INTEGRATED GROUNDWATER SAMPLING AND ANALYSIS PLAN

STUDY AREAS 5, 6, AND 7 JERSEY CITY, NEW JERSEY

Prepared for

HONEYWELL
Morristown, New Jersey

November 5, 2013

(revised March 12, 2014)

(revised April 29, 2014)

Prepared by

cornerstone environmental

100 Crystal Run Road, Suite 101
Middletown, NY 10941

Project 130109

TABLE OF CONTENTS

LIST OF TABLES, FIGURES AND DRAWINGS

Tables

Table B Summary of Groundwater Quality Monitoring Requirements

Sub-table B-1 Monitoring Wells for Groundwater Quality Sampling – GWET Long-term Monitoring Plan

Sub-table B-2 Monitoring Wells for Groundwater Quality Sampling – S-3 Injection Mass Removal Program

Sub-table B-3 Monitoring Wells for Groundwater Quality Sampling – SA-6 South Development AOC

Sub-table B-4 Monitoring Wells for Groundwater Quality Sampling – SA-6 South "L-zone Wells" Plume Diversion Area

Sub-table B-5 Monitoring Wells for Groundwater Quality Sampling – SA-5 (NJCU) Sites 90 and 184 Long-term Monitoring Plan

Sub-table B-6 Monitoring Wells for Groundwater Quality Sampling – SA-5 Site 117 South Remedial Action Permit for Groundwater

Sub-table B-7 Monitoring Wells for Groundwater Quality Sampling – SA-5 Site 079 Long-term Monitoring Plan

Sub-table B-8 Monitoring Wells for Groundwater Quality Sampling – SA-5 Site 153 South Remedial Action Permit for Groundwater

Table C Summary of Analytical Methods, Containers, Preservatives Hold Times

Table D Summary of Tidal Lag and Tidal Efficiency in Selected Monitoring Wells

Figures

1 INTRODUCTION

This Sampling and Analysis Plan (SAP) was developed as a guide for implementation of the Integrated Groundwater Monitoring Plan (IGWMP) to monitor the various groundwater remedies within Study Areas 5, 6, and 7 (Project Area). The objective of the plan is to characterize regional groundwater conditions and document compliance with area-specific remedial objectives. These monitoring activities generally consist of the collection of water level measurements and groundwater quality samples, and the reporting of these data in accordance with site-specific work plans. Because well locations and sampling frequencies vary from plan to plan and over time, there is a potential for duplication of efforts and inefficiency, both in the field, and in reporting. The specific objectives of the SAP and associated annual report are to:

- Improve consistency and efficiency in field procedures including sample collection and scheduling.
- Provide a central database for monitoring well specifications and status.
- Provide regional groundwater flow interpretations that consider the impact of features such as subsurface barrier walls, drains, caps, and drawdown from pumping.
- Provide localized groundwater flow maps consistent with the regional contour maps.
- Facilitate preparation of CEA biennial certifications.

The contents of this SAP will be reviewed and re-issued on an annual basis to document such occurrences as:

- a change in contractor,
- modifications to field procedures, equipment, or reporting that may be necessary due to changes in field conditions,
- changes in regulatory requirements or standards,
- changes in consent decrees, monitoring plans or remedial designs.

The results of this review will be reported in the Annual Integrated Groundwater Performance Report and reflected in a revised SAP to be issued annually.

2 FIELD PROCEDURES

2.1 Groundwater Level Measurements

Groundwater level measurements are required in the various monitoring plans listed in column B on **Table A**. The associated consent order or consent decree that requires these plans to be implemented is listed in column C on **Table A**. The individual wells associated with each plan are identified on **Sub-tables A-1 through A-8** and a key to the appropriate Sub-table is provided in column F.

The frequency of water level measurement ranges from monthly in the SA-7 perimeter pools and SA-6 North and South containment cells (once constructed), to quarterly, semi-annually, or annually in other plans. The mainstay of the IGMP is the quarterly round currently conducted in all available wells as part of the GWET Long Term Monitoring Plan (LTMP). These data will be plotted for each of the four flow zones (Shallow, Intermediate, Deep, and Bedrock) and will be used to define regional flow conditions in the annual report. For those plans requiring monthly measurements, the events will be coordinated to the extent feasible to occur on the same day to improve efficiency.

Accuracy and consistency in water level measurements are critical considering the close tolerances in performance standards used to demonstrate capture zones, inward/outward gradients across barrier walls, and the like. As a result, groundwater level measurements will be conducted in accordance with the procedures provided below.

Field Procedures. The depth to groundwater will be measured manually with an electronic depth indicating sounder. The sequence of manual water level measurements at a given well cluster will be pre-determined on the basis of existing groundwater quality data. Generally, the least contaminated well (in terms of hexavalent chromium concentration) will be measured first proceeding to progressively more contaminated wells based upon historic water quality data. The calibrated cable on the depth indicator will be checked against a surveyor's steel tape at the beginning of each quarterly event and replaced if more than 0.01 feet in error. The following procedures will be used for each water level measurement.

- The well cap will be removed and the well head allowed to vent for a short period of time.
- A new pair of latex gloves will be donned.
- The probe will lowered into the well until the meter indicates water is reached.

- The probe will be raised above the water level and slowly lowered again until water is indicated.

- The cable will be held against the side of the inner well at the point designated for water level measurements and a depth reading taken.

- This procedure will be followed three times or until a consistent value is obtained.

- The value will be recorded to the nearest 0.01 feet in a field notebook.

- The time of the measurement and the reference point on the well head will be recorded in a field notebook.

- The probe will be raised to the surface and, together with the amount of cable that was wetted in the well, will be decontaminated as described in **Appendix A**.

Tidal Corrections. Groundwater levels in wells that are tidally influenced will rise and fall throughout the day in response to the rise and fall of the Hackensack River. The magnitude of this fluctuation relative to the magnitude of the tidal change defines the tidal efficiency of the well. The time delay between the river fluctuation and the associated groundwater fluctuation is the tidal lag. The objective of tidal corrections is to determine the average groundwater elevation in a tidally-influenced well. Wells affected by the tides are generally within 500 feet of the river and are screened below the Meadow Mat. A list of the wells that are tidally influenced is provided in **Table D.** The tidal efficiency and tidal lag values shown on **Table D** were determined during prior tidal studies using pressure transducers. The tidal correction procedure for each well is as follows.

1. Hackensack river tidal fluctuations are plotted for a 5-day period centered on the date of the manual groundwater measurement. Tidal data are recorded in 6-minute intervals at the tide gauge on the SA-7 bulkhead.

2. A graph of the predicted groundwater fluctuations in the well of interest is then generated for this 5-day period based on the tidal lag and efficiency properties of the well as shown on **Table D**.

3. The date and time of the manual groundwater measurement is located on this chart and the correction amount is calculated as the difference between the manually- measurement head and the average head for this well during the 5-day period.

4. The calculated head correction value is then added to, or subtracted from, the measured (raw) groundwater elevation to determine the corrected groundwater elevation for that well. For example, if the measurement was taken at time when groundwater levels in this well are predicted to be above

the average, the correction value is subtracted from the manual reading and vice versa.

2.2 Groundwater Sample Collection

Groundwater sample collection for laboratory analysis is required in the various monitoring plans listed on **Table B**. The associated consent order or consent decree that requires these plans to be implemented is listed in column C on **Table B**. The individual wells associated with each plan are identified on **Sub-tables B-1 through B-8** and a key to the appropriate Sub-table is provided in column F. The frequency of sampling varies from approximately every six weeks as part of the S-3 injection mass removal effort, to quarterly and annually for other plans. In most monitoring plans, the frequency decreases over time to annual or biennial after two years.

Accuracy and consistency in groundwater sampling methods are critical and thus, groundwater sample collection will be conducted using a dedicated field team familiar with the nuances associated with the various well locations.

Field Procedures.

- A well maintenance check that includes visual observation of the condition of the protective casing and surface seal will be performed. In addition, the well will be checked for other signs of damage or unauthorized entry.
- Plastic sheeting will be placed on the ground around the well (on the up-wind side of well) for a clean work area.
- The well cap will be removed and the well head allowed to vent for a short period of time before collecting a water level measurement.
- The static water level in each well/piezometer will be measured manually and recorded.
- The Grunfos Redi-flow 2 submersible sampling pump will be placed in the well such that the intake is in the middle of the screened interval.
- The gasoline-powered electric generator will be positioned down-wind and as far from the well as feasible.
- The discharge tubing from the pump will be attached to the in-line flow cell fitted with the probes to monitor the appropriate indicator parameters.
- The generator will be started and the control box used to set the pumping rate.
- The pump discharge rate will be measured and calculated using a graduated vessel and stop watch.
- The static water level in each well/piezometer will be measured manually and recorded.
- The discharge rate will be adjusted to minimize drawdown.

- Purging will continue until three consecutive readings have stabilized as follows:
  - pH (+/- 0.1 pH units)
  - Specific Conductivity (+/- 3%)
  - Temperature (+/- 3%)
  - ORP (+/- 10mv)
  - Dissolved Oxygen (+/- 10%)
  - Turbidity (+/- 10%)
- Upon stabilization, samples will be collected in appropriate containers in accordance with the analytical methods as provided in **Table C**. Each container will be filled to the appropriate volume required for analysis. VOC vials will be filled to capacity, with no head space.

Sample Labeling and Handling. Samples destined for chemical analysis will be given sample designations. Sample designations will consist of the following information:

- Project name
- Sample identification
- Sample location
- Sample date and time
- Sample matrix
- Analyses to be performed
- Sample preservation, if appropriate.

The sample designation information will be printed on a waterproof label affixed to each sample container. Upon collection of each analytical sample, it will immediately be placed in a cooler. The contents of the cooler will be maintained at approximately 4°C with ice or cold packs. At the end of each day, the samples will be packed in the cooler(s) and prepared for pickup. The appropriate chain-of-custody form will be completed and the sampler's copies retained. The remaining copies will be placed inside a zip-lock bag and taped to the inside of the respective cooler lid. Sufficient ice/cold packs will be added to the cooler to ensure 4°C is maintained during delivery/shipment. The lid will then be closed and securely taped using nylon fiber strapping or duct tape. Two signed and dated custody seals will be affixed across the seam of the cooler/lid (one on the front of the cooler and the other on the back).

Field QA/QC Samples. In addition to groundwater samples from the identified wells, one set of QA/QC samples will also be submitted for analysis for those events which consists of between five and twenty field samples (wells). If more than 20 field samples are collected, a second set of QA/QC samples will be submitted for analyses and will be associated with this second "batch" of samples, and so on. Each batch of 20 (or fewer) samples will include the following QA/QC samples:

- One field duplicate
- One equipment rinsate blank
- One matrix spike and one matrix spike duplicate
- One trip blank per cooler containing samples for VOC analysis.

2.3 Laboratory Analysis and Reporting

The laboratory analyses of groundwater samples will be performed by AccuTest Laboratories in Dayton, New Jersey. The analytical methods, containers, preservatives, and hold times are provided on **Table C**. Due to the relatively short hold time for hexavalent chromium, samples should be collected as late in the day as feasible and a pickup arranged as early in the day as feasible. Coordination between the laboratory and field staff on meeting hold times should be conducted by the project manager in advance of the sampling event. Special arrangements may be necessary when samples are collected on a Friday and need to be analyzed on the following Saturday. In general, sampling on Friday should be avoided.

Laboratory deliverables will include electronic transfer of data both Excel spreadsheet and Access database formats, and in hardcopy. Case narratives describing observations made in the lab or the reasons for any "qualified" data will be provided in PDF format and in hardcopy. Standard turn-around time for this project is 2 weeks unless otherwise requested.

3 ANNUAL REPORTING

Groundwater data collected as part of the IGMP will be compiled and reported on an annual basis. Requirements for more frequent reporting (S-3 injection plan for example), will met through supplemental submissions as necessary. An outline of the proposed report format is provided as **Attachment B**. The primary section headings are:

General Conditions.

This section will summarize factors that have influenced groundwater conditions during the year, such as the total annual precipitation, significant storm events, and subsurface remedies that were completed such as barrier walls, caps, or dewatering operations. Changes to the monitoring well network will also be documented in this section. This may include wells that were temporarily out of service due to soil surcharging operations, wells that were permanently abandoned within the SA-6 North and South containment cells, and wells that were added/replaced. The results of the "well search" of NJDEP files required for the biennial certification of the groundwater Classification Exception Areas (CEA) will also be reviewed and reported in the Annual Integrated Groundwater Performance Report.

