The Chemours Company FC, LLC

2000 Cannonball Road

Pompton Lakes, Passaic County, New Jersey

Implementation Work Plan - Hydraulic Surcharging Pilot Study

Pompton Lakes Works Site
Pompton Lakes, Passaic County, New Jersey
PI #007411

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Acronyms

ASTM	American Society for Testing and Materials
bpf	blows per foot
bgs	below ground surface
CEA	Classification Exception Area
Chemours	The Chemours Company FC, LLC
COC	constituent of concern
DGW	discharge to groundwater
Draft Design Package	*Draft Design Package – Installation of Horizontal Well for Hydraulic Surcharging Pilot Study*
DTD	Directed Technologies Drilling, Inc.
DuPont	E.I. du Pont de Nemours and Company
gpm	gallons per minute
GRAWP	*Groundwater Remedial Action Work Plan*
GWET	groundwater extraction and treatment
GWIIA	Class IIA Ground Water Quality Standard
HDD	horizontal directional drilling
HDPE	high density polyethylene
IWP	*Implementation Work Plan - Hydraulic Surcharging Pilot Study*
msl	mean sea level
NAD 1983	New Jersey State Plan Coordinate System
NJDEP	New Jersey Department of Environmental Protection
NJPDES	New Jersey Pollutant Discharge Elimination System
NYSWR	New York Susquehanna & Western Railway Corporation
PBR	Discharge to Groundwater Permit-by-Rule
PLW	Pompton Lakes Works
psi	pounds per square inch
PW	Parratt-Wolff, Inc.
PSA	project safety analysis
RASR	Remedial Action Selection Report
ROW	right-of-way
RTC	response to comments
SPT	Standard Penetration Tests

ug/l	micrograms per liter
USEPA	U.S. Environmental Protection Agency
VOC	volatile organic compound
2013 IWP	*Implementation Work Plan - Hydraulic Surcharging Pilot Study*

1 Introduction

This *Implementation Work Plan – Hydraulic Surcharging Pilot Study* (IWP) presents the proposed approach for conducting a pilot study of hydraulic surcharging at the Pompton Lakes Works (PLW) Site located at 2000 Cannonball Road in Pompton Lakes, Passaic County, New Jersey which was formerly operated by E. I. du Pont de Nemours and Company (DuPont). In 2015, DuPont transferred the PLW Site to The Chemours Company FC, LLC (Chemours). The location of the Site is depicted on Figure 1.

1.1 Current Groundwater Remediation Program

The Site currently operates a groundwater extraction and treatment (GWET) system that was installed as part of the July 1993 New Jersey Department of Environmental Protection (NJDEP)-approved *Groundwater Remedial Action Work Plan* (GRAWP) and fully implemented in 1998. Onsite groundwater is withdrawn from the unconsolidated alluvial aquifer along the southern boundary of the Site via six recovery wells (62, 64, 65, 66, 72, and 73 as shown on Figure 2) to establish a hydraulic capture zone that prevents groundwater containing chlorinated volatile organic compounds (VOCs) from migrating offsite. Groundwater is extracted from the shallow (approximately 10 to 30 feet below ground surface [bgs]), intermediate (30 to 70 feet bgs), and deep (greater than 70 feet bgs) portions of the aquifer.

Extracted groundwater is conveyed to an onsite treatment system building for treatment via air stripping. The air stripper drains to an approximate 700-gallon sump, where collected water is pumped on a batch basis (as controlled by a sump level sensor) to discharge conveyance pipes. The pipes are routed to a series of six pairs (12 total) of onsite groundwater infiltration beds (each approximately 25 feet wide by 30 feet long in size, lined with pea gravel, located approximately 4 to 6 feet bgs, and covered with native soils), which allow for infiltration of treated groundwater into the subsurface. The infiltration beds are located along the southern and southeastern Site boundary (see Figure 2) and are partially within the capture zone of the GWET system and entirely within the Classification Exception Area (CEA) established for offsite groundwater. Flows to the various infiltration beds are controlled via manual adjustment/throttling of the GWET system effluent line valves. The groundwater table in the vicinity of the infiltration beds is estimated at 10 to 20 feet bgs, so discharges to the beds are allowed to infiltrate into the subsurface via gravity flow and hydraulically surcharge the groundwater. Discharge of treated groundwater is conducted in accordance with the NJDEP-approved GRAWP and New Jersey Pollutant Discharge Elimination System (NJPDES) Discharge to Groundwater (DGW) Permit No. NJ001851.

Treated groundwater (effluent) being discharged to the infiltration beds is sampled on a monthly basis for the 10 Site constituents of concern (COCs) [chlorinated VOCs] and lead. The effluent limits are NJDEP's Class IIA Ground Water Quality Standards (GWIIA). Operation of the GWET system (including the collection of monthly water levels from select wells) and analytical results from influent/effluent sampling are reported to NJDEP and the U.S. Environmental Protection Agency (USEPA) on a quarterly basis. Data collected over time from the semi-annual groundwater monitoring program indicates that there is a reduction in concentrations in the offsite plume area (see Section 2.2).

1.2 Regulatory Background

In a letter dated April 5, 2011, NJDEP and USEPA required that a Remedial Action Selection Report (RASR) be submitted to address the shallow portion of the alluvial aquifer impacted by operations at the former manufacturing facility. The primary objective of the RASR was to identify potential technologies to address VOC concentrations in shallow groundwater in the offsite plume area, while continuing and enhancing remediation efforts currently ongoing in the onsite plume area.

The RASR, submitted on August 31, 2011, proposed optimization of the current GWET system, to enhance hydraulic surcharging, as the technology for implementation to address onsite and offsite shallow groundwater. In their December 21, 2011 correspondence regarding the RASR, NJDEP and USEPA agreed that hydraulic surcharging is an acceptable part of the remedial alternative for the offsite groundwater plume. In response to the comments outlined in that correspondence and as discussed in the December 6, 2011 meeting, implementation of the hydraulic surcharging remedy was undertaken as two tasks and time schedules. The first task was to modify the existing GWET system to increase flow within the shallow aquifer in the western portion of the plume near the Site boundary. The second task was to identify potential methods to increase hydraulic surcharging further offsite; thus reducing the amount of time to decrease shallow VOC concentrations in areas further downgradient. The results of the two tasks were documented in two technical memoranda and a basis of design document that were submitted to NJDEP and USEPA in 2012.

The *Implementation Work Plan - Hydraulic Surcharging Pilot Study* (2013 IWP) dated June 28, 2013, was prepared to present a summary of the hydraulic surcharging work completed to date (i.e., two tasks described above); proposed pre-design activities; details on the horizontal well design, installation, start-up and commissioning; and overview of the pilot study operation and monitoring program. On September 9, 2013, NJDEP and USEPA provided comments on the 2013 IWP and a response to comments (RTC) was submitted on October 14, 2013. On November 25, 2013, NJDEP and USEPA requested a schedule of the hydraulic surcharging pilot study. A sequence of activities and schedule was submitted to NJDEP and USEPA on January 2, 2014. This IWP incorporates the responses from the October 14, 2013 RTC, documents the activities completed from the January 2, 2014 schedule, and presents the path forward for the hydraulic surcharging pilot study.

1.3 Purpose of Pilot Study

The purpose of conducting the hydraulic surcharging pilot study is to collect data on the efficacy of optimizing groundwater flow rates within the shallow aquifer in the western portion of the plume near the Site boundary through the design and installation of a water delivery system (i.e., horizontal well). The pilot study is expected to run for approximately one year; at which time a report will be submitted with the results and recommendations/proposed actions for the path forward.

1.4 Purpose and Organization of Work Plan

The purpose of this IWP is to present details on the horizontal well design, installation, start-up and commissioning, and pilot study operation and monitoring program. Brief summaries of the remaining sections are presented below.

- Section 2: *Site Background* – This section provides a summary of the physical setting of the Site, groundwater quality, and work conducted to date on the hydraulic surcharging pilot study.
- Section 3: *Pilot Study Implementation* – This section presents details on the activities associated with implementation of the hydraulic surcharging pilot study including horizontal well design, installation, operation and monitoring, reporting, and schedule.
- Section 4: *References* – This section lists the references cited in the IWP.

2 Site Background

2.1 Environmental Setting

Geology

The Site is situated within the Highlands Physiographic Province adjacent to the northwestern boundary of the Newark Basin. Bedrock beneath the Site consists of Precambrian gneiss and diabase. Previous studies show that two primary geologic units, crystalline bedrock and alluvial deposits consisting of colluviums and stratified glacial drift, underlie the Site. The crystalline bedrock is comprised of deformed and metamorphosed high-grade gneisses.

The topography of the bedrock surface varies from gently undulating to steeply sloping. A 45-foot thick diabase dike bisects the Site on the eastern ridge between the Former Eastern Manufacturing Area and Former Western Manufacturing Area. The bedrock contains joints that are observable in outcrops at the Site.

The alluvial deposits are up to 170 feet thick. The texture of the alluvial deposits is a fining downward stratified glacial sequence which can generally be divided into three depositional types.

- The shallow alluvial depositional type is comprised of fill, colluvium, and glacial deposits. These deposits are generally poorly sorted, coarse to medium-grained sand and gravel, and may contain layers of very coarse-grained gravel. This shallow zone ranges from approximately 5 to 20 feet thick.
- The intermediate alluvial deposits are generally comprised of very fine to medium-grained sand, and range from 15 to 80 feet thick. These deposits are considered to represent glacial fluvial and deltaic deposits.
- The deep alluvial deposits are generally comprised of very fine-grained silty sand and very fine-grained sandy silt, which represent glacial lacustrine deposits. The thickness of this zone is highly variable and can be up to 90 feet thick in bedrock surface structural lows.

