log By: Cathy Grzybek
Driller: B.L Meyers
Slot Size: 0.020"
Type: PVC
Sample Method: Cuttings


Date: 16-May-03
Borehole Dia: 6.25"
Water Level (Init): NA

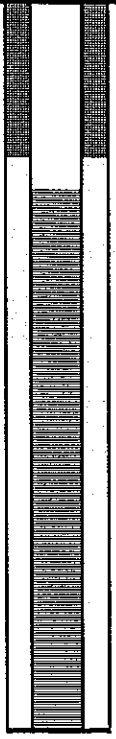
Rig Type:

Total Well Depth: 22'
Screen Interval: 5'-22'
Sand Pack Interval: 4'-22'
Completion Details: Completed with 8-inch manhole cover and locking cap

Construction Details

Bentonite Interval: 0'-4'
Cement/Grout Interval: NA
Sand Pack Type: No. 2 sand


 = Backfill
 = Cement/Grout
 = Bentonite
 = Sand

Depth (ft)	Sample Depth (ft)	OVN (ppm)	Sample Number	Lithology	Well Schematic
0	0'-5'			NA, Hydroexcavated to 7' bgs.	
5	5'-10'			Some cobbles, silt, and sand	
10	10'-15'			Wet clay, sand, gravel, hard drilling at 13'	
15	15'-20'			Some clay, hard drilling	
20	20'-22'				
22				Borehole complete at 22' BGS	

NOTE: Shaded sample submitted for laboratory analysis

Aquaterra Technologies, Inc.

Subsurface Log: S-168

Project Name: Pollock St Sewer
Location: 869 Unit
Boring Number: S-168
Casing Elevation: N/A
Screen Diameter: 4" **Length:** 20'
Casing Diameter: 4" **Length:** 5'
Drilling Method: Hollow Stem Auger Drilling

Owner: Sunoco, Inc. (R&M)
Permit No.: N/A
Log By: M. Brad Spancake
Driller: B.L Meyers
Slot Size: 0.020"
Type: PVC
Sample Method: Split-Spoon/Grab


Date: 27-May-03
Borehole Dia: 6.25"
Water Level (Init): NA

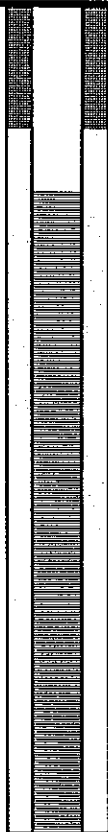
Rig Type:

Total Well Depth: 25'
Screen Interval: 5'-25'
Sand Pack Interval: 3'-25'
Completion Details: Completed with 8-inch manhole cover and locking cap

Construction Details

Bentonite Interval: 1'-3'
Cement/Grout Interval: NA
Sand Pack Type: No. 2 sand


 = Backfill
 = Cement/Grout
 = Bentonite
 = Sand

Depth (ft)	Sample Depth (ft)	OVN (ppm)	Sample Number	Lithology	Well Schematic
0				Augered to 12'	
2					
4					
6					
8					
10					
12	12-14'	20	1	Compact wet gravel, clay, brown silt, and rock fragments	
14	14-16	467	2	Compact gravel, rocks and coarse sand in brown silt matrix Quartz fragments	
16	16-18	378	3	Same as above	
18	18-20			Augered to 25' bgs	
25				Borehole completed at 25' bgs	

NOTE: Shaded sample submitted for laboratory analysis

Aquaterra Technologies, Inc.

Subsurface Log: S-169

Project Name: Pollack St Sewer Location: 869 Unit Boring Number: S-169 Casing Elevation: N/A Screen Diameter: 2" Casing Diameter: 2" Drilling Method: Hollow Stem Auger Drilling	Owner: Sunoco, Inc. (R&M) Permit No.: N/A Log By: Cathy Grzybek Driller: B.L. Meyers Slot Size: 0.020" Type: PVC Sample Method: Cuttings	Date: 16-May-03 Borehole Dia: 6.25" Water Level (Init): NA Rig Type:
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Construction Details

Total Well Depth: 20' Screen Interval: 5'-20' Sand Pack Interval: 3'-20' Completion Details: Completed with 8-inch manhole cover and locking cap	Bentonite Interval: 1'-3' Cement/Grout Interval: NA Sand Pack Type: No. 2 sand
---	---

	= Backfill
	= Cement/Grout
	= Bentonite
	= Sand

Depth (ft)	Sample Depth (ft)	OVM (ppm)	Sample Number	Lithology	Well Schematic
0	0'-5'			NA, Hydroexcavated to 7' bgs.	
5	5'-10'			Gravel, silt, sand, and small cobble	
10	10'-15'			Clay at 12' bgs	
15	15'-20'			Wet, gray clay Refusal at 20' bgs	
20				Borehole complete at 20' BGS	

NOTE: Shaded sample submitted for laboratory analysis

Aquaterra Technologies, Inc.