Groundwater Extraction.

This section will document groundwater pumping history and rate for the GWET system and the contingent pumping systems that may have been in operation at SA-6 North, SA-6 South, and NJCU. The data will be provided in tables and graphs as appropriate.

Hydraulic Monitoring

This section will include groundwater level data in tabular form and groundwater elevation contour maps of the four flow zones based on the quarterly data. Subsections will be provided for each Study Area to include various tables and charts illustrating the performance of the local hydraulic remedy. For the GWET system this will include the capture zone of the downgradient extraction wells, and for the other Study Areas, it will include a comparison of hydraulic gradients across the barrier walls with the site-specific performance criteria.

The water-level data will be examined to ensure that hydraulic gradients meet the requirements of remediation plans such as:

- Outward gradient from SA7
- Inward gradient into containment cells on SA6 North and South
- Inward hydraulic gradients on the New Jersey City University property

- Plume capture by the GWET system.

Groundwater Quality Monitoring.

This section will include groundwater quality data in tabular form and groundwater concentration maps of the four flow zones based on the annual LTMP sampling round. Subsections will be provided for each Study Area to include various tables and charts illustrating the local groundwater quality. Time-series charts depicting water quality trends in the GWET extraction wells, injection wells, and monitoring wells in this program will also be provided.

In general, detections of chromium above the New Jersey Ground Water Quality Standard of 0.07 ppm in a well that previously met the standard, or a substantial increase in chromium concentrations, will require further evaluation. *A detection of hexavalent chromium in a well where hexavalent chromium was not previously detected will also be noted."* Major ion data from the one-time sampling of "L" and "T" horizons will be evaluated to confirm slow movement of groundwater in that area.

S-3 Injection and Mass Removal Program.

This section will summarize the performance of the S-3 mass removal (reductant injection) program during the year. Tabulations of the amount of reductant and water injected (by well), the sulfide content of the calcium polysulfide, and the stoichiometric equivalent amount of hexavalent chromium that has been treated will be provided in tables and graphs.

Conclusions and Recommendations

This section will summarize the performance of the various groundwater remedies and recommend modifications to the plan as appropriate. These recommendations may include:

- Addition or subtraction of wells within the monitoring network
- Changes to water level and/or water quality sampling frequency
- Changes to analytical parameters/methods
- Changes to pumping rates
- Changes to performance criteria
- Other recommendations

APPENDIX A

DECONTAMINATION PROCEDURES

An important aspect of quality control is the decontamination of field equipment. Improperly cleaned equipment can lead to cross-contamination and misinterpretation of data. The decontamination procedures used in this project are outlined in the following paragraphs.

Water Level Indicators and Water Quality Probes
Upon completion of the measurement, the probe will decontaminated with the following procedure:

- Wipe with Nitric Acid (only if coated with non-Cr petroleum contaminants)
- Wash in potable water and non-phosphate detergent
- Rinse with potable water
- Rinse with deionized water

Redi-flow 2 Sampling Pump and Other Non-dedicated Sampling Equipment
Non-dedicated equipment used for the collection of samples will be decontaminated between each use by the following procedure.

- Submerge the pump in a clean bucket containing non-phosphate detergent and potable water and pump this mixture through the pump and flow-through cell.
- Pump deionized water through the pump and flow-through cell
- Replace tubing prior to sampling next well.
- Air dry
- Wrap in foil unless used immediately.

APPENDIX B

ANNUAL INTEGRATED GROUNDWATER MONITORING REPORT OUTLINE

1.0 INTRODUCTION
- *1.1 General*
- *1.2 Purpose and Objectives*
- *1.3 Status of Integrated Monitoring Requirements for 20xx*
- *1.4 Document Organization*

2.0 GENERAL CONDITIONS
- *2.1 Annual Precipitation*
- *2.2 Tidal Monitoring*
- *2.3 Monitoring Well Inventory*

3.0 GROUNDWATER EXTRACTION
- *3.1 GWET System Operation*
  - *3.1.1 Pumping Rates*
  - *3.1.2 Force Main Acid Flushing*
  - *3.1.3 Well Redevelopment*
- *3.2 SA-6 North Contingent Pumping System*
- *3.3 SA-6 South Contingent Pumping System*
- *3.4 SA-5 NJCU Contingent Pumping System*

4.0 HYDRAULIC MONITORING
- *4.1 Regional Groundwater Flow*
  - *4.1.1 Shallow Zone*
  - *4.1.2 Intermediate Zone*
  - *4.1.3 Deep Zone*
  - *4.1.4 Bedrock Zone*
- *4.2 GWET System Capture Zone*
- *4.3 New Jersey City University*
- *4.4 SA-7 Perimeter Pools*
- *4.5 SA-6 North Containment Cell*
- *4.6 SA-6 South Containment Cell*
- *4.7 SA-5 Site 117*
- *4.8 Miscellaneous Events*

LIST OF FIGURES

LIST OF TABLES

APPENDICES

1" 3/4" 1/2" 1/4" 0" 1"

N

SA6-MW-AA1
087-MW-U28
087-MW-W25
087-MW-029
087-MW-119
087-MW-I30
087-MW-120
087-MW-Y20
087-PZ-001
087-MW-023
RIVER
087-PZ-005
087-MW-S19
087-MW-102
087-MW-101
087-MW-121
087-MW-A26
115-W1-SO
079-MW-01
087-MW-019
087-PZ-003
HACKENSACK
073-MW-BB11
115-W3-SO
079-MW-A2
073-PZ-001
087-MW-001
073-MW-5
079-MW-C6
163-MW-CC08
073-MW-Y10
088-PZ-003
088-MW-103
115-E5-SO
088-MW-001
184-MW-04
088-MW-101
088-MW-102
134-MW-V09
088-PZ-001
134-PZ-001
134-PZ-003
184-MW-05
SUMP
BARRIER WALL
134-MW-Q08
088-MW-002
115-W5-SO
184-MW-06
140-PZ-001
SUMP B
184-MW-C10
140-MW-06
125-PZ-001
163-MW-R05
115-E3-SO
140-MW-07
125-MW-01
090-PZ-05
117-MW-A99
140-MW-08
117-MW-S4
140-MW-1R
115-E1-SO
090-PZ-06
140-MW-04
125-PZ-002
124-MW-06
154-MW-D01
115-E2-SO
124-MW-09
090-MW-F14
117-MW-A82
154-MW-A01
154-MW-E08
124-MW-02
117-MW-A85
154-MW-A5A
154-MW-C6A
124-MW-07
154-MW-B6A
124-MW-10
154-MW-A06
117-MW-A05
117-MW-A89
124-MW-11
153-MW-A13
117-MW-A14
153-MW-A15
153-MW-02

LEGEND:

154-MW-E08 SHALLOW MONITORING WELL

154-MW-E08 ABANDONED WELL

0 400 800

SCALE IN FEET

HONEYWELL

GWET LTMP

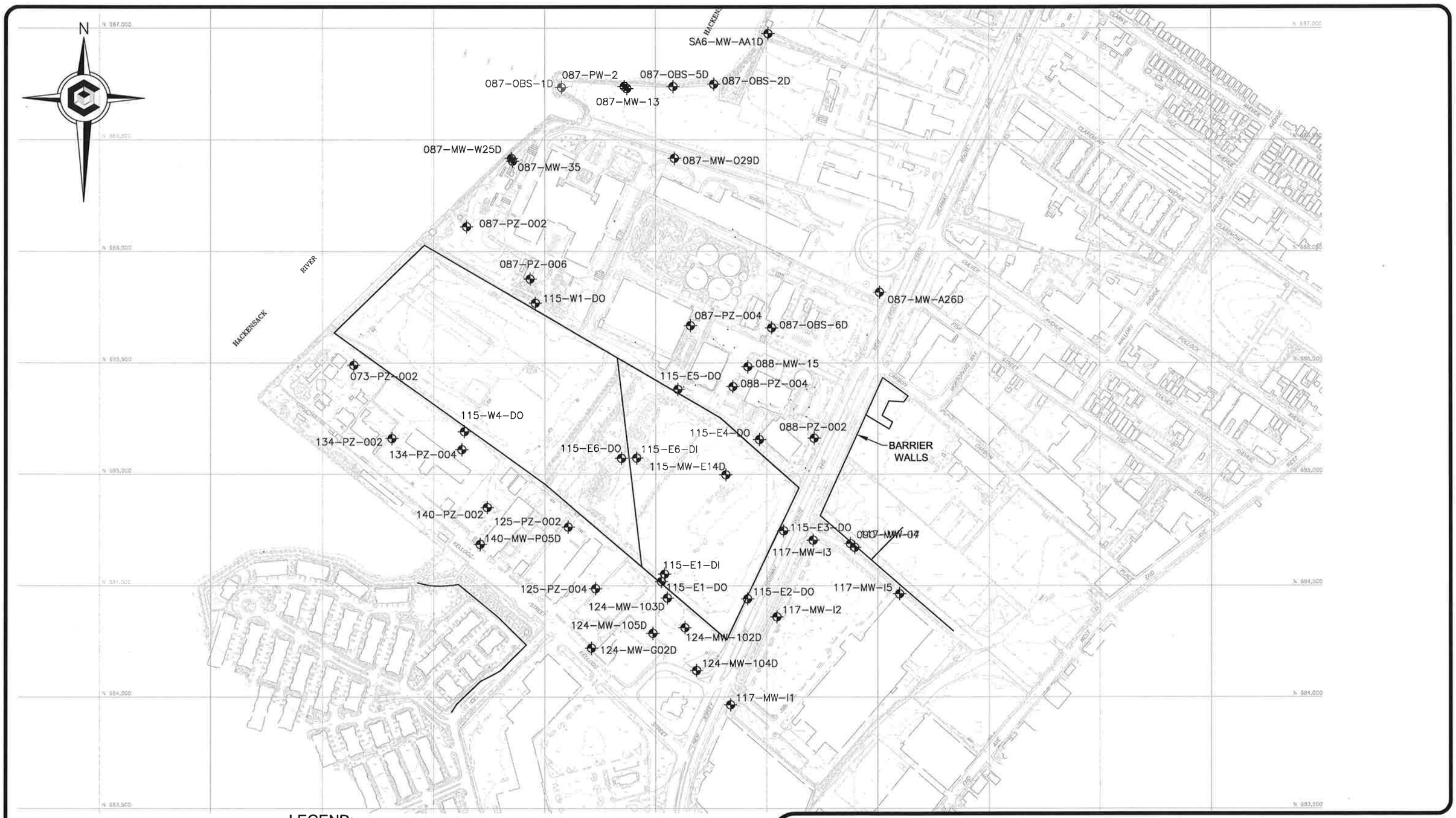
GROUNDWATER LEVEL MONITORING WELLS SHALLOW ZONE

FIGURE NO.

A-1a

PROJECT NO.