Hydrogeology

The groundwater table is encountered between 5 and 15 feet bgs. The alluvial deposits comprise a single aquifer system in that no layer of low permeability has been found that would act as a confining unit. However, because of varying permeability in the stratified deposits, the alluvium has been divided into three hydrogeologic zones which generally coincide with the geologic units described above. The horizontal well is being installed in the shallow hydrogeologic zone which is located at approximately 10 to 30 feet bgs. The hydraulic conductivity of this zone generally ranges from 43 to 82 feet/day.

Groundwater elevations range from approximately 206 feet mean sea level (msl) near the recovery wells to approximately 202 feet msl near Pompton Lake. Currently, offsite groundwater flow in the alluvial aquifer is generally to the south and southeast towards Pompton Lake. Groundwater recharge to the alluvial aquifer occurs both onsite and offsite. Onsite groundwater pumping and infiltration have altered the onsite groundwater flow patterns. To the north of the pumping wells, groundwater flow is toward the south and southeast (to the wells). To the south of the pumping wells, the infiltration beds have created a groundwater divide under the beds such that part of the groundwater flows to the pumping wells and part flows toward Pompton Lake.

2.2 Groundwater Quality Summary

Groundwater investigations have shown that there is VOC-impacted groundwater both onsite and offsite. As stated in the November 1995 *Comprehensive Groundwater Monitoring Program*, the following ten chlorinated VOCs have been identified as Site COCs for groundwater: tetrachloroethene, trichloroethene, 1,1,1-trichloroethane, 1,1-dichloroethane, 1,2-dichloroethane, 1,1-dichloroethene, cis-1,2-dichloroethene, trans-1,2-dichloroethene, carbon tetrachloride, and vinyl chloride. In the shallow hydrogeologic zone, total concentrations of these VOCs range from non-detect (less than 0.1 micrograms per liter [ug/l]) to approximately 25 ug/l during 2015 (latest round of groundwater monitoring).

Hydraulic surcharging, through the operation of the existing GWET system, has reduced VOC concentrations in the eastern portion of the offsite plume area; and natural reductive dechlorination is occurring in the western portion of the offsite plume area which has also reduced concentrations. Groundwater from the areas of former lagoons 1, 2, 3, and 4 is no longer flowing offsite. VOC concentrations in groundwater downgradient of the Site and in the vicinity of the infiltration beds have decreased by one or more orders of magnitude since the GWET system began operation, as evidenced by monitoring results over time. The treated water flowing from the infiltration beds is creating a zone of cleaner water downgradient of the beds. The zone of cleaner water is larger in the shallow zone because the shallow zone is more permeable and, as such, preferentially transports the water from the infiltration beds. The zone of cleaner water is progressively smaller in the intermediate and deep zones, based on their limited ability to transmit water.

2.3 Work Conducted to Date

As part of the first task in implementing the hydraulic surcharging remedy, the flow has been increased 100% (from 25 gallons per minute [gpm] to 50 gpm) to the westernmost infiltration beds onsite (identified as 1C and 1D on Figure 2); thus increasing the amount of water entering the subsurface in that area.

The groundwater model presented in the RASR was used to simulate various surcharging scenarios including the evaluation of the groundwater flow rate through an area, for different configurations. This modeling was completed in response to a comment made in the December 21, 2011 correspondence from NJDEP and USEPA.

The *Technical Memorandum: Scenarios Evaluating Hydraulic Surcharging Remedy* was submitted on January 31, 2012 and presented the modeling scenarios simulated to evaluate the most effective means of hydraulically surcharging groundwater to increase flow within the shallow aquifer in the western portion of the plume near the Site boundary. The goal of the simulations was to conceptually determine what actions could be reasonably implemented in the short term. The modeling indicated that additional water infiltration in the area west of the Site boundary would be needed to achieve the project goals of increasing groundwater flow (i.e., increase in the groundwater movement rate in that portion of the shallow plume).

In response to the March 8, 2012 correspondence from NJDEP and USEPA regarding comments on the *Technical Memorandum: Scenarios Evaluating Hydraulic Surcharging Remedy*, the *Technical Memorandum – Response to Comments* was submitted on March 30, 2012.

Based on the modeling effort, the *Horizontal Well Implementation Technical Memorandum* was also submitted on March 30, 2012 and outlined the anticipated implementation steps for horizontal well installation and pilot study testing, preliminary design considerations being evaluated, and path forward for design of this water delivery system.

NJDEP and USEPA issued correspondence dated May 2, 2012 requesting the submission of a Discharge to Groundwater Permit-by-Rule (PBR) application for the hydraulic surcharging pilot study. The PBR was submitted on June 15, 2012.

The *Basis of Design: Horizontal Well/Hydraulic Surcharging IRM Pilot Study* was submitted on June 29, 2012 and presented additional details on the design approach for implementation of a hydraulic surcharging pilot study through the installation of a horizontal well. This document provided the basis of design for the pilot study including: anticipated horizontal well general characteristics/performance requirements; conceptual design of the horizontal well; associated potential modifications to the existing GWET system; conceptual system operations monitoring plan; and preliminary program schedule.

Two potential alignments were identified to locate the horizontal well; below a Borough of Pompton Lakes-owned roadway (Barbara Drive) or along a railroad right-of-way (ROW) that runs parallel to this roadway to the south. Both alignments are accessible from the Site. However, the railroad ROW location allows for a longer well to be installed which will potentially allow for a larger zone of hydraulic surcharging to occur. Additionally, the railroad ROW location will allow for a construction method which provides for easier completion and maintenance activities to be conducted. Based on this information, a concept design/railroad access request was submitted to the New York Susquehanna & Western Railway Corporation (NYSWR) [owner] and was approved via email during December 2012.

The 2013 IWP was submitted on June 28, 2013 and presented a summary of the hydraulic surcharging work completed to date; details on the horizontal well design; proposed pre-design activities; installation, start-up and commissioning; and pilot study operation and monitoring program. On September 9, 2013, NJDEP and USEPA provided comments on the 2013 IWP and a RTC document was submitted on October 14, 2013. On November 25, 2013, NJDEP and USEPA requested a schedule of the hydraulic surcharging pilot study. A sequence of activities and schedule was submitted to NJDEP and USEPA on January 2, 2014.

In January 2014, the *Draft Design Package – Installation of Horizontal Well for Hydraulic Surcharging Pilot Study* (Draft Design Package) was submitted to NYSWR. The Draft Design Package presented the conceptual design and installation of the horizontal well and requested access to NSYWR property to conduct pre-design activities. As a result of their review, NSYWR executed a license agreement for the project and assigned an entry permit for contractors completing work within the ROW. Pre-design activities were completed in 2015 and consisted of a field (land) survey, geophysical survey, and geotechnical borings. Additional details on the pre-design activities are included in Section 3.4.4. A Revised Draft Design package was submitted to NSYWR in February 2016 which presented the results of the pre-design activities, horizontal well alignment on the southern side of the NYSWR ROW (Figure 2), and final design drawings for the horizontal well. The final design elements presented in the Revised Draft Design package have been incorporated into this IWP and the final design drawings are provided in Appendix A. NYSWR approved the installation of the horizontal well within the NYSWR ROW (on the southern side of the railroad tracks) in a letter dated March 21, 2016. The approval letter is provided in Appendix B.

3 Pilot Study Implementation

3.1 Overview

The existing GWET system discharges water to the shallow aquifer along the southern boundary of the Site into shallow infiltration beds. This water moves through the unsaturated portion of the aquifer until it reaches the saturated zone (i.e., water table) of the shallow aquifer which is present at approximately 10 to 12 feet bgs. The process of adding water to the shallow aquifer can be referred to as hydraulically surcharging the aquifer. A review of data collected from monitoring wells in the offsite plume area and GWET system operational information over the last 18 years indicates that the surcharging process is a main factor that has resulted in the significant reduction of VOC concentrations at locations within the offsite plume area.

A detailed modeling analysis was completed to evaluate the efficacy of hydraulically surcharging the shallow aquifer over a larger area. This analysis estimated aquifer flushing rates for various hydraulic surcharging options. This evaluation indicated that this surcharging process should provide results similar to those observed in the areas downgradient from the GWET system, which is increased flushing of the shallow aquifer. Based on the data collected, a pilot study has been designed that will enable the collection of the necessary engineering and hydrogeologic data to evaluate the effectiveness and implementability of the horizontal well as a remedial technology in optimizing groundwater flow rates within the shallow aquifer in the western portion of the plume near the Site boundary.

The pilot study design objective will be to distribute treated groundwater along an approximate 1,410 linear foot alignment, at an estimated depth of 20 to 25 feet bgs (approximately 5 feet below the seasonally low water table elevation), in areas of elevated VOC concentrations within the shallow aquifer. Surcharging will result in an increase in the groundwater flow in the higher permeability interval of the local shallow aquifer (located between approximately 10 to 30 feet bgs).