Subsurface Log: S-170

Project Name: Pollack St Sewer
Location: 869 Unit
Boring Number: S-170
Casing Elevation: N/A
Screen Diameter: NA **Length:** NA
Casing Diameter: NA **Length:** NA
Drilling Method: Hollow Stem Auger Drilling





Owner: Sunoco, Inc. (R&M)
Permit No.: N/A
Log By: M. Brad Spancake
Driller: B.L. Meyers
Slot Size: 0.020"
Type: PVC
Sample Method: Cuttings

Date: 16-May-03
Borehole Dia: 6.25"
Water Level (Init): NA

Rig Type:

Total Well Depth: NA
Screen Interval: NA
Sand Pack Interval: NA
Completion Details: NA

Construction Details
Bentonite Interval: NA
Cement/Grout Interval: NA
Sand Pack Type: NA


 = Backfill

 = Cement/Grout

 = Bentonite

 = Sand

Depth (ft)	Sample Depth (ft)	OVN (ppm)	Sample Number	Lithology	Well Schematic
0	0'-5'			NA, Hydroexcavated to 7' bgs. Some gravel, silt, and clay	
5	5'-10'			Clay	
10	10'-15'			Refusal at 16' bgs Three other locations yielded refusal at 15' bgs, well not constructed	

NOTE: Shaded sample submitted for laboratory analysis

Aquaterra Technologies, Inc.

Subsurface Log: S-171

Project Name: Pollack St Sewer
Location: Tank 178
Boring Number: S-171
Casing Elevation: N/A
Screen Diameter: 2" **Length:** 17'
Casing Diameter: 2" **Length:** 5'
Drilling Method: Hollow Stem Auger Drilling


Owner: Sunoco, Inc. (R&M)
Permit No.: N/A
Log By: M. Brad Spancake
Driller: B.L Meyers
Slot Size: 0.020"
Type: PVC
Sample Method: Cuttings


Date: 19-May-03
Borehole Dia: 6.25"
Water Level (Init): NA

Rig Type:

Total Well Depth: 22'
Screen Interval: 5'-22'
Sand Pack Interval: 4'-22'
Completion Details: Completed with 8-inch manhole cover and locking cap

Construction Details
Bentonite Interval: 0'-4'
Cement/Grout Interval: NA
Sand Pack Type: No. 2 sand


 = Backfill
 = Cement/Grout
 = Bentonite
 = Sand

Depth (ft)	Sample Depth (ft)	OVN (ppm)	Sample Number	Lithology	Well Schematic
0	0'-5'			NA, Hydroexcavated to 7' bgs.	
5	5'-10'			Grey silty clay	
10	10'-15'	76		Slightly moist grey silty clay	
15	15'-20'	257		Grey silty clay, becoming wet, gravel and coarse sand.	
20	20'-22'	40		Same as above, wet	
22				Borehole complete at 22' BGS	

NOTE: Shaded sample submitted for laboratory analysis

Aquaterra Technologies, Inc.

Subsurface Log: S-172


Project Name: Pollack St Sewer
Location: Tank 178
Boring Number: S-172
Casing Elevation: N/A
Screen Diameter: 2" **Length:** 17'
Casing Diameter: 2" **Length:** 4.5'
Drilling Method: Hollow Stem Auger Drilling

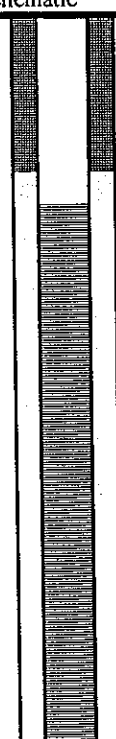
Owner: Sunoco, Inc. (R&M)
Permit No.: N/A
Log By: M. Brad Spancake
Driller: B.L. Meyers
Slot Size: 0.020"
Type: PVC
Sample Method: Cuttings

Date: 19-May-03
Borehole Dia: 6.25"
Water Level (Init): NA

Rig Type:

Construction Details
Total Well Depth: 21.5'
Screen Interval: 4.5'-21.5'
Sand Pack Interval: 3.5'-21.5'
Completion Details: Completed with 8-inch manhole cover and locking cap
Bentonite Interval: 1.5'-3.5'
Cement/Grout Interval: NA
Sand Pack Type: No. 2 sand


 = Backfill
 = Cement/Grout
 = Bentonite
 = Sand

Depth (ft)	Sample Depth (ft)	OVN (ppm)	Sample Number	Lithology	Well Schematic
0	0'-5'			NA, Hydroexcavated to 7' bgs.	
5	5'-10'	108		Brown grey silty clay, some coarse sand, slight moisture	
10	10'-15'	208		Dark brown silty clay, coarse sand, some gravel.	
15	15'-20'	285		Wet, same as above, more sand and gravel.	
20	20'-21.5'	390		Same as above	
21.5				Refusal at 21.5' Borehole complete at 21.5' BGS	

NOTE: Shaded sample submitted for laboratory analysis

Aquaterra Technologies, Inc.

Subsurface Log: S-173

Project Name: Pollock St Sewer
Location: Tank 178
Boring Number: S-173
Casing Elevation: N/A
Screen Diameter: 4" **Length:** 20'
Casing Diameter: 4" **Length:** 5'
Drilling Method: Hollow Stem Auger Drilling


Owner: Sunoco, Inc. (R&M)
Permit No.: N/A
Log By: M. Brad Spancake
Driller: B.L Meyers
Slot Size: 0.020"
Type: PVC
Sample Method: Split-Spoon/Grab


Date: 27-May-03
Borehole Dia: 6.25"
Water Level (Init): NA

Rig Type:

Total Well Depth: 25'
Screen Interval: 5'-25'
Sand Pack Interval: 3'-25'
Completion Details: Completed with 8-inch manhole cover and locking cap

Construction Details
Bentonite Interval: 1'-3'
Cement/Grout Interval: NA
Sand Pack Type: No. 2 sand


 = Backfill
 = Cement/Grout
 = Bentonite
 = Sand

Depth (ft)	Sample Depth (ft)	OVN (ppm)	Sample Number	Lithology	Well Schematic
0				Augered to 10'	
2					
4					
6					
8					
10	10-12'	0	1	Brown silt, sand, gravel, and rock fragments	
12	12-14'	156	2	Rock, sand, and gravel in brown silt matrix	
14	14-16	510	3	Same as above Compacted gravel and rock material, brown silt and coarse sand	
16	16-18	NA		No sample	
18	18-20	710	4	Same as above	
25				Borehole completed at 25' bgs	

NOTE: Shaded sample submitted for laboratory analysis

Aquaterra Technologies, Inc.

Subsurface Log: S-174

Project Name: Pollock St Sewer

Location: 869 Unit

Boring Number: S-174

Casing Elevation: N/A

Screen Diameter: 2" **Length:** 17'

Casing Diameter: 2" **Length:** 5'

Drilling Method: Hollow Stem Auger Drilling

Owner: Sunoco, Inc. (R&M)

Permit No.: N/A

Log By: M. Brad Spancake

Driller: B.L Meyers

Slot Size: 0.020"

Type: PVC

Sample Method: Cuttings

Date: 27-May-03

Borehole Dia: 6.25"

Water Level (Init): NA

Rig Type:

Construction Details

Total Well Depth: 22'

Screen Interval: 5'-22'

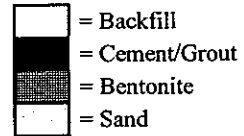
Sand Pack Interval: 3'-22'

Completion Details: Completed with 8-inch manhole cover and locking cap

Bentonite Interval: 1'-3'

Cement/Grout Interval: NA

Sand Pack Type: No. 2 sand



Depth (ft)	Sample Depth (ft)	OVN (ppm)	Sample Number	Lithology	Well Schematic
0	0-5'			NA, Hydroexcavated to 7' bgs.	
5	5-10'	41		Silty clay and dark brown coarse sand	
10	10-15'	67		Same as above, gravel present, wet	
15	15-20'	103		Same as above Grinding rock at 17' bgs	
20	20-22'	248		Same as above	
22				Well set at 22' bgs	

NOTE: Shaded sample submitted for laboratory analysis

Aquaterra Technologies, Inc.