File: X:\PROJECTS\HONEYWELL\090354 - SA7_PROJECT DRAWINGS\2014 WELL SAMPLING FIGURES\MIHONSF-A-1a.dwg Layout: FIGURE 2-2 SHALLOW ZONE User: magdc.mendola Apr 29, 2014 - 12:27pm



LEGEND:

087-MW-029D INTERMEDIATE ZONE MONITORING WELL

154-MW-E08 ABANDONED WELL

0 400 800

SCALE IN FEET

CORNERSTONE Environmental Group, LLC

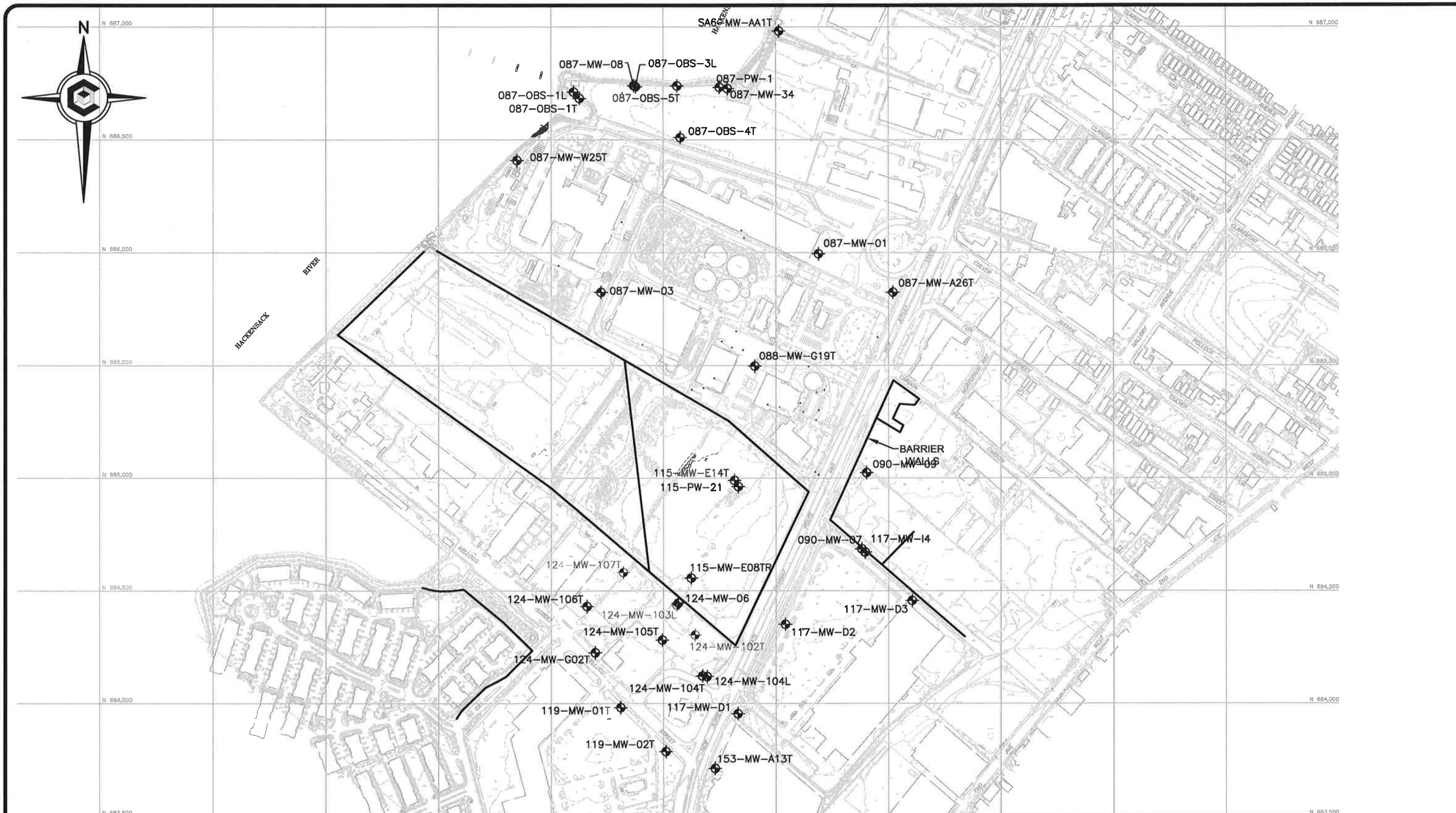
HONEYWELL

GWET LTMP
GROUNDWATER LEVEL MONITORING WELLS
INTERMEDIATE ZONE

FIGURE NO. A-1b

PROJECT NO.

File: X:\PROJECTS\HONEYWELL\090354 - SA7_PROJECT DRAWINGS\2014 WELL SAMPLING FIGURES\MIHONSF-A-1b.dwg Layout: FIGURE 4-2 INTERMEDIATE ZONE User: magda.mendola Apr 29, 2014 - 12:30pm



LEGEND:

087-MW-029D DEEP ZONE MONITORING WELL

087-MW-029D ABANDONED WELL

0 400 800

SCALE IN FEET

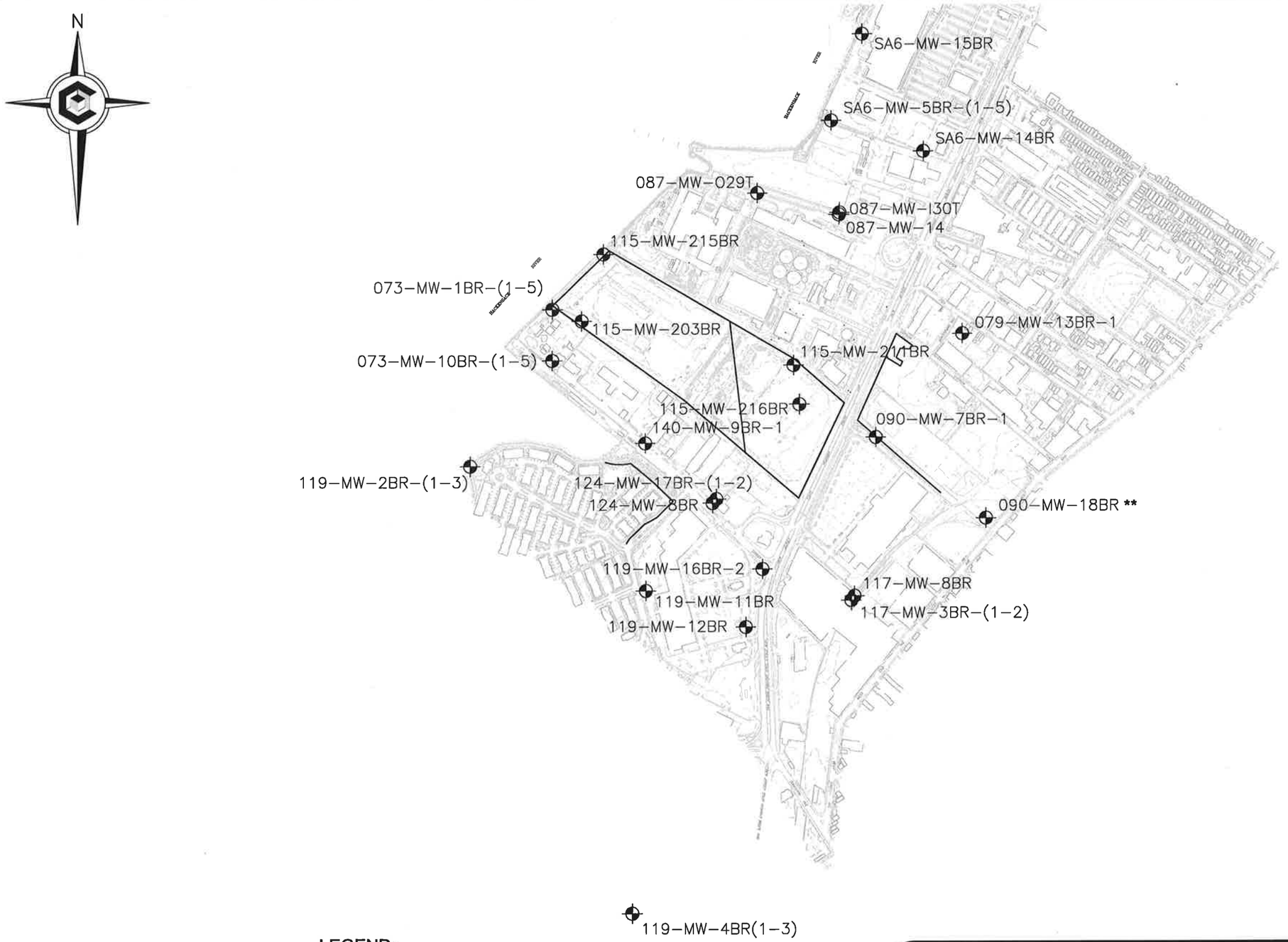
CORNERSTONE
Environmental Group, LLC

HONEYWELL

GWET LTMP
GROUNDWATER LEVEL MONITORING WELLS
DEEP ZONE

FIGURE NO.
A-1c
PROJECT NO.

File: X:\PROJECTS\HONEYWELL\090354 - SA7_PROJECT DRAWINGS\2014 WELL SAMPLING FIGURES\MIHONSF-A-1c.dwg Layout: FIGURE A-1c User: magda.mendola Apr 29, 2014 - 12:33pm



0 750 1500

SCALE IN FEET

LEGEND:

119-MW-11BR **BEDROCK ZONE MONITORING WELL**

* **INOPERATIVE IN 2013: STATUS UNDER EVALUATION**

** **ABANDONED BY NJCU CONTRACTORS: STATUS UNDER EVALUATION**

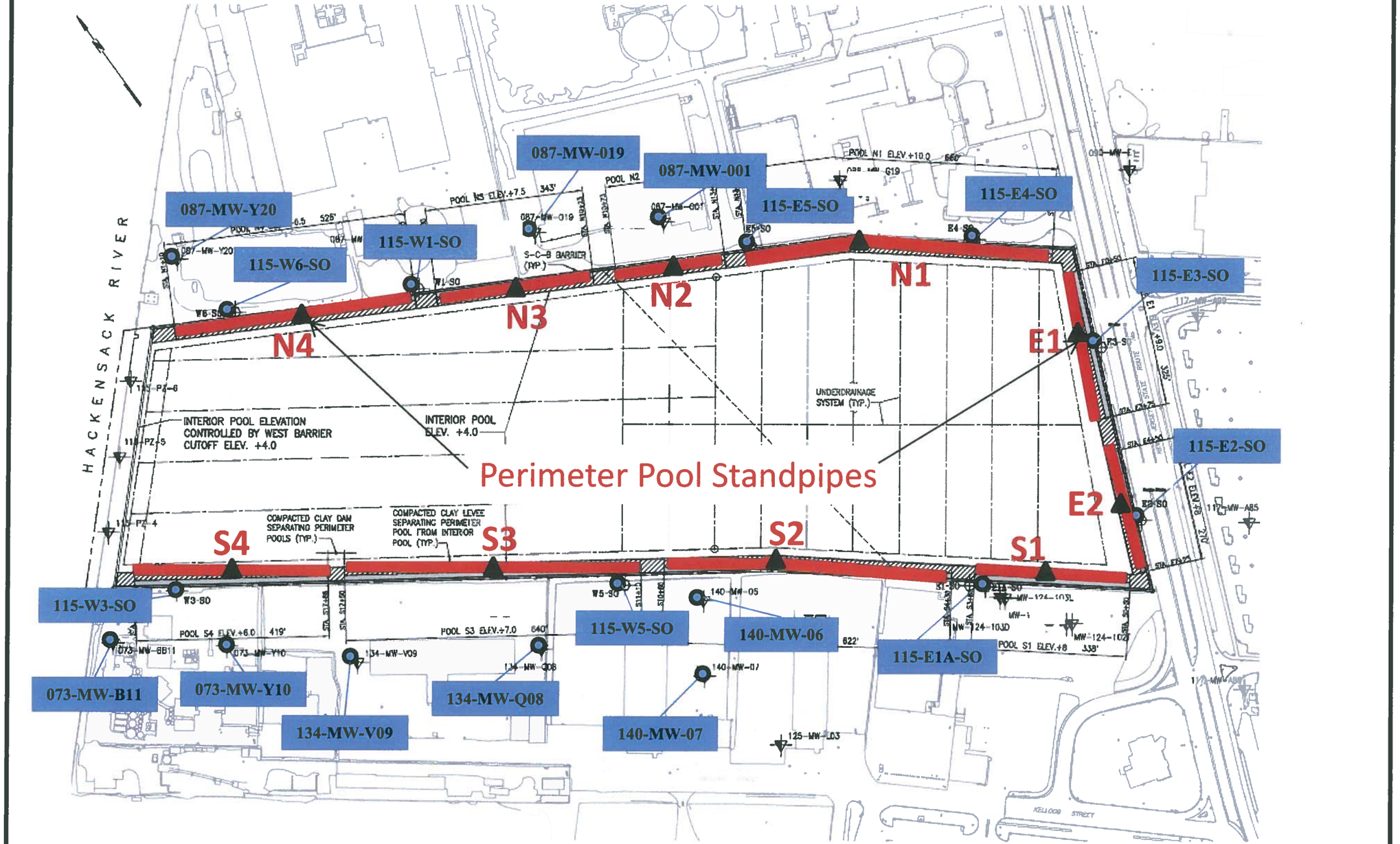
CORNERSTONE Environmental Group, LLC

HONEYWELL

GWET LTMP
GROUNDWATER LEVEL MONITORING WELLS
BEDROCK ZONE

FIGURE NO. **A-1d**

PROJECT NO.