As depicted on Figure 2, a horizontal well will be installed adjacent to the southern side of the railroad tracks. Drilling will be initiated in the area where infiltration bed sets 4, 5, and 6 are located and extend westward to the area near Grant Avenue. Treated groundwater currently discharged to the existing infiltration beds will be utilized as the supply of water to be discharged to the horizontal well. The anticipated flow rates/discharges from the GWET system to the horizontal well will be in the range of normal operations of the GWET system (typically between approximately 120 and 140 gpm) and will not exceed the permitted discharge rate of 280 gpm. The pilot study is expected to run for approximately one year and the shallow aquifer will be monitored during that period.

3.2 Additional Groundwater Model Simulations

The effect of the discharge of treated groundwater on water levels within the aquifer was evaluated as part of the NJDEP-approved GRAWP. The maximum discharge rate of the GWET was based on groundwater modeling, pump tests, and routine measurements of groundwater elevations in the area of discharge. Based on these data, it has been shown that discharge of treated groundwater to the aquifer has not caused water levels to rise to a point at which groundwater would enter the basements of structures located in the pilot study area.

Using the same groundwater model (scenarios presented in previous submittals as outlined in Section 2.3), additional simulations have been performed to assist with the horizontal well design and provide further characterization of the water table response. These additional simulations have considered the depths of basements, utilities, and other features that could be impacted by water table increases. The goal of the simulations was to evaluate the potential for impact of infiltrating water in a horizontal well located along the railroad ROW to these features and evaluate the potential effect on flushing rates within the shallow aquifer.

Figures 3 and 4 depict these modeling results. The figures show the existing onsite infiltration beds (green symbols) and offsite horizontal well (blue rectangles). The figures reflect the simulated piezometric surface for Layer 1; the upper part of the shallow zone.

A base model run RR Trial 1 (see Figure 3) used physical data collected from aquifer pumping tests and simulated a horizontal well placed offsite within the railroad ROW with 130 gpm of the treated water being infiltrated into the well. Water table mounding increases to about 207.5 feet msl (or approximately 15 feet bgs) in the immediate vicinity of the horizontal well, which is the location of maximum mounding. Less water table mounding occurs upgradient and downgradient from the horizontal well, with the amount of mounding declining logarithmically with increasing distance from the horizontal well. The water table mounding causes an increased rate of flushing for the shallow aquifer.

To evaluate a conservative (increased mounding) scenario, a second model run (RR Trial 2 as depicted on Figure 4) was conducted where the hydraulic conductivity in the aquifer in the area of the proposed horizontal well was decreased by an order of magnitude (0.1 times the original value; area in figure not shaded) to represent conditions where the aquifer may not be able to move water as quickly as expected. There is no indication that hydraulic conductivities in the shallow zone are this low, but this conservative simulation was conducted to demonstrate that water table mounding should not impact existing subsurface infrastructure. This run simulated a horizontal well placed offsite within the railroad ROW with 130 gpm of the treated water being infiltrated into that well. Water table mounding increases to about 211.5 feet msl (or approximately 11 feet bgs) in the immediate vicinity of the horizontal well, which is the location of maximum mounding. Less water table mounding occurs upgradient and downgradient from the horizontal well, with the amount of mounding declining quickly with increasing distance from the horizontal well.

A schematic cross section perpendicular to the horizontal well shows potential water table elevations with the horizontal well operating and all the treated water being infiltrated into the well (Figure 5). This figure shows that even using the maximum groundwater elevation observed, the additional infiltration by the horizontal well will not cause groundwater to intersect the residential basements upgradient along Barbara Drive or downgradient at the residences close to the proposed horizontal well.

3.3 Horizontal Well Design

The proposed horizontal well is intended to expand the available area for infiltration by providing an extended, linear discharge path to supplement the existing infiltration zone.

An analysis of Site data indicates that the horizontal well screen length will not impede the infiltration of treated groundwater at the historical or permitted flow rates. A very low flow rate per foot of screen, distributed along the screened interval, will be sufficient to handle the output from the treatment system.

The distribution of water at relatively low pressures and low flow rates across a long well screen has been evaluated. In order to facilitate the distribution of water along the entire horizontal well length, an inner manifold of smaller diameter high density polyethylene (HDPE) pipe will be placed within the outer stainless-steel well screen. Perforations spaced along the length of this manifold will provide treated water to be uniformly metered out along the length of the screen. A 6-inch diameter, Schedule 10 stainless-steel will be used for the permanent well, with an inner metering manifold of 4-inch diameter HDPE. The stainless-steel well screen will have 12 longitudinal slots per foot with each slot 2 inches long and a slot diameter of 0.012 inches. The addition of the inner manifold will also provide greater accuracy and flexibility in operating the system.

The installation of the horizontal well is proposed along the southern side of the railroad ROW which has been approved by NYSWR (see Appendix B). The final design drawings for the horizontal well (as submitted to NYSWR) are included in Appendix A. The final design elements presented in the Revised Draft Design package submitted and approved by NYSWR have been incorporated into this IWP.

3.4 Horizontal Well Installation

3.4.1 Health and Safety

All work will be performed in accordance with the Site-specific health and safety plan, which will be modified to incorporate the activities of the horizontal well installation and pilot study operation. Based on the evaluation of work activities required to complete the well installation, a Site-specific activity hazard analysis for horizontal directional drilling will also be developed by DTD to address Site-specific conditions. A Project Safety Analysis (PSA) will be completed prior to the start of drilling and will include DTD's hazard analysis. The PSA process consists of a pre-planning phase to address scope items and how they will be completed; preparation of the PSA form and addendum to the Site-specific HASP; and PSA meeting with all key stakeholders (Site representatives, consultant, drilling firm, safety professionals, etc.) to discuss the project scope, potential safety hazards, and means to mitigate these potential safety hazards. The PSA documentation will be made available to NJDEP and USEPA prior to project initiation. In addition to these documents, field activities will be coordinated with and follow applicable NYSWR safety rules and regulations.

3.4.2 Permits

Prior to the start of field activities, necessary permits will be obtained. This includes, but is not limited to, the following:

- NJDEP well construction permits for horizontal well and monitoring locations; and
- PBR greater than 180 days.

A Draft PBR package has been prepared and is provided in Appendix C. The Draft PBR includes the authorization request form and discharge to groundwater proposal as well as a draft public notice. The public notice will be published in a local newspaper upon

NJDEP and USEPA review and approval of the PBR, notice, and IWP. A copy will also be submitted to the appropriate local agencies (Board of Health, Municipal Clerk, and Mayor of Pompton Lakes).

3.4.3 Utility and Railroad Clearance

Prior to field mobilization, DTD will contact the New Jersey One-Call System and request a utility mark-out to be performed to identify underground utilities in the work area. Additionally, utility drawings provided by NYSWR, maps generated during the May 2015 pre-design geophysical survey, and/or individual utility companies will be reviewed. Specifically AT&T, Western Union, and United Water have been contacted to identify the locations of their utilities along the alignment of the horizontal well. Soft-dig methods may be used in select locations to further demarcate utility locations prior to well installation, especially in the area of the exit point of the well.

3.4.4 Pre-Design Activities

The following pre-design activities were completed in support of NYSWR's review and approval of the installation of the horizontal well within their ROW:

- Field survey;
- Geophysical survey; and
- Geotechnical evaluation.

A description of each pre-design activity and the results are provided in the sub-sections below.

<u>Field Survey</u>

A survey was conducted along the railroad ROW to generate accurate information for final design plans on topography (i.e., embankment is higher/steeper at some locations than others) and property lines (railroad runs adjacent to residents' backyards and fence lines). The field survey was completed by Vargo Associates in May 2015 and the results have been incorporated into the final design drawings provided in Appendix A. Survey elevations are based on the North American Vertical Datum of 1988 and the horizontal datum is based on the New Jersey State Plan Coordinate System (NAD 1983).

<u>Geophysical Survey</u>

A geophysical survey was performed along the extent of the work area by Naeva Geophysics in May 2015. A magnetometer and ground penetrating radar were used to identify anomalies which may represent subsurface utilities or other subsurface obstructions that could be encountered while drilling. The results of the geophysical survey have been incorporated into the final design drawings provided in Appendix A.

<u>Geotechnical Evaluation</u>

Five soil borings were completed (approximate 150- to 350-foot spacing as depicted on Figure G-1 of Appendix A) utilizing "soft-dig" excavation techniques in the upper 6 feet of each exploration and hollow stem auger drilling from 6 to 36 feet bgs.

Parratt-Wolff, Inc. (PW) drilled the soil borings in December 2015 using a truck-mounted drill rig. The borings (B-2, B-3, B-4, B-6, and B-7) were advanced and Standard Penetration Tests (SPT) with split-barrel spoon sampling of soils was conducted in accordance with American Society for Testing and Materials (ASTM) D1556 using an automatic hammer. Continuous 24-inch long SPT samples were collected below a depth of 6 feet (after the soft-dig interval). The borings were backfilled with grout and auger cuttings upon completion.

PW Laboratories, Inc. performed laboratory testing (moisture content, grain size analysis, and atterberg limits) on disturbed jar soil samples collected from the soil borings. The laboratory tests were performed in accordance with applicable ASTM test methods. The results of completed laboratory tests are documented in the Revised Draft Design package submitted to NYSWR.