Subsurface Log: S-175

Project Name: Pollack St Sewer Location: 869 Unit Boring Number: S-175 Casing Elevation: N/A Screen Diameter: 2" Length: 17' Casing Diameter: 2" Length: 5' Drilling Method: Hollow Stem Auger Drilling	Owner: Sunoco, Inc. (R&M) Permit No.: N/A Log By: M. Brad Spancake Driller: B.L. Meyers Slot Size: 0.020" Type: PVC Sample Method: Cuttings	Date: 20-May-03 Borehole Dia: 6.25" Water Level (Init): NA Rig Type:
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Construction Details

Total Well Depth: 22' Screen Interval: 5'-22' Sand Pack Interval: 4'-22' Completion Details: Completed with 8-inch manhole cover and locking cap	Bentonite Interval: 0'-4' Cement/Grout Interval: NA Sand Pack Type: No. 2 sand
---	---

	= Backfill
	= Cement/Grout
	= Bentonite
	= Sand

Depth (ft)	Sample Depth (ft)	OVM (ppm)	Sample Number	Lithology	Well Schematic
0	0'-5'			NA, Hydroexcavated to 7' bgs.	
5	5'-10'	1		Brown grey silty clay with some sand and gravel	
10	10'-15'	5		Moist grey and brown silty clay, coarse sand and small gravel	
15	15'-20'	52		Same as above, wet	
20	20'-22'	5		Refusal at 22' BGS. Wet silty clay and gravel, coarse sand.	
22				Borehole complete at 22' BGS	

NOTE: Shaded sample submitted for laboratory analysis

Aquaterra Technologies, Inc.

Subsurface Log: S-176


Project Name: Pollack St Sewer
Location: 869 Unit
Boring Number: S-176
Casing Elevation: N/A
Screen Diameter: 2" **Length:** 17'
Casing Diameter: 2" **Length:** 3'
Drilling Method: Hollow Stem Auger Drilling

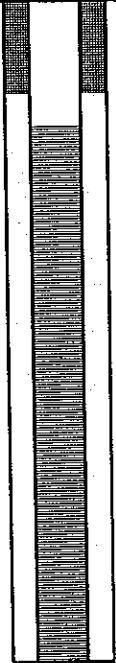
Owner: Sunoco, Inc. (R&M)
Permit No.: N/A
Log By: M. Brad Spancake
Driller: B.L. Meyers
Slot Size: 0.020"
Type: PVC
Sample Method: Cuttings

Date: 27-May-03
Borehole Dia: 6.25"
Water Level (Init): NA

Rig Type:

Construction Details
Total Well Depth: 20'
Screen Interval: 3'-20'
Sand Pack Interval: 2'-20'
Completion Details: Completed with 8-inch manhole cover and locking cap
Bentonite Interval: 1'-2'
Cement/Grout Interval: NA
Sand Pack Type: No. 2 sand


 = Backfill
 = Cement/Grout
 = Bentonite
 = Sand

Depth (ft)	Sample Depth (ft)	OVM (ppm)	Sample Number	Lithology	Well Schematic
0	0'-5'			NA, Hydroexcavated to 7' bgs.	
5	5'-10'	37		Brown silty clay, gravel, coarse sand, moist	
10	10'-15'			No cuttings available	
15	15'-20'	15		Brown silty clay, coarse sand, gravel, and rock, wet	
20	20'-22'	11		Same as above with small pebbles	
				Borehole complete at 22' BGS Well set at 20' bgs	

NOTE: Shaded sample submitted for laboratory analysis

Aquaterra Technologies, Inc.

Subsurface Log: S-177


Project Name: Pollack St Sewer
Location: 869 Unit
Boring Number: S-177
Casing Elevation: N/A
Screen Diameter: 2" **Length:** 17'
Casing Diameter: 2" **Length:** 4'
Drilling Method: Hollow Stem Auger Drilling


Owner: Sunoco, Inc. (R&M)
Permit No.: N/A
Log By: M. Brad Spancake
Driller: B.L. Meyers
Slot Size: 0.020"
Type: PVC
Sample Method: Cuttings

Date: 27-May-03
Borehole Dia: 6.25"
Water Level (Init): NA

Rig Type:

Construction Details
Total Well Depth: 21'
Screen Interval: 4'-21'
Sand Pack Interval: 3'-21'
Completion Details: Completed with 8-inch manhole cover and locking cap
Bentonite Interval: 0'-3'
Cement/Grout Interval: NA
Sand Pack Type: No. 2 sand