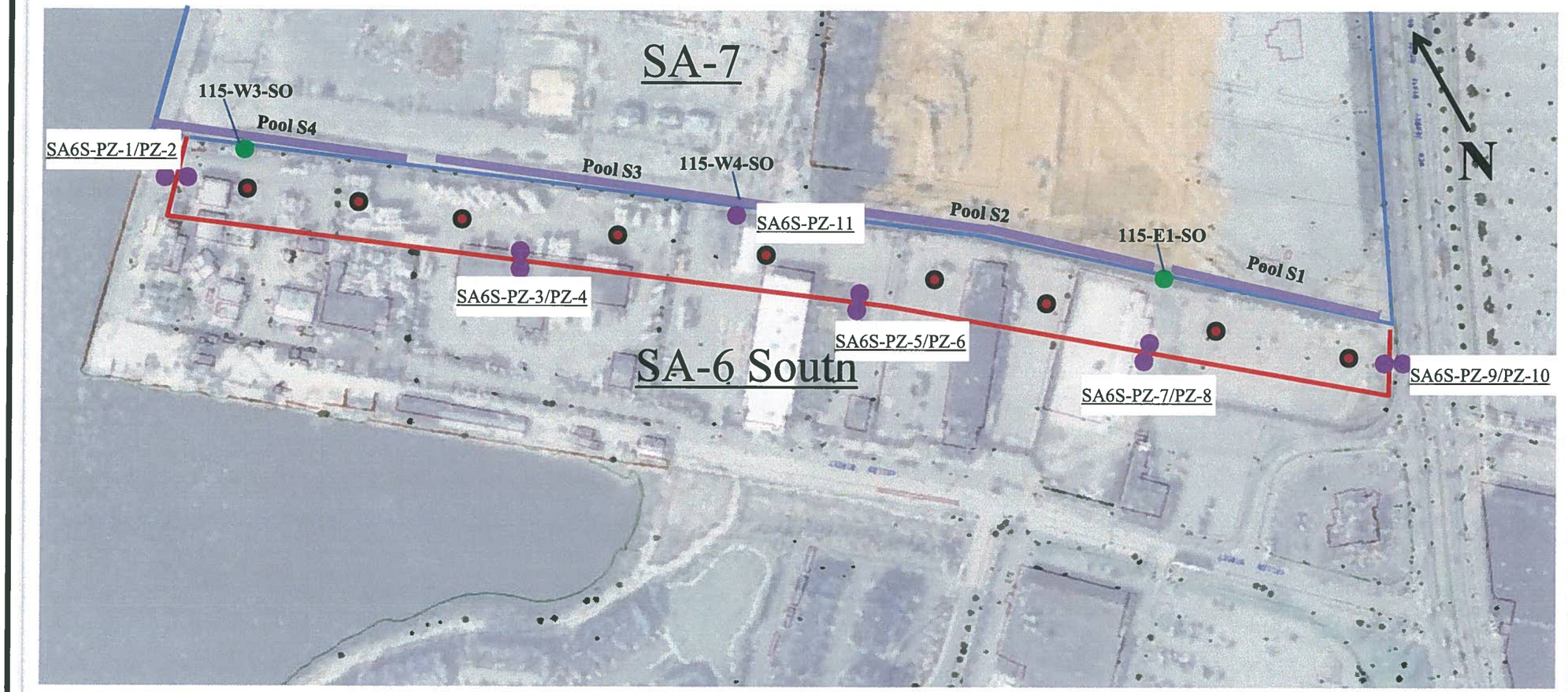


115-W3-SO

CORNERSTONE Engineering Group, LLC

HONEYWELL
Jersey City, New Jersey
SA-7 Perimeter Pool Monitoring Locations

Figure
A-2



NTS

LEGEND

SA-7 SCB

SA-6S Hydraulic Barrier

SA-7 Perimeter Pool

Pool S4

115-W4-SO Existing Piezometer

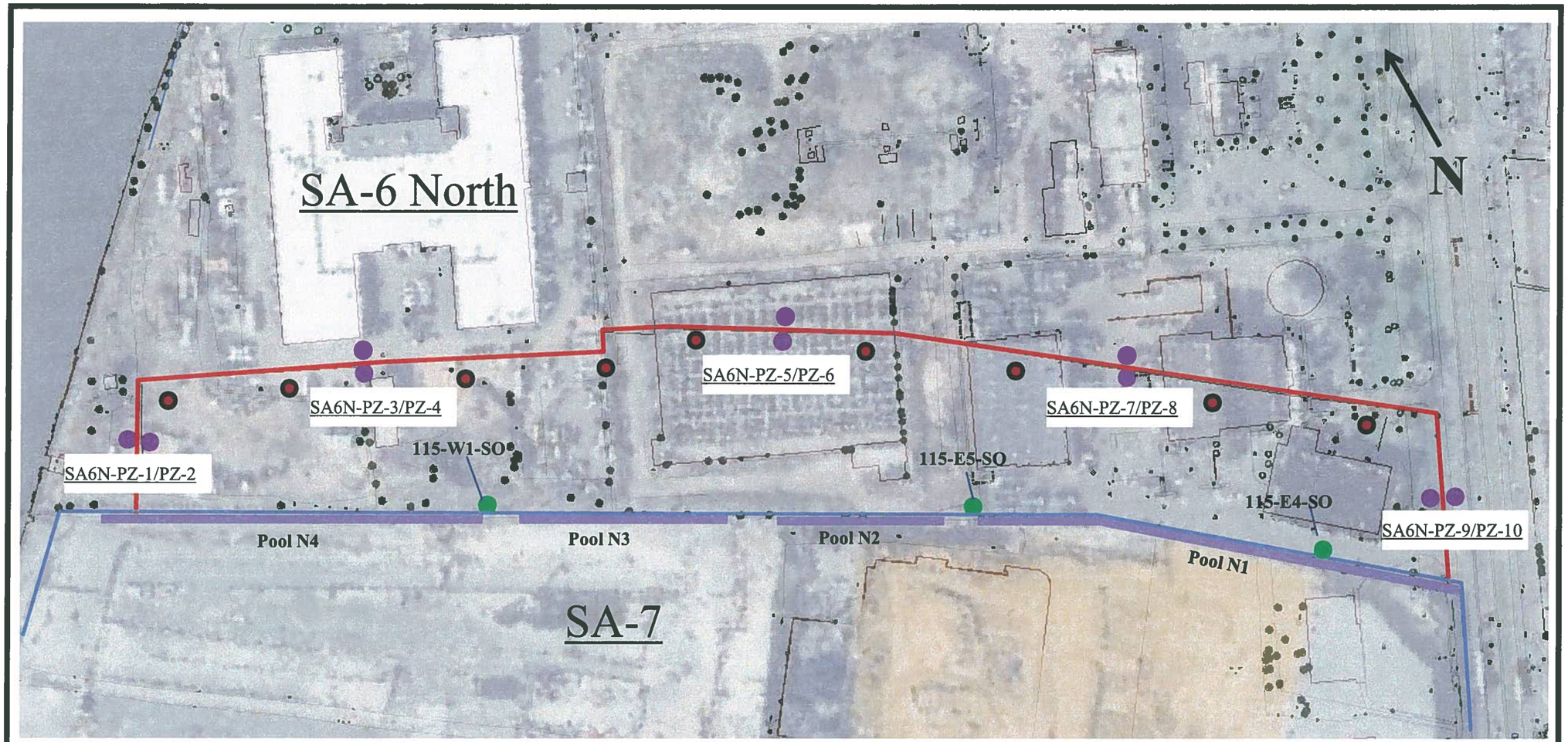
Proposed Piezometer

Contingent Pumping Well

FIGURE A-3

Groundwater Level Monitoring Plan Locations - SA-6 South

Study Areas 6 North & South
Jersey City, NJ



NTS

LEGEND

- SA-7 SCB
- SA-6N Hydraulic Barrier
- SA-7 Perimeter Pool (Pool S4)
- Existing Piezometer
- Proposed Piezometer
- Contingent Pumping Well

FIGURE A-4

Groundwater Level Monitoring Plan Locations – SA-6 North

Study Areas 6 North & South
Jersey City, NJ

1" 3/4" 1/2" 1/4" 0" 1"

N

RIVER

HACKENSACK

079-MW-01

079-MW-A2

184-MW-04

SUMP A

184-MW-05

SUMP B

184-MW-06

184-MW-S10

117-MW-A99

090-PZ-05

BARRIER WALLS

090-PZ-06

117-MW-A82

090-MW-F14

SOCIETY HILL SLURRY WALL

117-MW-A85

117-MW-A05

117-MW-A89

153-MW-A13

117-MW-A14

153-MW-A15

153-MW-02

153-MW-05

N 686,000

N 685,500

685,000

N 684,500

N 683,500

LEGEND:

90-MW-F14	SITE 90 + 184 LTMP
079-MW-A2	SITE 079 LTMP
154-MW-E08	SITE 153 SOUTH REMEDIAL ACTION PERMIT FOR GROUNDWATER
117-MW-A05	SITE 117 SOUTH REMEDIAL ACTION PERMIT FOR GROUNDWATER
90-MW-F14	SITE 90 + 184 LTMP

0 400 800

SCALE IN FEET

CORNERSTONE Environmental Group, LLC

HONEYWELL

STUDY AREA 5
GROUNDWATER MONITORING WELLS
SHALLOW ZONE

FIGURE NO.
A-5
PROJECT NO.

1" 1/4" 1/2" 3/4" 0" 1"

N

N 687,000
N 686,500
N 686,000
N 685,500
N 685,000
N 684,500
N 684,000
N 683,500

SA6-MW-AA1D

087-MW-W25D

087-MW-019D

087-MW-A26D

HACKENSACK RIVER

BARRIER WALLS

117-MW-I5

117-MW-I1

LEGEND:

087-MW-029D INTERMEDIATE ZONE MONITORING WELL

0 400 800

SCALE IN FEET

CORNERSTONE Environmental Group, LLC

HONEYWELL

GWET LTMP
GROUNDWATER QUALITY MONITORING WELLS
INTERMEDIATE ZONE

FIGURE NO.
B-1a
PROJECT NO.

1" 3/4" 1/2" 1/4" 0" 1"

N

SA6-MW-AA1T

087-MW-W25T

087-MW-A26T

HACKENSACK RIVER

124-MW-107T

115-MW-E08TR

124-MW-106T

117-MW-D3

124-MW-102T

124-MW-G02T

124-MW-104T

119-MW-01T

119-MW-02T

N 687,000
N 686,500
N 686,000
N 685,500
N 685,000
N 684,500
N 684,000
N 683,500

LEGEND:

087-MW-08	DEEP ZONE MONITORING WELL
087-MW-08	ABANDONED WELL

0 400 800

SCALE IN FEET

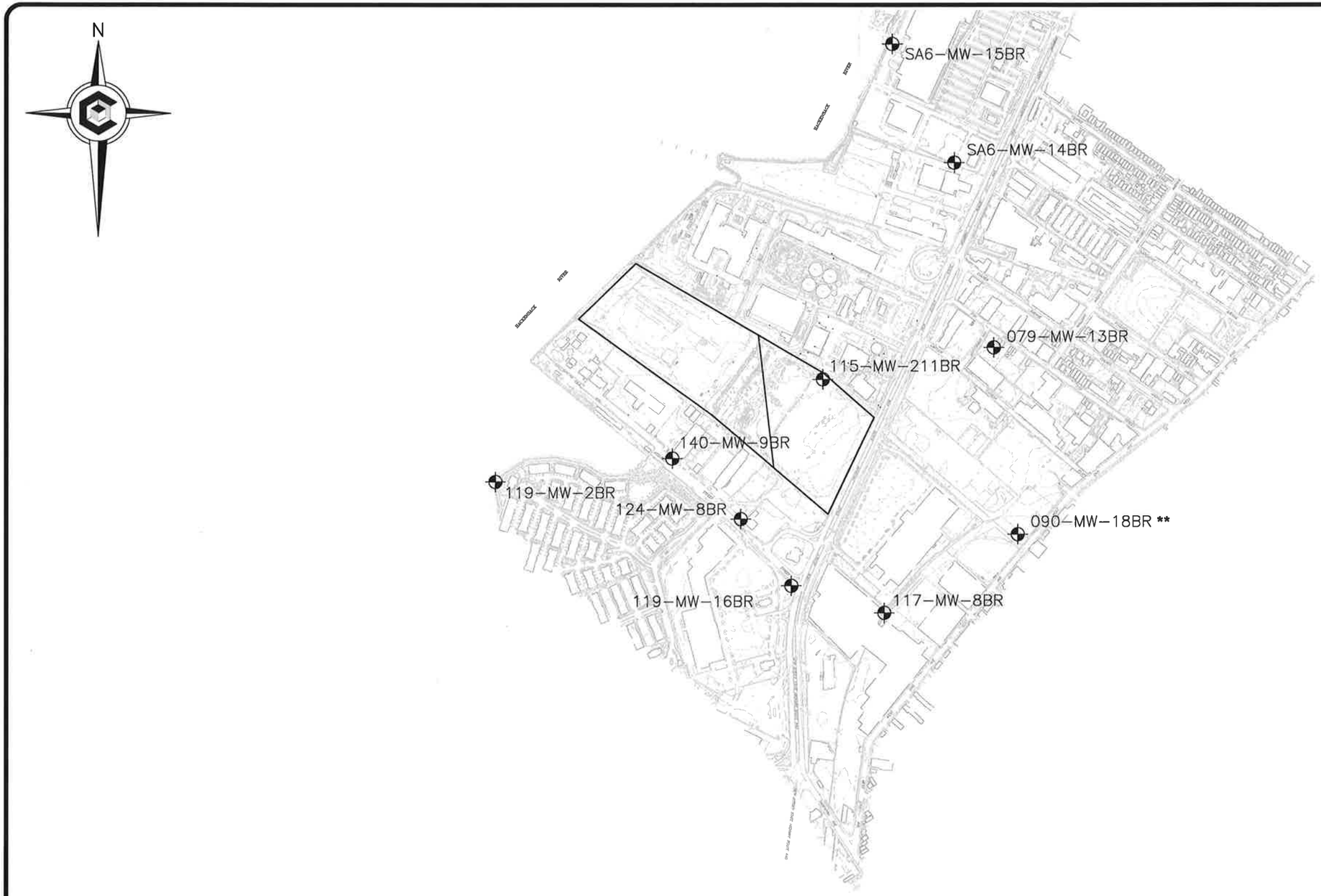
CORNERSTONE Environmental Group, LLC

HONEYWELL

GWET LTMP
GROUNDWATER QUALITY MONITORING WELLS
DEEP ZONE

FIGURE NO.
B-1b
PROJECT NO.

File: X:\PROJECTS\HONEYWELL\090354 - SA7_PROJECT DRAWINGS\2014 WELL SAMPLING FIGURES\MIHONSF-B-1b.dwg Layout: FIGURE 4-3 DEEP ZONE User: magda.mendola Apr 29, 2014 - 12:19pm



0 750 1500

SCALE IN FEET

LEGEND:

119-MW-11BR **BEDROCK ZONE MONITORING WELL**

* **INOPERATIVE IN 2013: STATUS UNDER EVALUATION**

** **ABANDONED BY NJCU CONTRACTORS: STATUS UNDER EVALUATION**

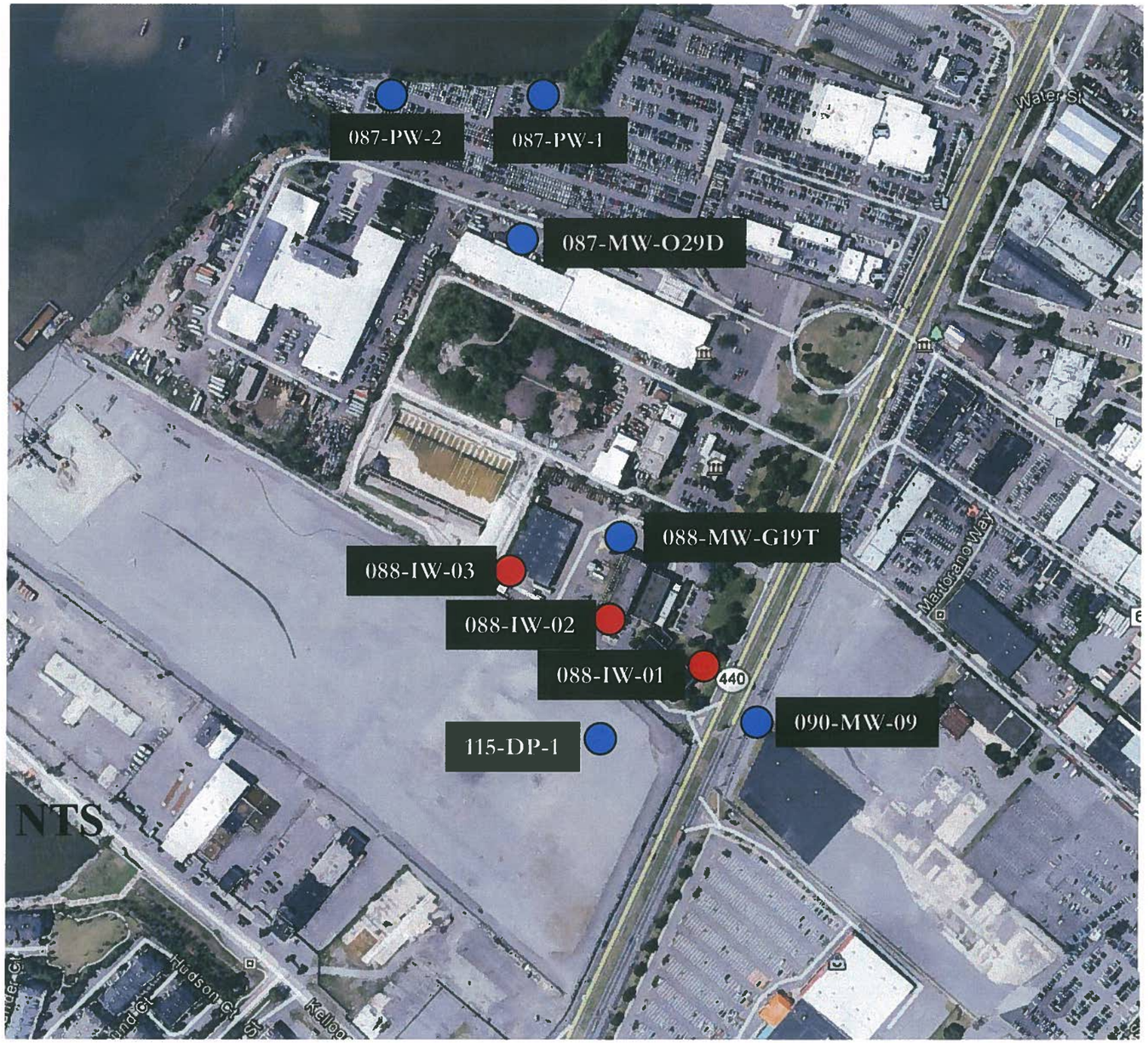
CORNERSTONE Environmental Group, LLC

HONEYWELL

GWET LTMP
GROUNDWATER QUALITY MONITORING WELLS
BEDROCK ZONE

FIGURE NO. **B-1c**

PROJECT NO.



LEGEND

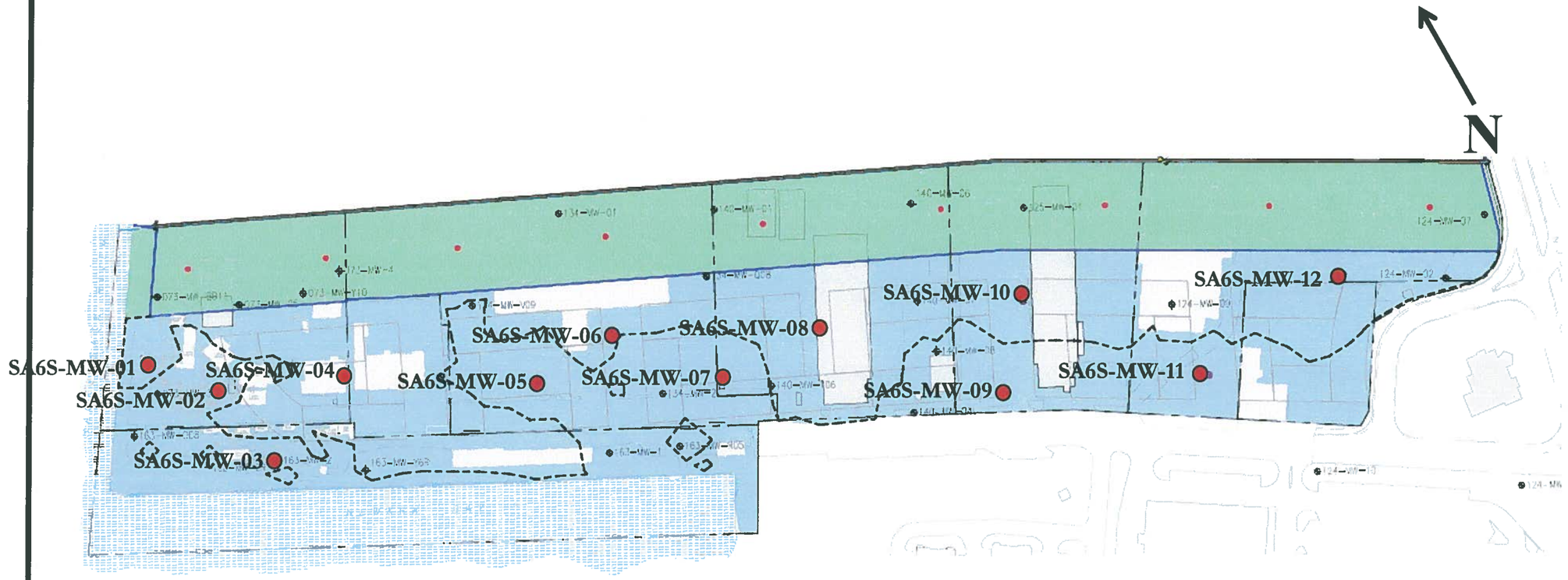
N

- Monitoring Well
- Injection Well

FIGURE B-2

S-3 Injection Mass Removal Plan
Monitoring Locations

Study Areas 6 North & South
Jersey City, NJ



LEGEND

● Monitoring Well (to be installed)

NTS

FIGURE B-3

SA-6 South Development AOC
Monitoring Locations

Study Areas 6 North & South
Jersey City, NJ

LEGEND:

087-MW	DEEP ZONE MONITORING WELL
087-MW-08	ABANDONED WELL

0 400 800
SCALE IN FEET

CORNERSTONE
Environmental Group, LLC

HONEYWELL

SA-6 SOUTH "L ZONE" GROUNDWATER MONITORING WELLS DEEP ZONE

FIGURE NO.
B-4
PROJECT NO.

File: X:\PROJECTS\HONEYWELL\090354 - SA7_PROJECT DRAWINGS\2014 WELL SAMPLING FIGURES\MIHONSF-03.dwg Layout: FIGURE 4-3 DEEP ZONE User: Blayne.Gibbons Mar 06, 2014 - 3:48p

1" 3/4" 1/2" 1/4" 0" 1"

N

RIVER

HACKENSACK

079-MW-01

079-MW-A2

184-MW-04

184-MW-05

184-MW-06

117-MW-A09

BARRIER WALLS

117-MW-A82

117-MW-A85

117-MW-A05

117-MW-A89

153-MW-A13

117-MW-A14

153-MW-A15

SOCIETY HILL SLURRY WALL

N 685,000

N 684,500

LEGEND:

90-MW-F14	SITE 90 & 184 LTMP
079-MW-A2	SITE 079 LTMP
154-MW-E08	SITE 153 SOUTH REMEDIAL ACTION PERMIT FOR GROUNDWATER
117-MW-A05	SITE 117 SOUTH REMEDIAL ACTION PERMIT FOR GROUNDWATER

0 400 800

SCALE IN FEET

CORNERSTONE Environmental Group, LLC

HONEYWELL

STUDY AREA 5
GROUNDWATER MONITORING WELLS
SHALLOW ZONE

FIGURE NO.
B-5
PROJECT NO.