Based on the results of the soil boring and laboratory testing program, three subsurface strata were observed in the pilot study area:

- *Stratum 1 – Fill*: Fill soils were observed in borings B-2, B-3, and B-4 to depths ranging from approximately 2 to 5 feet (El. 220 to 216 feet) below the existing ground surface. Fill soils typically consisted of sands with varying amounts of silt (SM) interbedded with silts with varying amounts of sand (ML). Coal slag was observed in the fill soils. Densities of fill soils were not recorded because borings were advanced to a depth of 6 feet using an “air knife”.
- *Stratum 2 – Dense to Very Dense Sand*: Stratum 2 was observed in all soil borings underlying Stratum 1, where present, to depths of approximately 12 to 14 feet (El. 210 to 205 feet). Stratum 2 typically consisted of dense to very dense sands and gravels with varying amounts of silt (SM, SP, SP-SM, GP, GW-GM). SPT N-values ranged from 24 blows per foot (bpf) to split spoon refusal (50/1”), with an average of approximately 40 bpf. Densities of Stratum 2 soils were not recorded prior to a depth of 6 feet as borings were advanced to this depth using an “air knife”. Dense to very dense soils may have extended above noted depths (elevations) if they had not been penetrated with the “air knife” method of excavation.
- *Stratum 3 – Loose to Medium Dense Sand*: Stratum 3 was observed in all borings underlying Stratum 2 and extended to the termination depth of 36 feet. Stratum 3 typically consisted of loose to medium dense sands with varying amounts of silt (SP, SP-SM). SPT N-values in Stratum 3 ranged from 5 to 38 bpf, with an average of approximately 12 bpf. This is the predominant stratum where the horizontal well will be installed.

Topsoil was not noted at any of the boring locations.

The results of the soil boring and laboratory testing program were used with geotechnical calculations to evaluate the potential impact of installing the horizontal well along the southern side of the NYSRW ROW. The calculations, along with a summary of the results, are presented below.

Summary of Geotechnical Calculations, Purpose, and Result

Geotechnical Calculation	Purpose	Result
Effect of E80 Surcharge on Well	Determine additional pressure well must be capable of withstanding under E80 surcharge loading.	All well materials must be capable of supporting 3.5 pounds per square inch (psi) of additional surcharge associated with E80 loading in addition to pressures necessary for installation and service.
Maximum Allowable Drilling Fluid Pressures	Determine maximum pressure drilling operations should utilize in order to prevent hydraulic fracturing of ground with expression of drilling fluids at surface (“frac-out”).	Drilling fluid pressures should remain below 58 psi (depth 5 feet) and 180 psi (depth 23 feet) when completing horizontal directional drilling (HDD) relative to depth of cutting head below ground surface in order to reduce potential for “frac-out.”
Minimum Allowable Drilling Fluid Pressures	Determine minimum pressure expected to adequately maintain stability during HDD.	As a minimum, drilling fluid pressures should remain above 5 psi (5-foot depth) and 16 psi (23-foot depth) when completing HDD to maintain stability of excavation. This pressure does not address minimum pressure required for clearing of cuttings or advancement of HDD, merely what is necessary to maintain excavation stability considering effective overburden pressure and surcharge loading.
Potential Surficial Settlement within NYSWR ROW	Determine maximum calculated surficial settlement resulting from total collapse of 12-inch diameter HDD excavation.	Based on assumption of full collapse of a 12-inch diameter reamed HDD excavation, calculated surficial settlement on NYSWR ROW is less than 1 inch. This settlement is calculated to occur where invert of well is approximately 15 feet bgs, which is expected at the eastern edge of the ROW as the HDD progresses towards the invert El. of 199 at the southern end of the well. Significantly less settlement is expected as a result of soils filling the annulus between the well and HDD excavation after installation, which is expected to occur after installation.
Well Screen Slot Size for Filtration	Confirm no void causing erosion of soil particles into well would occur if gradient reversed into well.	Based on well screen slot size of 0.012 inches, migration of soil into well is considered unlikely if reverse gradient occurs (flow into well) as the slot effectively “filters” subsurface soils.

The Revised Draft Design package presented additional details of the geotechnical evaluation as well as the supporting calculations. Based on the completed geotechnical calculations, horizontal well installation and service will have little impact on the NYSRW rail line and ROW. Furthermore, it is not expected that horizontal well installation and operation will impede long-term operation of NYSRW facilities.

3.4.5 Pre-Mobilization Activities

The following additional pre-mobilization activities may be required prior to well installation:

- *Site Clearing* – Understory/brush along the proposed alignment may need to be cleared due to the significant vegetative growth within and directly adjacent to the proposed horizontal well alignment (on both sides of rail line).
- *Physical Confirmation of Utility Lines* – Although the One-Call, geophysical survey, and records review process will identify the presence of underground utilities, based on the complexity of this project and known existing utilities along the railroad ROW, physical confirmation may also be completed. Soft-dig methods may be used in select locations to further demarcate utility locations prior to well installation, especially in the area of the exit point of the well.

3.4.6 Mobilization and Site Preparation

Drill Rig and Support Equipment

Drilling equipment will be mobilized to the Site by flatbed trailers, with the tooling arriving in a 48-foot long enclosed trailer. Loads will include the drill rig, mud system, drilling rods, tooling, and driller's control trailer. There may be as many as 11 trailer loads of tooling and equipment.

This equipment will occupy an area approximately 150 x 150 feet, although assembly of casing or conveyance lines may temporarily extend outside that footprint. The approximate location of the drill equipment footprint is shown on Sheets G-1 and G-2 of Appendix A. The final location will be identified in the field during mobilization activities.

An American Augers DD210 drill rig will be used for this project. This drill rig generates 210,000 pounds of thrust and pullback force and 25,000 foot-pounds of torque. The drill rods are stored adjacent to the drill rig occupying a space approximately 10 feet wide and 50 feet long. The drill rig has a footprint of approximately 9 feet by 60 feet. Rods that are 31 feet in length will be used, with an outside diameter of approximately 8 inches at the joint.

The rig is supplied with drilling mud from the Mud Technology International MT-800 mud system. The MT-800 mud system is a self-contained unit 9 feet wide and 50 feet long. There are several hoses connecting the mud system, drill rig, and mud pit. In addition to the drilling and drill fluid equipment, one or more roll-off containers will be located adjacent to the mud systems to capture drill cuttings as they are removed from the shaker screens.

Drilling Fluid

The efficiency of the well is directly influenced by the hydraulic connection between the well screen and the adjacent formation. A biodegradable polymer drilling fluid will be used as the drilling fluid for this project. The drilling mud proposed will be either CETCO CleanDrill or Baroid Biobore. CleanDrill and Biobore are both biodegradable, organic polymer drilling fluids that have been specifically formulated for use on environmental remediation horizontal well drilling projects. The products are a combination of several natural organic gums or resins including guar, xanthan, and vegetable-derived starch. These products have been used for environmental remediation projects for approximately 16 years, with excellent results.

Cuttings and Waste Management

The estimated volume of cuttings from the borehole, totaling approximately 1,950 feet, is approximately 1,500 cubic feet (11,000 gallons). This is approximately equal to the amount of drilling fluid that will be required to fill the bore during drilling. Additional drilling mud is required beyond this volume to keep the mud pit and recycler full during operation. The total volume of waste cuttings and drilling fluid is estimated to be approximately 2,300 cubic feet (15,000-18,000 gallons).

Containment of waste cuttings during drilling will be accomplished with the use of roll-off containers, which are parked adjacent to the mud recycler and changed out as they are filled. The recycler cleans the mud through a series of shakers and sand and silt separating hydrocyclones. The cuttings are side-discharged from the recycler into the roll-off container. The crew members in charge of recycler operation manage the flow of cuttings into the recycler and will notify appropriate personnel in advance when a container change is necessary.

The 25 cubic yard roll-offs will be equipped with sealed doors and polyethylene liners. Three to five roll-off containers are expected to be used to contain the drilling derived materials. At least one roll-off will be staged at the exit side of the bore.

Decontamination

Drilling equipment will be decontaminated prior to mobilization to the Site. Once the well is installed, the drilling equipment will be cleaned at the work location. A decontamination area will be constructed of plastic sheeting and hay bales or local earth to create a containment area. All hoses and fluid transfer lines will be washed and flushed with the resulting fluids pumped into a roll-off container. The drilling machine, drill rods, and other heavy equipment will be washed and rinsed as required to remove any material.

3.4.7 Borehole Advancement

The drilling rig and primary support equipment that will be used for this project will consist of two key units: the directional drill and a mud mixing and supply system. Due to the combination of the length and depth of the bore and the drilling conditions anticipated, an American Augers DD210 drill rig will be used. This rig was selected on the basis of the Site conditions and the power and tooling requirements to successfully complete the project.

The drill rig is supplied with drilling fluid from a separate module, a MTI MT-800 system, that mixes and cleans the drill mud. This mud system includes multiple mud tanks, mixing jets, scalper screens/shakers, desilting and desanding hydrocyclones, pumps, and associated fluid conveyance lines. The mud system is equipped with a high-pressure mud pump of sufficient capacity to drive a downhole mud motor. The system is staged a short distance away from the drill and is connected by high pressure hoses. The mud system is set up to minimize crew contact with the recycled drilling mud and can be decontaminated with relative ease after the project has been completed. Drill cuttings drop from the shakers directly into a roll-off container positioned adjacent to the mud system. The remaining support equipment and vehicles can be staged where convenient for rig operations.