 = Backfill
 = Cement/Grout
 = Bentonite
 = Sand

Depth (ft)	Sample Depth (ft)	OVM (ppm)	Sample Number	Lithology	Well Schematic
0	0'-5'			NA, Hydroexcavated to 7' bgs.	
5	5'-10'	30		Dark brown and grey silty clay, some coarse sand and small gravel	
10	10'-15'	160		Same as above, gravel and coarse sand, moist Hard layer encountered at 13' BGS	
15	15'-20'	221		Same as above, more rock and pebbles present, wet.	
20 21	20'-21'	244		Same as above, refusal at 21' BGS Borehole complete at 21' BGS	

NOTE: Shaded sample submitted for laboratory analysis

Aquaterra Technologies, Inc.

Subsurface Log: S-178

Project Name: Pollack St Sewer
Location: 869 Unit
Boring Number: S-178
Casing Elevation: N/A
Screen Diameter: 2" **Length:** 17'
Casing Diameter: 2" **Length:** 5'
Drilling Method: Hollow Stem Auger Drilling


Owner: Sunoco, Inc. (R&M)
Permit No.: N/A
Log By: M. Brad Spancake
Driller: B.L. Meyers
Slot Size: 0.020"
Type: PVC
Sample Method: Cuttings

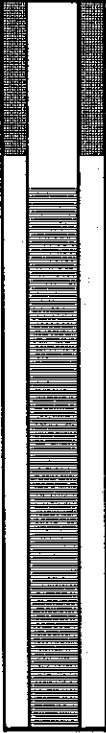
Date: 27-May-03
Borehole Dia: 6.25"
Water Level (Init): NA

Rig Type:

Total Well Depth: 22'
Screen Interval: 5'-22'
Sand Pack Interval: 3'-22'
Completion Details: Completed with 8-inch manhole cover and locking cap

Construction Details
Bentonite Interval: 0'-3'
Cement/Grout Interval: NA
Sand Pack Type: No. 2 sand


 = Backfill
 = Cement/Grout
 = Bentonite
 = Sand

Depth (ft)	Sample Depth (ft)	OVN (ppm)	Sample Number	Lithology	Well Schematic
0	0'-5'			NA, Hydroexcavated to 7' bgs.	
5	5'-10'	2		Dark brown silty clay, medium grain sand, slightly moist	
10	10'-15'	75		Same as above, gravel and coarse sand, becoming wet.	
15	15'-20'	52		Same as above, wet. Slight refusal encountered at 17' BGS	
20	20'-22'	63		Same as above.	
22				Borehole complete at 22' BGS	

NOTE: Shaded sample submitted for laboratory analysis

Aquaterra Technologies, Inc.

Subsurface Log: C Header

Project Name: Pollack St Sewer
Location: 869 Unit

Owner: Sunoco, Inc. (R&M)
Permit No.: N/A

Boring Number: C-Header

Log By: M. Brad Spancake

Date: 28-May-03

Casing Elevation: N/A

Driller: B.L. Meyers

Borehole Dia: 6.25"

Screen Diameter: 2"

Length: 20'

Slot Size: 0.020"

Water Level (Init): NA

Casing Diameter: 2"

Length: 1'

Type: PVC


Drilling Method: Hollow Stem Auger Drilling

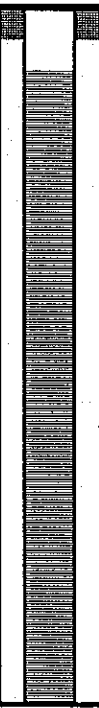
Sample Method: Cuttings

Rig Type:

Total Well Depth: 21'
Screen Interval: 1'-21'
Sand Pack Interval: 0.5-21'
Completion Details: Completed with 8-inch manhole cover and locking cap

Construction Details
Bentonite Interval: 0-0.5'
Cement/Grout Interval: NA
Sand Pack Type: No. 2 sand


 = Backfill
 = Cement/Grout
 = Bentonite
 = Sand

Depth (ft)	Sample Depth (ft)	OVN (ppm)	Sample Number	Lithology	Well Schematic
0	0'-5'			NA, Hydroexcavated to 8' bgs.	
5	5'-10'	45		Brown silty clay matrix, gravel, coarse sand, moist	
10	10'-15'	72		Wet clay silt matrix, gravel, and coarse sand Wet cuttings at 14' bgs	
15	15'-20'	140		Same as above	
20	20'-25'	295		Same as above.	
				Well set at 21' bgs	

NOTE: Shaded sample submitted for laboratory analysis