TABLE A
GROUNDWATER LEVEL MONITORINGREQUIREMENTS
for Integrated Groundwater Monitoring Plan

A	B	C	D	E	F	F	G				
Location	**Monitoring Plan**	**Consent Decree**	**Depth**	**Frequency**	**# Wells (ref table)**	**Figure Ref. #**	**Estimated Start Date**	**Qtr1**	**Qtr2**	**Qtr3**	**Qtr4**
Regional[1]	GWET Long Term Monitoring Plan June 10, 2008	Deep Overburden and Bedrock Groundwater Remedies Consent Order	All Zones	Quarterly	150 (A-1)	A-1	On-going	x	x	x	x
Study Area 7	SA-7 Perimeter Pools	Final Judgement, ICO v Honeywell	Shallow and Interm.	Monthly	30 (A-2)	A-2	On-going	x(3)	x(3)	x(3)	x(3)
SA-6 South	SA-6 South GW Level Monitoring Plan Appendix J of SA-6 South 100% Design June 28, 2013	First Amended Consent Decree Regarding Remediation and Redevelopment of SA-6 South	Shallow and Interm.	1st year - Monthly 2nd year - Quarterly 3rd year -Semi-Annual	13 (A-3)	A-3	Post Remedy (2017)				
SA-6 North	SA-6 North GW Level Monitoring Plan Appendix J of SA-6 North 100% Design June 28, 2013	First Amended Consent Decree Regarding Remediation and Redevelopment of Study Area 6 North	Shallow and Interm.	1st year - Monthly 2nd year - Quarterly 3rd year -Semi-Annual	13 (A-4)	A-4	Post Remedy (2017)				
Study Area 6 N&S	"Long Term Monitoring Plan" Due October 1, 2015	Same Consent Decrees as Above for SA-6 South and SA-6 North	Shallow	Quarterly	TBD	TBD	Post Remedy (2017)				
SA-5 (NJCU) Sites 90 & 184	Long Term Monitoring Plan (2/29/12)[2]	Consent Decree Regarding Remediation of the New Jersey City University Redevelopment Area	Shallow	Quarterly through 2013 future TBD[2]	7 (A-5)	A-5	On-going	x	x	x	x
SA-5: Site 079	"Long Term Monitoring Plan" (9/07/11)[3]	Consent Decree Regarding Remediation of the Study Area 5 Shallow Groundwater and the Site 79 Residential Properties	Shallow	March 2014 then Annual	2 (A-6)	A-5	On-going				x
SA-5: Site153 South	Remedial Action Permit for GW[4]	Consent Decree Regarding Sites 79 and 153 South	Shallow	Annual	2 (A-7)	A-5	2015				
SA-5 Site 117	Remedial Action Permit for GW[4]	Consent Decree Regarding Remediation of the Study Area 5 Shallow Groundwater and the Site 79 Residential Properties	Shallow	Annual	7 (A-8)	A-5	2015				

[1] Includes available wells on SA-5, SA-6, SA-7, and surrounding areas historically considered part of the Deep Overburden Plume investigation..

[2]Post-remedy triggers plan under NJCU Consent Decree; plan expected to be updated 1st quarter 2014; future monitoring frequency TBD pending updated LTMP

[3]Plan currently being updated

[4]Remedial Action Permit application in progress

TABLE A
GROUNDWATER LEVEL MONITORINGREQUIREMENTS
for Integrated Groundwater Monitoring Plan

A	B																			
Location	**Monitoring Plan**	**Qtr1**	**Qtr2**	**Qtr3**	**Qtr4**	**Qtr1**	**Qtr2**	**Qtr3**	**Qtr4**	**Qtr1**	**Qtr2**	**Qtr3**	**Qtr4**	**Qtr1**	**Qtr2**	**Qtr3**	**Qtr4**	**Qtr1**	**Qtr2**	**Qtr3**	**Qtr4**
Regional[1]	GWET Long Term Monitoring Plan June 10, 2008	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Study Area 7	SA-7 Perimeter Pools	x(3)	x(3)	x(3)	x(3)	x(3)	x(3)	x(3)	x(3)	x(3)	x(3)	x(3)	x(3)	x(3)	x(3)	x(3)	x(3)	x(3)	x(3)	x(3)	x(3)
SA-6 South	SA-6 South GW Level Monitoring Plan Appendix J of SA-6 South 100% Design June 28, 2013	SA-6 North and South Construction												12-month equilibrium period				x(3)	x(3)	x(3)	x(3)	x	x	x
SA-6 North	SA-6 North GW Level Monitoring Plan Appendix J of SA-6 North 100% Design June 28, 2013	SA-6 North and South Construction												12-month equilibrium period				x(3)	x(3)	x(3)	x(3)	x	x	x
Study Area 6 N&S	"Long Term Monitoring Plan" Due October 1, 2015	SA-6 North and South Construction												12-month equilibrium period				x	x	x	x	x	x	x
SA-5 (NJCU) Sites 90 & 184	Long Term Monitoring Plan (2/29/12)[2]	TBD																			
SA-5: Site 079	"Long Term Monitoring Plan" (9/07/11)[3]					x				x				x				x			
SA-5: Site153 South	Remedial Action Permit for GW[4]									x				x				x			
SA-5 Site 117	Remedial Action Permit for GW[4]									x				x				x			

[1] Includes available wells on SA-5, SA-6, SA-7, and surrounding areas historically considered part of the Deep Overburden Plume investigation..

[2]Post-remedy triggers plan under NJCU Consent Decree; plan expected to be updated 1st quarter 2014; future monitoring frequency TBD pending updated LTMP

[3]Plan currently being updated

[4]Remedial Action Permit application in progress

Table A-1
Monitoring Wells for Groundwater Level Measurements
GWET Long-term Monitoring Plan

(refer to Figures A-1a through A-1d)

Monitoring Zone	Well ID	Comments
Shallow	073-MW-5	
Shallow	073-MW-BB11	Abandonded Feb. 2014 for soil excavation
Shallow	073-MW-Y10	
Shallow	073-PZ-001	
Shallow	079-MW-01	
Shallow	079-MW-A2	
Shallow	079-MW-C6	
Shallow	087-MW-001	
Shallow	087-MW-101	
Shallow	087-MW-102	
Shallow	087-MW-119	
Shallow	087-MW-120	
Shallow	087-MW-121	
Shallow	087-MW-A26	
Shallow	087-MW-I30	
Shallow	087-MW-O19	Abandonded Feb. 2014 for soil excavation
Shallow	087-MW-O23	
Shallow	087-MW-O29	
Shallow	087-MW-S19	
Shallow	087-MW-U28	
Shallow	087-MW-W25	
Shallow	087-MW-Y20	Abandonded Feb. 2014 for soil excavation
Shallow	087-PZ-001	Abandonded Feb. 2014 for soil excavation
Shallow	087-PZ-003	
Shallow	087-PZ-005	Abandonded Feb. 2014 for soil excavation
Shallow	088-MW-001	Abandonded Feb. 2014 for soil excavation
Shallow	088-MW-002	
Shallow	088-MW-101	
Shallow	088-MW-102	
Shallow	088-MW-103	
Shallow	088-PZ-001	
Shallow	088-PZ-003	
Shallow	090-MW-F14	Abandoned for NJCU Development
Shallow	090-PZ-05	
Shallow	090-PZ-06	
Shallow	115-E1-SO	
Shallow	115-E2-SO	
Shallow	115-E3-SO	
Shallow	115-E5-SO	
Shallow	115-W1-SO	

Table A-1
Monitoring Wells for Groundwater Level Measurements
GWET Long-term Monitoring Plan

(refer to Figures A-1a through A-1d)

Monitoring Zone	Well ID	Comments
Shallow	115-W3-SO	
Shallow	115-W5-SO	
Shallow	117-MW-A05	
Shallow	117-MW-A14	
Shallow	117-MW-A62	
Shallow	117-MW-A85	
Shallow	117-MW-A89	
Shallow	117-MW-A99	
Shallow	117-MW-I4S	
Shallow	124-MW-02	Abandonded Oct. 2013 for soil excavation
Shallow	124-MW-06	Abandonded Oct. 2013 for soil excavation
Shallow	124-MW-07	Abandonded Oct. 2013 for soil excavation
Shallow	124-MW-09	Abandonded Oct. 2013 for soil excavation
Shallow	124-MW-10	
Shallow	124-MW-11	
Shallow	125-MW-01	Abandonded Feb. 2014 for soil excavation
Shallow	125-PZ-001	Abandonded Feb. 2014 for soil excavation
Shallow	125-PZ-003	Abandonded Feb. 2014 for soil excavation
Shallow	134-MW-2	
Shallow	134-MW-Q08	Abandonded Feb. 2014 for soil excavation
Shallow	134-MW-V09	
Shallow	134-PZ-001	Abandonded Feb. 2014 for soil excavation
Shallow	134-PZ-003	
Shallow	140-MW-04	
Shallow	140-MW-06	
Shallow	140-MW-07	
Shallow	140-MW-08	
Shallow	140-MW-1R	
Shallow	140-PZ-001	Abandonded Feb. 2014 for soil excavation
Shallow	153-MW-02	
Shallow	153-MW-05	
Shallow	153-MW-A13	
Shallow	153-MW-A15	
Shallow	154-MW-A01	
Shallow	154-MW-A06	
Shallow	154-MW-A5A	
Shallow	154-MW-B6A	
Shallow	154-MW-C6A	
Shallow	154-MW-D01	
Shallow	154-MW-E08	

Table A-1
Monitoring Wells for Groundwater Level Measurements
GWET Long-term Monitoring Plan

(refer to Figures A-1a through A-1d)

Monitoring Zone	Well ID	Comments
Shallow	163-MW-R05	Abandonded Feb. 2014 for soil excavation
Shallow	184-MW-001	
Shallow	184-MW-04	
Shallow	184-MW-05	
Shallow	184-MW-06	
Shallow	184-MW-C10	Abandoned for NJCU Development
Shallow	SA6-MW-AA1	
Shallow	Sump A	
Shallow	Sump B	
Intermediate	073-PZ-002	
Intermediate	087-MW-13	
Intermediate	087-MW-35	
Intermediate	087-MW-A26D	
Intermediate	087-MW-O29D	
Intermediate	087-MW-W25D	
Intermediate	087-OBS-1D	
Intermediate	087-OBS-2D	
Intermediate	087-OBS-5D	
Intermediate	087-OBS-6D	
Intermediate	087-PW-2	
Intermediate	087-PZ-002	Abandonded Feb. 2014 for soil excavation
Intermediate	087-PZ-004	
Intermediate	087-PZ-006	Abandonded Feb. 2014 for soil excavation
Intermediate	088-MW-15	
Intermediate	088-PZ-002	
Intermediate	088-PZ-004	
Intermediate	090-MW-07	
Intermediate	115-E1-DI	
Intermediate	115-E1-DO	
Intermediate	115-E2-DO	
Intermediate	115-E3-DO	
Intermediate	115-E4-DO	
Intermediate	115-E5-DO	
Intermediate	115-E6-DI	
Intermediate	115-E6-DO	
Intermediate	115-MW-20	
Intermediate	115-MW-E14D	
Intermediate	115-W1-DO	
Intermediate	115-W4-DO	
Intermediate	117-MW-I1	

Table A-1
Monitoring Wells for Groundwater Level Measurements
GWET Long-term Monitoring Plan

(refer to Figures A-1a through A-1d)

Monitoring Zone	Well ID	Comments
Intermediate	117-MW-I2	
Intermediate	117-MW-I3	
Intermediate	117-MW-I5	
Intermediate	124-MW-102D	Abandonded Oct. 2013 for soil excavation
Intermediate	124-MW-103D	Abandonded Oct. 2013 for soil excavation
Intermediate	124-MW-104D	Abandonded Oct. 2013 for soil excavation
Intermediate	124-MW-105D	Abandonded Oct. 2013 for soil excavation
Intermediate	124-MW-G02D	
Intermediate	125-PZ-002	Abandonded Feb. 2014 for soil excavation
Intermediate	125-PZ-004	Abandonded Feb. 2014 for soil excavation
Intermediate	134-PZ-002	
Intermediate	134-PZ-004	
Intermediate	140-MW-P05D	
Intermediate	140-PZ-002	Abandonded Feb. 2014 for soil excavation
Intermediate	SA6-MW-AA1D	
Deep	087-MW-01	
Deep	087-MW-03	
Deep	087-MW-08	
Deep	087-MW-34	
Deep	087-MW-A26T	
Deep	087-MW-W25T	
Deep	087-OBS-1L	
Deep	087-OBS-1T	
Deep	087-OBS-3L	
Deep	087-OBS-4T	
Deep	087-OBS-5T	
Deep	087-PW-1	
Deep	088-IW-01	
Deep	088-IW-02	
Deep	088-IW-03	
Deep	088-MW-G19T	
Deep	090-MW-09	
Deep	115-MW-A12T	
Deep	115-MW-E14T	
Deep	115-OMW-E08TR	
Deep	115-PW-21	
Deep	117-MW-D1	
Deep	117-MW-D2	
Deep	117-MW-D3	
Deep	117-MW-I4	

Table A-1
Monitoring Wells for Groundwater Level Measurements
GWET Long-term Monitoring Plan