Drilling operations will include preparing the entry and exit pits, advancing the pilot hole, reaming the pilot hole, and pulling the well materials into the hole. A drill bit appropriate to cut a 9- to 11-inch pilot bore will be used to initiate the drilling, with an entry angle of approximately 12 to 17 degrees. At this entry angle, it will require an entry (riser) length of approximately five times the depth to reach the target depth. Since the target depth is 20 to 25 feet, the entry length will be approximately 360 feet.

The drill is advanced into the formation by the rotary wash method. Drilling fluid passes through the drill rods and drill head into the borehole, flushing the drill cuttings up the annular space between the rods and the borehole. Drilling fluid clears the cuttings and stabilizes the borehole, as well as cooling the electronics package in the drill head. The driller steers the drill head through the bore profile using the information provided by the electronics package.

Walkover or wireline equipment manufactured by Digital Control Inc. will be used for navigation and steering during borehole advancement. This equipment is capable of meeting or exceeding the tolerance of 0.5 feet vertically and 1 foot horizontally for the screened section of the well. A combination of precision pitch data and the surface elevations will be used to advance the bore along the horizontal profile. As the well progresses, data will be entered into a worksheet that has been generated for the bore path. Flags or spray paint will be used to mark rod lengths along the ground surface for post-construction surveying.

Once the pilot bore is completed, a reamer is attached to the drill rods at the exit end of the bore. For 6-inch well materials, a 10- to 12-inch diameter reamer will be used based on observations of the drilling and soil conditions. The stability of the borehole will be assessed at this time. If the boring does not seem likely to cave, the well casing will be attached directly behind the reamer, making the connection with a swivel to prevent rotation of the well casing during installation. The reamer is pulled back through the pilot bore with the well casing and screen trailing behind.

If the borehole appears to have zones of caving, the bore will be pre-reamed. This is generally done by retracting the reamer back towards the drill rig, attaching drill rods behind the reamer as they are removed. After the reamer has been recovered at the rig, the drill will re-attach it at the exit end, and attach the well casing string to it, using a swivel. This method has the advantage of always leaving tooling in the borehole and enabling the driller to re-establish the bore in case of caving.

As set-up continues and the pilot bore is being drilled, the well screen and casing will be assembled. To the extent possible, the welding and fusing of the well materials will occur in one continuous string prior to pullback to avoid any delays and potential for borehole collapse during the pullback operation. The stainless steel outer screen will be pulled into the borehole during pullback, and the HDPE manifold will be installed after the well has been developed.

Grout seals will be installed at both ends of the well. Shale trap packers and a tremie will be installed on the distal end of the well casing approximately 20 feet from the screen. A tremie will be installed on the proximal end of the well once the outer screen and casing have been installed. The cement/bentonite mixture will be injected through the tremies to form an impermeable seal at each end of the well.

3.4.8 Well Completion and Development

Well Completion

Wellhead completions are typically designed with the site and operational considerations in mind. The entry and exit points of the horizontal well will be completed as a belowground access points.

Well Development

After the installation of the well casing and screen, the first steps in the well development process will be initiated. The development process typically includes several steps of flushing, jetting, and pumping with the duration lasting several days. It is important for the first steps of the development to be initiated as soon as possible after the well materials are pulled into position.

The initial step includes flushing clean water through the inside of the well casing and screen to remove as much drilling fluid as possible from both the bore and the well screen. A delay between well completion and development allows the borehole to collapse, which traps drilling fluid in the formation and makes effective development of the well more reliant on the breakdown of the drilling fluid instead of its removal.

Immediately after the initial flush of water, a pH adjusting and fluid-breaking solution are injected into the well. This step can also be combined with the initial flush. The pH adjustment optimizes the water chemistry in the well to increase the effectiveness and reaction rate of the fluid-breaking enzyme. The breaking solution is jetted into the well using a high pressure jetting system moved through the length of the screen.

The biopolymer mud starts breaking immediately after injection of the breaking solution and typically will continue for several days. Most of the breaking occurs within the first 12 to 24 hours.

The remaining well development steps can be accomplished after a delay of hours or days. A Vactor high pressure sewer jetting tool will be used, passing it through the screened section for 2 to 3 round trips (4 to 6 passes each way through the screen). This step dislodges any silt or clay that may have been forced into the screen slots, which can reduce the open area of the well.

The final step in the well development is to remove several well-volumes of water. A Vactor sewer cleaner rig will be used to flush sediment and formation water from the well. This will ensure that the screen is cleared along the entire length of the developed section. Water resulting from the development efforts will be containerized in roll-offs.

To create the annular seals, a tremie will be used to inject cement-bentonite grout slurry, with up to 5% bentonite admixture with Type II or Type III Portland Cement, above the shale trap packers, back to the ground surface. Once the well is in place, the inner header pipe will be installed.

3.4.9 Waste Management

All investigation-derived materials will be handled and disposed of in accordance with the Site Waste Management Plan.

Residual solids (i.e., drill cuttings and mud) generated during the installation of the horizontal well will be placed in individual polyethylene-lined 25 cubic yard roll-offs with sealed doors and staged at a secured location for disposal. Waste classification samples will be collected from the residual solids, as appropriate, and the roll-offs will be transported offsite to an approved disposal facility.

Liquids (i.e., decontamination fluids and development water) generated during drilling activities will also be containerized in an appropriate container, such as a baker tank, and transported offsite to an approved disposal facility or back to the Site for disposal in Pond #3 as allowed by the DGW permit.

Personal protective equipment and other general wastes (i.e., miscellaneous trash and debris) will be disposed of in a non-hazardous waste dumpster located onsite.

3.5 Horizontal Well Startup and Commissioning

The total estimated flow to be distributed through the horizontal well system will not exceed 280 gpm (in accordance with the DGW permit), with an anticipated working flow rate of 120 to 140 gpm. With an estimated total screen length of approximately 1,410 feet, the flow rate per foot of screen will range between 0.09 to 0.20 gpm. The infiltration pressure in the well will be gravity drainage or just above the natural groundwater pressure around the well.

The horizontal well will be tested using GWET system effluent at controlled flow rates and volumes. An inline flow meter and totalizer will be used to monitor and control water flow rates and volumes for a set duration. While treated water is discharged to the horizontal well, groundwater elevation measurements in adjacent piezometers and nearby monitoring wells will be periodically collected to evaluate changes to the water table during testing. This monitoring will also be performed to prevent unexpected mounding from intersecting nearby residential basements. Interlocks will be installed to shut the GWET system down if elevations get above a set point that could potentially cause concerns in nearby basements (similar to the current infiltration beds).

Treated groundwater will be introduced into the horizontal well at a low rate until a volume equal to the horizontal well pipe volume has been introduced. At that point, the injection rate will be increased to one half the target injection volume. This injection rate will continue for 6 hours, while monitoring for groundwater elevation changes in the piezometers and nearby monitoring wells. Both ends of the horizontal well will be observed periodically to see if the well seals leak. Absent any anomalous measurements, the injection rate will then be increased to the full volume for 6 hours while monitoring continues.

3.6 Monitoring Program

The pilot study is expected to run for approximately one year and the shallow aquifer will be monitored during that period. The goals of the system monitoring are to:

- Monitor the groundwater table in the vicinity of the horizontal well to evaluate the degree of mounding that occurs due to the injected groundwater. The rationale for this monitoring requirement is to evaluate whether groundwater mounding is occurring to a degree that it may impact nearby infrastructures (e.g., utilities and residential basements upgradient along Barbara Drive or downgradient at the residences close to the proposed horizontal well).
- Monitor the groundwater table in the vicinity of the horizontal well to evaluate the change in hydraulic gradient that occurs due to the injected groundwater. The rationale for this monitoring requirement is to evaluate the increases in pore volume flushing rates in shallow groundwater.

<u>Piezometer Installation</u>

Following installation of the horizontal well, shallow piezometers will be installed on the northern side of the tracks and horizontal well and on the southern side of the horizontal well. Horizontal piezometer clusters are being proposed along the horizontal well flow path as opposed to vertical clusters since the purpose of this pilot study is focused on evaluating horizontal flow across the shallow zone. The horizontal clusters will be able to show the head drop moving away from the horizontal well, which will be part of the plan for monitoring the potential for basement flooding.

Four shallow piezometers will be installed along the well alignment on the northern side of the railroad tracks in the ROW. These piezometers will be located at Schuyler Avenue, Jefferson Avenue, Perrin Avenue, and north of well 25 (located on Durham Street). Four additional piezometers will be installed perpendicular to these piezometers on the southern side of the horizontal well (immediately adjacent to). With the exception of the easternmost piezometer location since the well 25 cluster is nearby (on Durham Street), another piezometer will be installed approximately 20 feet south of these "southern side of tracks" piezometers to assess the change in hydraulic gradient over time. The locations of the piezometers are shown on Figure G-1 within Appendix A.

The elevation of each piezometer screen interval will be approximately the same elevation as the horizontal well. The location and top of casing elevation of these piezometers will be surveyed following installation (along with the entry and exit points of the horizontal well).

<u>Groundwater Elevation Measurements</u>

The primary performance metric for the hydraulic surcharging pilot study is a change in the hydraulic gradient in the shallow aquifer in the area of the horizontal well, which will be used to calculate the increase in pore surcharging rates. This metric can be effectively evaluated in a reasonable timeframe by documenting changes in groundwater elevations, changes in hydraulic gradients, and evaluations of pore flushing times. Groundwater elevations in the shallow groundwater zone will respond relatively rapidly to the horizontal well discharge. These shallow groundwater elevation changes will be used to evaluate the changes in hydraulic gradients and the expected change in pore flushing times. Therefore, the proposed monitoring will focus on groundwater elevations in the vicinity of the horizontal well and extending outward from the well.