(refer to Figures A-1a through A-1d)

Monitoring Zone	Well ID	Comments
Deep	119-MW-01T	
Deep	119-MW-02T	
Deep	124-MW-06	
Deep	124-MW-102T	Abandonded Oct. 2013 for soil excavation
Deep	124-MW-103L	Abandonded Oct. 2013 for soil excavation
Deep	124-MW-104L	
Deep	124-MW-104T	
Deep	124-MW-105T	
Deep	124-MW-106T	
Deep	124-MW-107T	Abandonded Oct. 2013 for soil excavation
Deep	124-MW-G02T	
Deep	153-MW-A13T	
Deep	SA6-MW-AA1T	
Bedrock	073-MW-10BR-1	
Bedrock	073-MW-10BR-2	
Bedrock	073-MW-10BR-3	
Bedrock	073-MW-10BR-4	
Bedrock	073-MW-10BR-5	
Bedrock	073-MW-1BR-1	
Bedrock	073-MW-1BR-2	
Bedrock	073-MW-1BR-3	
Bedrock	073-MW-1BR-4	
Bedrock	073-MW-1BR-5	
Bedrock	079-MW-13BR-1	
Bedrock	079-MW-13BR-2	
Bedrock	079-MW-13BR-3	
Bedrock	087-MW-14	
Bedrock	087-MW-I30T	
Bedrock	087-MW-O29T	
Bedrock	090-MW-18BR	Abandoned 2013: status under evaluation
Bedrock	090-MW-7BR-1	
Bedrock	090-MW-7BR-2	
Bedrock	090-MW-7BR-3	
Bedrock	115-MW-203BR	
Bedrock	115-MW-211BR	
Bedrock	115-MW-215BR	
Bedrock	115-MW-216BR	
Bedrock	117-MW-3BR-1	
Bedrock	117-MW-3BR-2	
Bedrock	117-MW-8BR	

Table A-1
Monitoring Wells for Groundwater Level Measurements
GWET Long-term Monitoring Plan

(refer to Figures A-1a through A-1d)

Monitoring Zone	Well ID	Comments
Bedrock	119-MW-11BR	
Bedrock	119-MW-12BR	
Bedrock	119-MW-16BR-1	
Bedrock	119-MW-16BR-2	
Bedrock	119-MW-16BR-3	
Bedrock	119-MW-2BR-1	
Bedrock	119-MW-2BR-2	
Bedrock	119-MW-2BR-3	
Bedrock	119-MW-4BR-1	
Bedrock	119-MW-4BR-2	
Bedrock	119-MW-4BR-3	
Bedrock	124-MW-17BR-1	
Bedrock	124-MW-17BR-2	
Bedrock	124-MW-8BR	
Bedrock	140-MW-9BR-1	
Bedrock	140-MW-9BR-2	
Bedrock	140-MW-9BR-3	
Bedrock	SA6-MW-14BR	
Bedrock	SA6-MW-15BR	
Bedrock	SA6-MW-5BR-1	
Bedrock	SA6-MW-5BR-2	
Bedrock	SA6-MW-5BR-3	
Bedrock	SA6-MW-5BR-4	
Bedrock	SA6-MW-5BR-5	

Table A-2
Monitoring Locations for Groundwater Level Measurements
SA-7 Perimeter Pool Monitoring
(refer to Figure A-2)

Perimter Pool	Pool Standpipe	Frequency	Related Monitoring Well	Frequency
N-1	N-1 Standpipe	bi-weekly	115-E4-SO	Monthly
			115-E5-SO	Monthly
N-2	N-2 Standpipe	bi-weekly	087-MW-001	Monthly
N-3	N-3 Standpipe	bi-weekly	115-W1-SO	Monthly
			087-MW-O19	Monthly
N-4	N-4 Standpipe	bi-weekly	087-MW-Y20	Monthly
			115-W6-SO	Monthly
E-1	E-1 Standpipe	bi-weekly	115-E3-SO	Monthly
E-2	E-2 Standpipe	bi-weekly	115-E2-SO	Monthly
S-1	S-1 Standpipe	bi-weekly	115-E1A-SO	Monthly
S-2	S-2 Standpipe	bi-weekly	115-E1A-SO	Monthly
			140-MW-06	Monthly
			140-MW-07	Monthly
S-3	S-3 Standpipe	bi-weekly	115-W5-SO	Monthly
			134-MW-V09	Monthly
			134-MW-Q08	Monthly
S-4	S-4 Standpipe	bi-weekly	115-W3-SO	Monthly
			073-MW-B11	Monthly
			073-MW-Y10	Monthly

Table A-3
Monitoring Locations for Groundwater Level Measurements
SA-6 South Groundwater Level Monitoring Plan

(refer to Figure A-3)

Monitoring Zone	Well ID	Comments
Shallow	SA6S-PZ-1	Outside wall
Shallow	SA6S-PZ-2	Inside wall
Shallow	SA6S-PZ-3	Outside wall
Shallow	SA6S-PZ-4	Inside wall
Shallow	SA6S-PZ-5	Outside wall
Shallow	SA6S-PZ-6	Inside wall
Shallow	SA6S-PZ-7	Outside wall
Shallow	SA6S-PZ-8	Inside wall
Shallow	SA6S-PZ-9	Outside wall
Shallow	SA6S-PZ-10	Inside wall
Shallow	SA6S-PZ-11	Inside wall
Shallow	115-W3-SO	Outside wall
Shallow	115-W4-SO	Outside wall
Shallow	115-E1-SO	Outside wall

Table A-4
Monitoring Locations for Groundwater Level Measurements
SA-6 North Groundwater Level Monitoring Plan

(refer to Figure A-4)

Monitoring Zone	Well ID	Comments
Shallow	SA6N-PZ-1	Outside wall
Shallow	SA6N-PZ-2	Inside wall
Shallow	SA6N-PZ-3	Outside wall
Shallow	SA6N-PZ-4	Inside wall
Shallow	SA6N-PZ-5	Outside wall
Shallow	SA6N-PZ-6	Inside wall
Shallow	SA6N-PZ-7	Outside wall
Shallow	SA6N-PZ-8	Inside wall
Shallow	SA6N-PZ-9	Outside wall
Shallow	SA6N-PZ-10	Inside wall
Shallow	115-W1-SO	Outside wall
Shallow	115-E4-SO	Outside wall
Shallow	115-E5-SO	Outside wall

Table A-5
Monitoring Locations for Groundwater Level Measurements
SA-5 (NJCU) Sites 90 & 184 Long-term Monitoring Plan
(refer to Figure A-5)

Monitoring Zone	Well ID	Comments
Shallow	090-PZ-05	
Shallow	090-PZ-06	
Shallow	090-MW-F14	abandoned 2013 by NJCU development
Shallow	184-MW-04	
Shallow	184-MW-05	
Shallow	184-MW-06	
Shallow	184-MW-C10	abandoned 2013 by NJCU development
Shallow	Sump A	
Shallow	Sump B	

Table A-6
Monitoring Locations for Groundwater Level Measurements
SA-5 Site 079 Long-term Monitoring Plan

(refer to Figure A-5)

Monitoring Zone	Well ID	Comments
Shallow	079-MW-01	
Shallow	079-MW-A02	

Table A-7
Monitoring Locations for Groundwater Level Measurements
SA-5 Site 153 South Remedial Action Permit for Groundwater
(refer to Figure A-5)

Monitoring Zone	Well ID	Comments
Shallow	153-MW-2	
Shallow	153-MW-5	
Shallow	153-MW-A13	
Shallow	153-MW-A15	

Table A-8
Monitoring Locations for Groundwater Level Measurements
SA-5 Site 117 Remedial Action Permit for Groundwater

(refer to Figure A-5)

Monitoring Zone	Well ID	Comments
Shallow	117-MW-A05	
Shallow	117-MW-A14	
Shallow	117-MW-A62	
Shallow	117-MW-A85	
Shallow	117-MW-A89	
Shallow	117-MW-A99	

TABLE B
GROUNDWATER QUALITY MONITORING REQUIREMENTS
for Integrated Groundwater Monitoring Plan

								2013			
Location	**Monitoring Plan**	**Consent Decree**	**Depth**	**Frequency**	**# Wells (ref table)**	**Figure Ref. #**	**Estimated Start Date**	**Qtr1**	**Qtr2**	**Qtr3**	**Qtr4**
Regional	GWET Long Term Monitoring Plan June 10, 2008	Deep Overburden and Bedrock Groundwater Remedies Consent Order	Shallow Intermediate Deep Bedrock	Biennial Biennial Biennial Biennial	0 (B-1) 6 (B-1) 12 (B-1) 10 (B-1)	 B-1a B-1b B-1c	 Dec. 2013 future events TBD				x x x x
Regional	S-3 Injection Mass Removal Operations Work Plan Final Feb. 28, 2012	Deep Overburden and Bedrock Groundwater Mass Removal Consent Decree, May 18, 2010	Deep	Every injection event Semi-annual Sampling	4 (B-2) 6 (B-2)	B-2	On-going (# events)	x	x x	x(2)	x(2) x
SA-6 South	SA-6 South Development AOC Appendix D of SA-6 South 100% Design Report June 28, 2013	First Amended Consent Decree Regarding Remediation and Redevelopment of SA-6 South	Shallow	Qtly first year[1]	12 (B-3)	B-3	Post Remedy (2017)[2]				
SA-6 South	L-zone Wells (Plume Diversion Area) Appendix E of SA-6 South 100% Design June 28, 2013	First Amended Consent Decree Regarding Remediation and Redevelopment of SA-6 South	Deep	Pre-Remedy Baseline Post Remedy	12 (B-4) 12* (B-4)	B-4	Completed May 2013 Post Remedy (2017)		x		
SA-5 (NJCU) Sites 90 & 184	Long Term Monitoring Plan (2/29/12)[3]	Consent Decree Regarding Remediation of the New Jersey City University Redevelopment Area	Shallow	Years 1 and 2 - Quarterly Year 3 + TBD	3 (B-5)	B-5	On-going	x	x	x	x
SA-5 Site 117	Remedial Action Permit for GW (in progress)	Consent Decree Regarding Remediation of the Study Area 5 Shallow Groundwater and the Site 79 Residential Properties	Shallow	Biennial[2]	7 (B-6)	B-5	2015				
SA-5: Site 079	Long Term Monitoring Plan[2]	Consent Decree Regarding Remediation of the Study Area 5 Shallow Groundwater and the Site 79 Residential Properties	Shallow	Once 2014 then TBD[4]	2 (B-7)	B-5	2014				x
SA-5: Site153 South	Remedial Action Permit for GW (in progress)	Consent Decree Regarding Sites 79 and 153 South	Shallow	Biennial[2]	2 (B-8)	B-5	2015				

* Number and location of wells subject to field conditions during and after remedy construction.
Biennial = every two years

[1]Monitoring begins 12 months after construction is complete

[2]Revised/updated LTMP(in progress).

[3]Post-remedy triggers plan under NJCU Consent Decree; plan expected to be updated 1st quarter 2014; future monitoring frequency TBD pending updated LTMP

[4]TBD based on water level monitoring data per LTMP

TABLE B
GROUNDWATER QUALITY MONITORING REQUIREMENTS
for Integrated Groundwater Monitoring Plan

Location	Monitoring Plan	2014 Qtr1	2014 Qtr2	2014 Qtr3	2014 Qtr4	2015 Qtr1	2015 Qtr2	2015 Qtr3	2015 Qtr4	2016 Qtr1	2016 Qtr2	2016 Qtr3	2016 Qtr4	2017 Qtr1	2017 Qtr2	2017 Qtr3	2017 Qtr4	2018 Qtr1	2018 Qtr2	2018 Qtr3	2018 Qtr4
Regional	GWET Long Term Monitoring Plan June 10, 2008																				
Regional	S-3 Injection Mass Removal Operations Work Plan Final Feb. 28, 2012	x(2)	x(2) x	x(2)	x(2) x	x(2)	x(2) x	x(2)	x(2) x	x(2)	x(2) x	x(2)	x(2) x	x(2)	x x						
SA-6 South	SA-6 South Development AOC Appendix D of SA-6 South 100% Design Report June 28, 2013	SA-6 North and South Construction								12-month equilibrium period				x	x	x		x	x	x	x
SA-6 South	L-zone Wells (Plume Diversion Area) Appendix E of SA-6 South 100% Design June 28, 2013	SA-6 North and South Construction								12-month equilibrium period				x							
SA-5 (NJCU) Sites 90 & 184	Long Term Monitoring Plan (2/29/12)[3]	x	TBD																		
SA-5 Site 117	Remedial Action Permit for GW (in progress)									x						x					
SA-5: Site 079	Long Term Monitoring Plan[2]																				
SA-5: Site153 South	Remedial Action Permit for GW (in progress)									x						x					

* Number and location of wells subject to field conditions during and after remedy construction.
Biennial = every two years

[1]Monitoring begins 12 months after construction is complete

[2]Revised/updated LTMP(in progress).

[3]Post-remedy triggers plan under NJCU Consent Decree; plan expected to be updated 1st quarter 2014; future monitoring frequency TBD pending updated LTMP

[4]TBD based on water level monitoring data per LTMP

Table B-1
Monitoring Wells for Groundwater Quality Sampling
GWET Long-term Monitoring Plan
(refer to Figures B-1a through B-1c)

Monitoring Zone	Well ID	Analytical Parameters	Analytical Methods
Shallow	None*	NA	NA
Intermediate	087-MW-O19D	Note 1	Note 2
Intermediate	087-MW-W25D	Note 1	Note 2
Intermediate	087-MW-A26D	Note 1	Note 2
Intermediate	117-MW-I1	Note 1	Note 2
Intermediate	117-MW-I5	Note 1	Note 2
Intermediate	SA6-MW-AA1D	Note 1	Note 2
Deep	087-MW-W25T	Note 1	Note 2
Deep	087-MW-A26T	Note 1	Note 2
Deep	115-MW-E08Tr	Note 1	Note 2
Deep	117-MW-D3	Note 1	Note 2
Deep	119-MW-01T	Note 1	Note 2
Deep	119-MW-02T	Note 1	Note 2
Deep	124-MW-G02T	Note 1	Note 2
Deep	124-MW-102T	Abandoned	
Deep	124-MW-104T	Note 1	Note 2
Deep	124-MW-106T	Note 1	Note 2
Deep	124-MW-107T	Abandoned	Note 2
Deep	SA6-MW-AA1T	Note 1	Note 2
Bedrock	079-MW-13BR	Note 1	Note 2
Bedrock	090-MW-18BR**	Note 1	Note 2
Bedrock	117-MW-8BR	Note 1	Note 2
Bedrock	119-MW-2BR-1	Note 1	Note 2
Bedrock	119-MW-16BR-1	Note 1	Note 2
Bedrock	124-MW-8BR	Note 1	Note 2
Bedrock	140-MW-9BR-1	Note 1	Note 2
Bedrock	SA6-MW-14BR	Note 1	Note 2
Bedrock	SA6-MW-15BR	Note 1	Note 2

*** Shallow groundwater is not considered part of the Deep Overburden Groundwater Plume.**

**** Abandoned in 2013 by NJCU Contractors; future status under evaluation**

Note 1: Total Cr (filtered and unfiltered), Hex Cr. (filtered and unfiltered)

Note 2: Total Cr method EPA 200.7; hex Cr method SW846-7199

Table B-2
Monitoring Wells for Groundwater Quality Sampling
S-3 Injection Mass Removal Program

(refer to Figure B-2)

Well Type	Well ID	Analytical Parameters	Analytical Methods
Monitoring	087-PW-1	Total Chromium, calcium, iron	EPA 200.7
		Hexavalent chromium	SW846-7199
		Sulfate	EPA 300/SW846 9056A
Monitoring	087-PW-2	same as above	same as above
Monitoring	090-MW-09	same as above	same as above
Monitoring	088-MW-G19T	same as above	same as above
Monitoring	087-MW-O29D	same as above	same as above
Monitoring	115-DP-1	same as above	same as above
Injection	088-IW-01	same as above	same as above
Injection	088-IW-02	same as above	same as above
Injection	088-IW-03	same as above	same as above

Table B-3
Monitoring Wells for Groundwater Quality Sampling
SA-6 South Development AOC

(refer to Figure B-3)

Monitoring Zone	Well ID	Comments	Analytical Parameters	Analytical Methods
Shallow	SA6S-MW-01	New Installation	Total and Hexavalent Chromium	EPA 200.7 and SW846-7199
Shallow	SA6S-MW-02	New Installation	Total and Hexavalent Chromium	EPA 200.7 and SW846-7199
Shallow	SA6S-MW-03	New Installation	Total and Hexavalent Chromium	EPA 200.7 and SW846-7199
Shallow	SA6S-MW-04	New Installation	Total and Hexavalent Chromium	EPA 200.7 and SW846-7199
Shallow	SA6S-MW-05	New Installation	Total and Hexavalent Chromium	EPA 200.7 and SW846-7199
Shallow	SA6S-MW-06	New Installation	Total and Hexavalent Chromium	EPA 200.7 and SW846-7199
Shallow	SA6S-MW-07	New Installation	Total and Hexavalent Chromium	EPA 200.7 and SW846-7199
Shallow	SA6S-MW-08	New Installation	Total and Hexavalent Chromium	EPA 200.7 and SW846-7199
Shallow	SA6S-MW-09	New Installation	Total and Hexavalent Chromium	EPA 200.7 and SW846-7199
Shallow	SA6S-MW-10	New Installation	Total and Hexavalent Chromium	EPA 200.7 and SW846-7199
Shallow	SA6S-MW-11	New Installation	Total and Hexavalent Chromium	EPA 200.7 and SW846-7199
Shallow	SA6S-MW-12	New Installation	Total and Hexavalent Chromium	EPA 200.7 and SW846-7199

Table B-4
Monitoring Wells for Groundwater Quality Sampling
SA-6 South "L-zone Wells" Plume Diversion Area

(refer to Figure B-4)

Monitoring Zone	Well ID	Comments	Analytical Parameters	Analytical Methods
Deep	124-MW-103L	abandoned	Total and Hexavalent Chromium	EPA 200.7 and SW846-7199
Deep	124-MW-102T	abandoned	Total and Hexavalent Chromium	EPA 200.7 and SW846-7199
Deep	124-MW-105T	retain*	Total and Hexavalent Chromium	EPA 200.7 and SW846-7199
Deep	124-MW-106T	retain*	Total and Hexavalent Chromium	EPA 200.7 and SW846-7199
Deep	124-MW-107T	abandoned	Total and Hexavalent Chromium	EPA 200.7 and SW846-7199
Deep	124-MW-G02T	retain	Total and Hexavalent Chromium	EPA 200.7 and SW846-7199
Deep	119-MW-02T	retain	Total and Hexavalent Chromium	EPA 200.7 and SW846-7199
Deep	119-MW-01T	retain	Total and Hexavalent Chromium	EPA 200.7 and SW846-7199
Deep	124-MW-104T	retain*	Total and Hexavalent Chromium	EPA 200.7 and SW846-7199
Deep	124-MW-104L	retain*	Total and Hexavalent Chromium	EPA 200.7 and SW846-7199

*** retain if feasible per SA-6 South Monitoring Well Abandonment Plan or optionally collect in-situ groundwater samples using direct push methods**

Table B-5
Monitoring Wells for Groundwater Quality Sampling
SA-5 (NJCU) Sites 090 and 184 Long Term Monitoring Plan
(refer to Figure B-5)

Monitoring Zone	Well ID	Analytical Parameters	Analytical Methods
Shallow	184-MW-04	Total and Hexavalent Chromium	EPA 200.7 and SW846-7199
Shallow	184-MW-05	Total and Hexavalent Chromium	EPA 200.7 and SW846-7199
Shallow	184-MW-06	Total and Hexavalent Chromium	EPA 200.7 and SW846-7199

Table B-6
Monitoring Wells for Groundwater Quality Sampling
SA-5 Site 117 Remedial Action Permit for GW
(refer to Figure B-5)

Monitoring Zone	Well ID	Analytical Parameters	Analytical Methods
Shallow	117-MW-A05	Total and Hexavalent Chromium	EPA 200.7 and SW846-7199
Shallow	117-MW-A14	Total and Hexavalent Chromium	EPA 200.7 and SW846-7199
Shallow	117-MW-A62	Total and Hexavalent Chromium	EPA 200.7 and SW846-7199
Shallow	117-MW-A85	Total and Hexavalent Chromium	EPA 200.7 and SW846-7199
Shallow	117-MW-A89	Total and Hexavalent Chromium	EPA 200.7 and SW846-7199
Shallow	117-MW-A99	Total and Hexavalent Chromium	EPA 200.7 and SW846-7199

Table B-7
Monitoring Wells for Groundwater Quality Sampling
SA-5 Sites 079 Long Term Monitoring Plan

(refer to Figure B-5)

Monitoring Zone	Well ID	Analytical Parameters	Analytical Methods
Shallow	079-MW-01	Total and Hexavalent Chromium	EPA 200.7 and SW846-7199
Shallow	079-MW-A02	Total and Hexavalent Chromium	EPA 200.7 and SW846-7199

Table B-8
Monitoring Wells for Groundwater Quality Sampling
SA-5 Site 153 South Remedial Action Permit for GW

(refer to Figure B-5)

Monitoring Zone	Well ID	Analytical Parameters	Analytical Methods
Shallow	153-MW-A13	Total and Hexavalent Chromium	EPA 200.7 and SW846-7199
Shallow	153-MW-A15	Total and Hexavalent Chromium	EPA 200.7 and SW846-7199

TABLE C
ANALYTICAL METHODS, CONTAINERS, PRESERVATION, AND HOLD TIMES

Analytical Parameter	Method	Container	Preservation	Hold Time
Total Chromium	EPA 200.7	500 ml poly	cool 4^{O} C*	6 months
Hexavalent Chromium	SW846-7199	500 ml poly	cool 4^{O} C*	24 hours
Iron	EPA 200.7	500 ml poly	cool 4^{O} C*	6 months
Sulfate	EPA 300/SW846 9056A	500 ml poly	cool 4^{O} C	6 months
Calcium	EPA 200.9	500 ml poly	cool 4^{O} C*	6 months
VOC	EPA 624	40 ml glass (3)	cool 4^{O} C	14 days

* Nitric acid to pH < 2 for dissolved (filtered) samples.

TABLE D
SUMMARY OF TIDAL EFFICIENCY AND TIDAL LAG

Well ID	Screened Zone	Tidal Efficiency (%)	Tidal Lag (minutes)
073-PZ-002	Intermediate	26.00%	50
087-MW-13	Intermediate	61.50%	18
087-MW-35	Intermediate	41.20%	22
087-MW-O29D	Intermediate	15.40%	107
087-MW-W25D	Intermediate	40.00%	22
087-OBS-1D	Intermediate	62.20%	25.5
087-OBS-2D	Intermediate	29.00%	19
087-OBS-5D	Intermediate	30.00%	20
087-PZ-002	Intermediate	30.00%	40
087-PZ-006	Intermediate	20.00%	100
115-MW-20	Intermediate	1.80%	285
115-W1-DO	Intermediate	20.00%	100
115-W4-DO	Intermediate	20.00%	100
125-PZ-002	Intermediate	2.00%	300
134-PZ-002	Intermediate	19.00%	60
134-PZ-004	Intermediate	12.50%	90
140-MW-P05D	Intermediate	3.60%	45
140-PZ-002	Intermediate	8.50%	92
SA6-MW-AA1D	Intermediate	44.10%	10
087-MW-03	Deep	3.90%	110
087-MW-08	Deep	45.70%	3.5
087-MW-34	Deep	29.10%	19
087-MW-W25T	Deep	33.00%	40
087-OBS-1L	Deep	62.20%	25.5
087-OBS-1T	Deep	48.40%	18
087-OBS-3L	Deep	45.00%	18
087-OBS-4T	Deep	18.50%	56.2
087-OBS-5T	Deep	30.00%	20
SA6-MW-AA1T	Deep	34.20%	4
073-MW-10BR	Bedrock	40.00%	20
073-MW-1BR	Bedrock	38.90%	32.8
087-MW-I30T	Bedrock	67.00%	100
087-MW-O29T	Bedrock	20.30%	39
115-MW-203BR	Bedrock	38.70%	25
115-MW-215BR	Bedrock	40.50%	14
119-MW-2BR	Bedrock	43.80%	16.4
119-MW-4BR	Bedrock	23.70%	7.5
SA6-MW-14BR	Bedrock	3.90%	183.7
SA6-MW-15BR	Bedrock	18.70%	187.1
SA6-MW-5BR	Bedrock	13.50%	53.7