The newly-installed piezometers shown on Figure G-1 will be used in conjunction with existing monitoring wells to measure groundwater elevations during the start-up and commissioning of the horizontal well, as well as for long-term operation as part of the pilot study evaluation. Existing monitoring wells that will be monitored include the Well 25 cluster and 146-S located on Durham Street, Well 128 cluster and shallow wells associated with the enhanced in-situ bioremediation pilot study located on Barbara Drive/Schuyler Avenue, and 150-S located on Grant Avenue. In addition, the water level within the horizontal well will be monitored.

Groundwater elevation monitoring during start-up and commissioning will be performed at a minimum of twice per week. This twice weekly monitoring will continue for a minimum of three months. After three months, the groundwater elevation monitoring will occur monthly.

During operation, the groundwater elevation monitoring data will be used to optimize the injection and (if necessary) the pumping to meet the objective of increasing shallow zone flushing rates in the western portion of the offsite plume area near the Site boundary.

The full-time pilot study operation will include continued evaluation of groundwater elevations as it relates to nearby basements along the well alignment. Transducers will be placed in select piezometers as well as the horizontal well to collect groundwater elevation data on a continual basis as well as to assess elevations over time. Data will be downloaded from the transducers on a weekly basis to assess conditions. There have been no basement issues to date with the existing infiltration beds. The horizontal well will surcharge the same amount of water currently going to the beds but along a larger lateral extent. Based on 18 years of operating the existing GWET system and the modeling of the horizontal well, there should be no issues with regards to potential flooding of basements.

Target groundwater elevations have been established for the monitoring program to address the potential for flooding of basements. If groundwater elevations in one or more of the piezometers adjacent to the horizontal well equal or exceed 213 feet (NGVD 1988), which is approximately 2 feet below the minimum basement elevation, then monitoring will be completed weekly and the horizontal well operation will be evaluated. If groundwater elevations in one or more of these piezometers adjacent to the horizontal well equal or exceed 214.5 feet (NGVD 1988), then the horizontal well discharge rate will be reduced until the groundwater elevations decline below 213 feet.

Data collected during the pilot study will also be used to update, if necessary, the groundwater model created for the Site. The model will be used to evaluate observations and understand the potential effects of groundwater mounding in the area of the horizontal well and to evaluate the change in the pore flushing rate.

<u>Groundwater Quality</u>

Groundwater quality (i.e., VOC concentrations), in the vicinity of the horizontal well, will be monitored as part of the ongoing semi-annual groundwater monitoring program to document the potential effects of the anticipated enhanced flushing in the shallow aquifer zone (approximately 10 to 30 feet bgs).

Shallow groundwater VOC concentrations are affected by many factors and the timeframe of this pilot study (approximately one year) may not allow for reliable evaluation of VOC concentration trends. The elevation of the water table, groundwater recharge rates, seasonal variations in groundwater flow rates and directions, and changes in extraction well pumping rates and the groundwater discharge rates to the horizontal well and infiltration beds are just some of the factors that affect shallow groundwater VOC concentrations. Shallow groundwater flow rates, though higher than the intermediate and deep zones, are still relatively slow. Groundwater modeling suggests that the steady state time required for a single pore flush of discrete areas around monitoring wells in the shallow groundwater in the horizontal well area ranges from about two months to a year. The time to define VOC concentration trends will be significantly longer based on modeling results. The ongoing semi-annual monitoring program has documented decreases in VOC concentrations of over an order of magnitude in the eastern offsite shallow zone. The ongoing semi-annual groundwater monitoring program should continue to provide sufficient groundwater quality data over time to document changes, and should be sufficient to demonstrate the effect of flushing of the shallow zone in the vicinity of the horizontal well.

3.7 Reporting

Status updates will be provided to NJDEP and USEPA during the course of the pilot study.

Quarterly status reports will be submitted to NJDEP and USEPA which summarizes pilot study activities for the reporting period. These reports, submitted as an attachment to the quarterly Site progress reports, will be submitted on the 30th day of the month following the reporting quarter.

Monitoring of the GWET system and treated groundwater discharge will continue to be reported in the quarterly operating reports submitted to NJDEP and USEPA.

A pilot study technical memorandum will be prepared after one year of full-time pilot study operation. This report will be submitted within 90 days following completion of the one-year operation period and will include any recommendations based on the evaluation of the collected data over the one-year study.

3.8 Schedule

Major components of the current schedule include the following:

- *Pilot Study Permitting* – A PBR (greater than 180 days) has been submitted (Appendix C). Approval of the PBR will be needed before installation begins.
- *Pilot Study Construction* – Pre-mobilization activities, mobilization and installation of the horizontal well, GWET system modifications (i.e., hook-up of well to system discharge piping), and start-up and testing is anticipated to take 3 to 4 months.
- *Pilot Operations* – Full-time operations will continue until sufficient data is collected to evaluate the efficacy of optimizing groundwater flow rates within the shallow aquifer in the western portion of the plume near the Site boundary. The pilot study is expected to run for approximately one year and the shallow aquifer will be monitored during that period.

4 References

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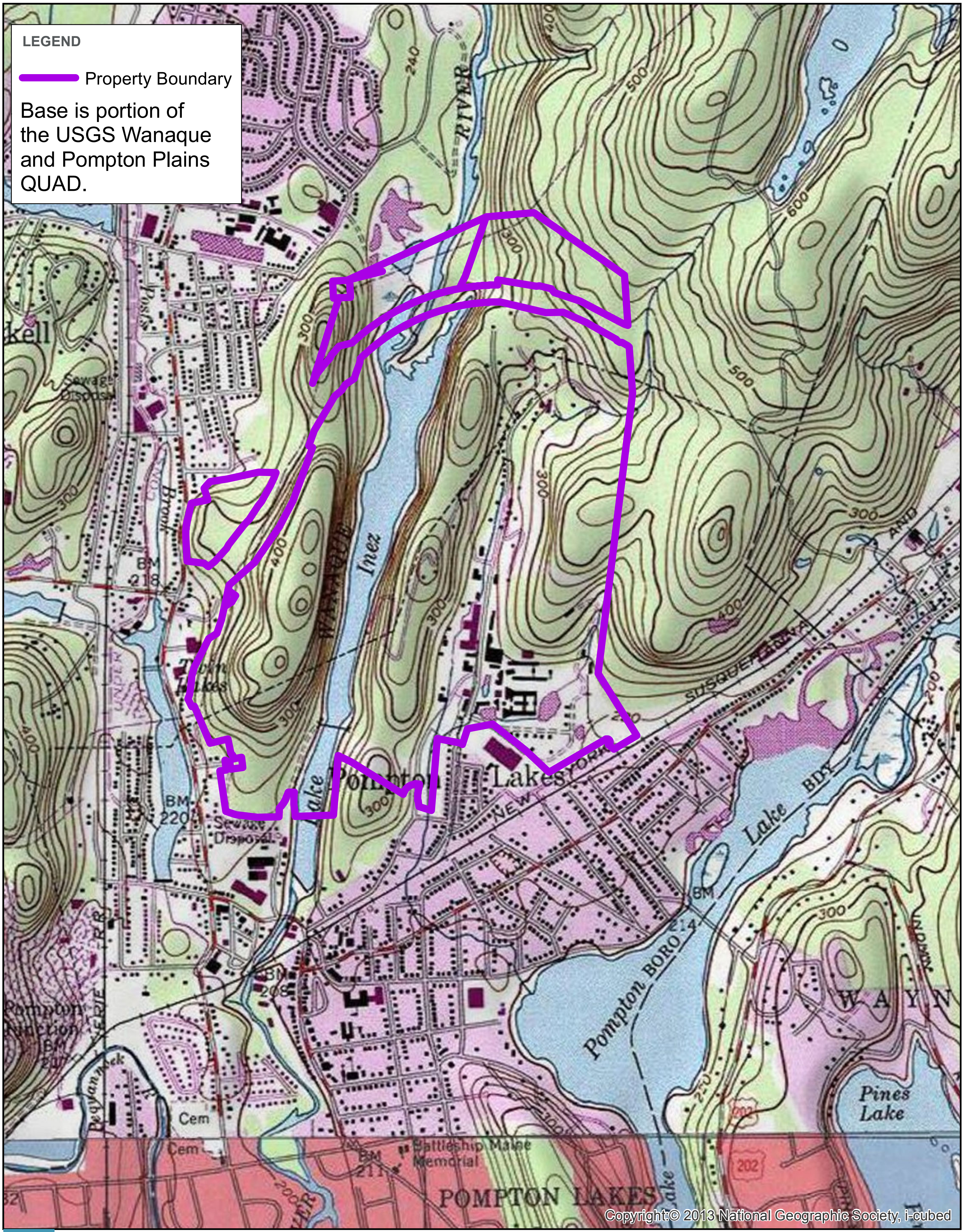
O'Brien and Gere. August 31, 2011. *Shallow Groundwater Remedial Action Selection Report*.

O'Brien and Gere. June 28, 2013. *Implementation Work Plan – Hydraulic Surcharging Pilot Study*.

Figures



0 0.125 0.25 0.5 Miles

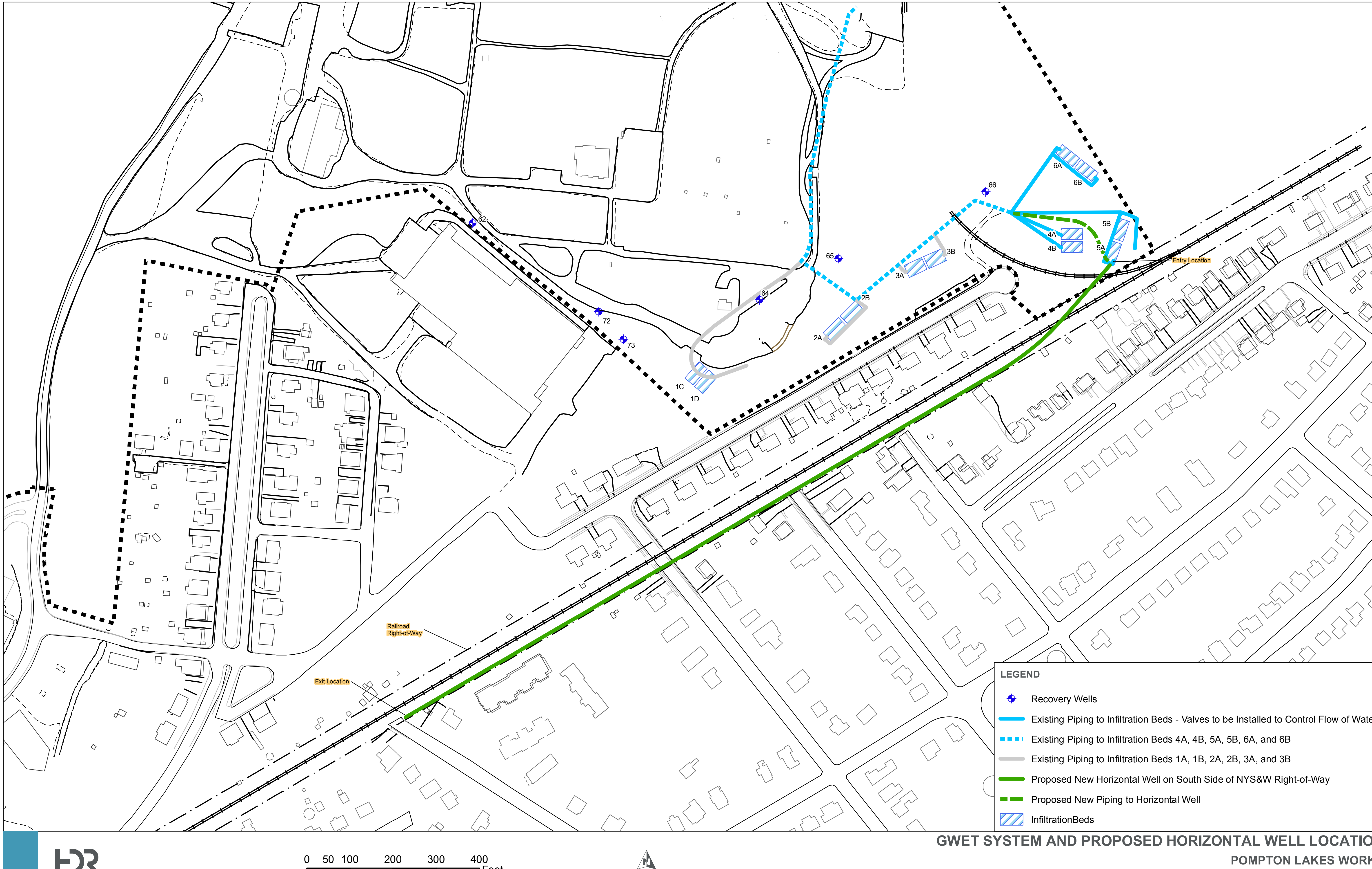
SITE LOCATION MAP

POMPTON LAKES WORKS

FIGURE 1

REVISED DRAFT IMPLEMENTATION WORK PLAN - HYDRAULIC SURGHARGING PILOT STUDY

PATH: I:\507881 - OFFSITE GROUNDWATER RD\47723.OFFSITE GW RD - 507881\DOCS\REPORTS\IMPLEMENTATION WP - HORIZONTAL WELL\FIGURES\FIGURE1.MXD - USER: CWEAVER - DATE: 4/29/2016

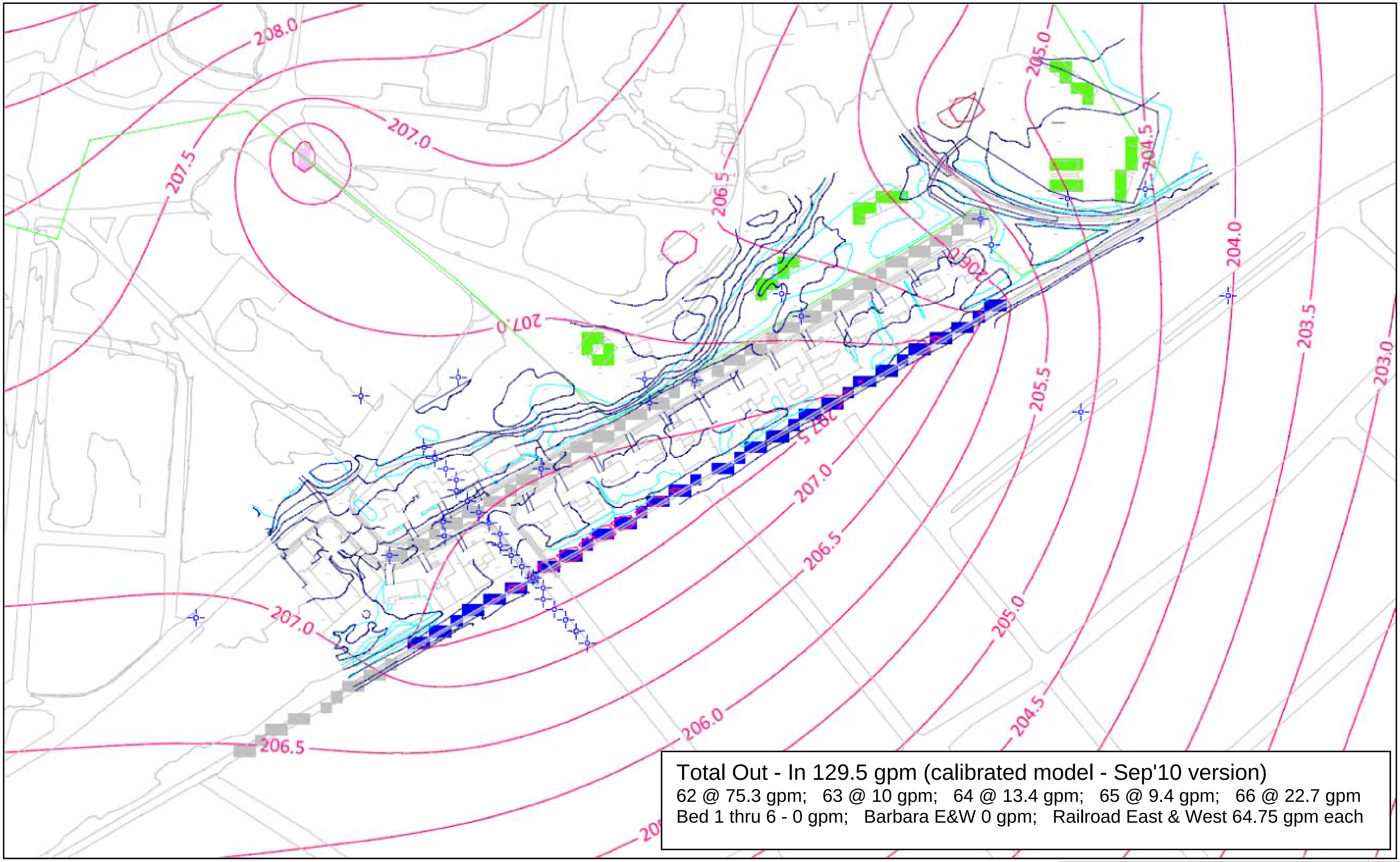


HDR

GWET SYSTEM AND PROPOSED HORIZONTAL WELL LOCATION

POMPTON LAKES WORKS

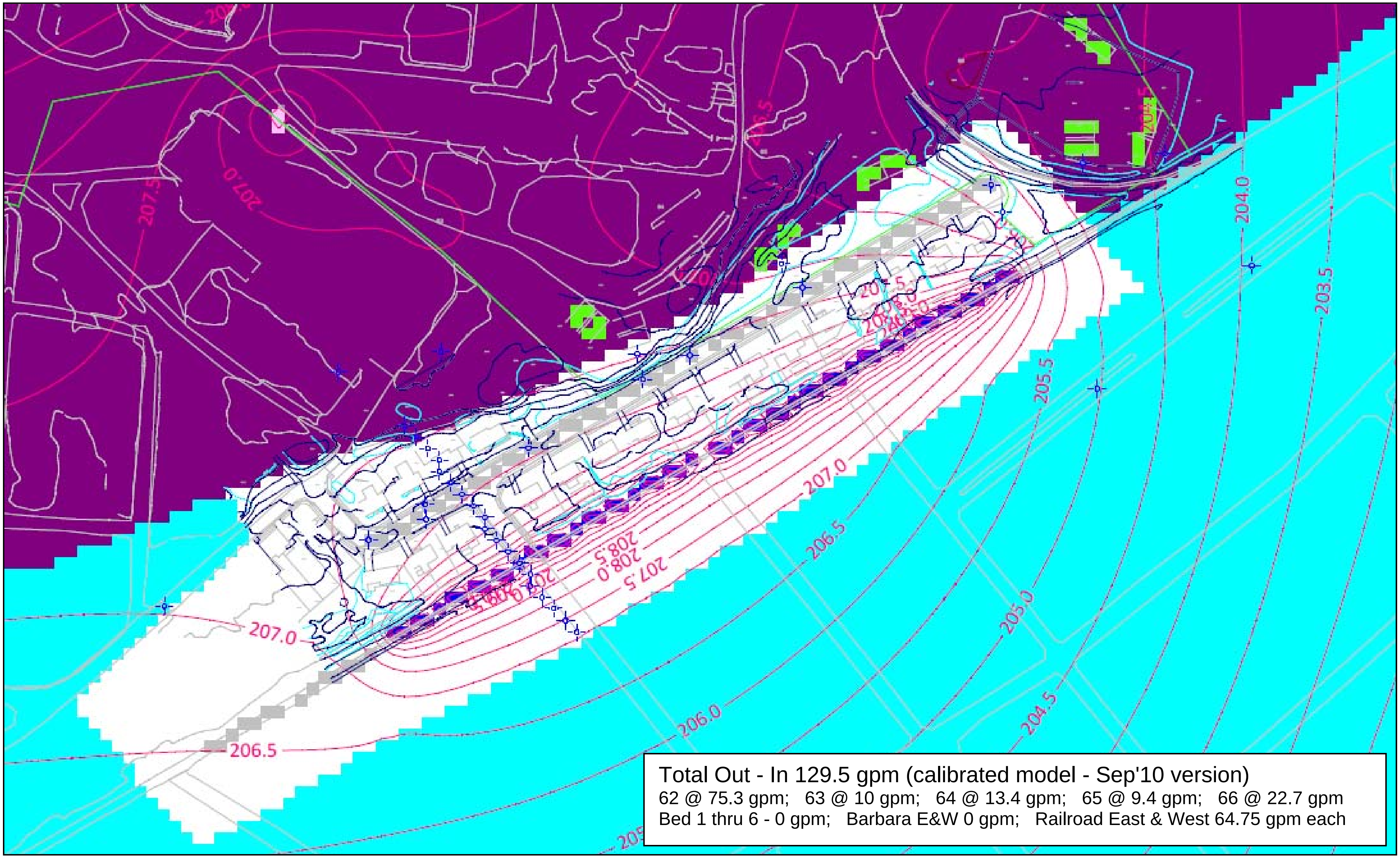
FIGURE 2



Model Run – RR Trial 1

PARSONS

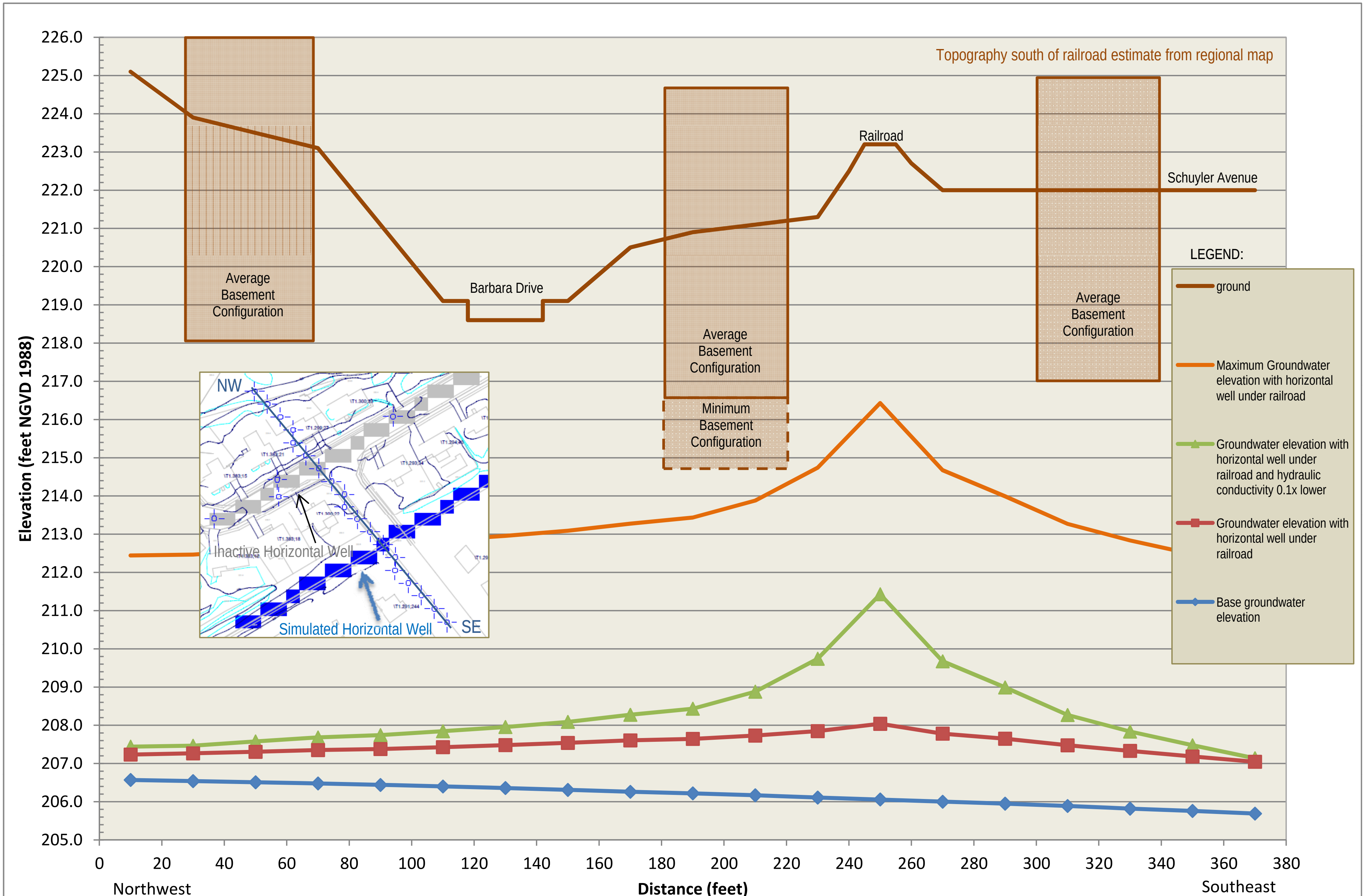
Figure 3



Model Run – RR Trial 2

PARSONS

Figure 4



Modeled Horizontal Well Groundwater Mounding

PARSONS

Figure 5

Appendices

Appendix A. Design Drawing Package

NOTES:
1. LOCATIONS OF PROPOSED FEATURES ARE APPROXIMATE AND MAY BE ADJUSTED BASED ON FIELD CONDITIONS.
2. SITE MAPPING ADAPTED FROM AERIAL MAPPING AS PRODUCED BY 3DI, LLC, DATED 1995 AND 1/30/99, PURSUANT TO INFORMATION PROVIDED BY DUPONT.
3. HORIZONTAL COORDINATES BASED ON NEW JERSEY STATE PLANE COORDINATE SYSTEM NAD 83. VERTICAL DATUM IS NGVD 29, (SUBTRACT 0.9 FT FROM NGVD 1929 ELEVATION TO CONVERT TO NAVD 1988 ELEVATION).
4. UTILITIES (WESTERN UNION, MCI, AT&T) SHOWN ARE BASED ON INFORMATION RECEIVED FROM NYS&W ON APRIL 23, 2013 AND GEOPHYSICAL SURVEY COMPLETED IN MAY 2015.
60" HIGH PRESSURE WATER LINE LOCATION BASED ON "AS-BUILT" DRAWINGS PROVIDED BY UNITED WATER NEW JERSEY ON NOV. 8, 2013 AND GEOPHYSICAL SURVEY COMPLETED IN MAY 2015.
5. CONTRACTOR/HORIZONTAL WELL DRILLER SHALL BE RESPONSIBLE FOR VERIFYING LOCATIONS OF ALL UTILITIES PRIOR TO INSTALLATION OF HORIZONTAL WELL.
6. RAILROAD EMBANKMENT GRADIENT/TOPOGRAPHY IS BASED ON SURVEY DATA COLLECTED BY VARGO ASSOCIATES IN MAY 2015.
7. THE DETAILS OF THE NEW PERMANENT RAILROAD SIGNS FOR THE HORIZONTAL WELL WILL BE SPECIFIED BY THE NYS&W.
8. THE LOCATION AND DESIGN OF THE NEW ONSITE ACCESS VAULT WILL BE SPECIFIED IN THE DESIGN DRAWINGS FOR THE HORIZONTAL WELL TIE-IN WITH THE EXISTING GROUNDWATER TREATMENT SYSTEM.
9. HORIZONTAL WELL ALIGNMENT ON THE SOUTH SIDE OF THE NYS&W RIGHT-OF-WAY WAS APPROVED BY THE NYS&W ON MARCH 21, 2016.

Legend

- Monitoring Wells
- Approximate Location of Proposed Piezometer (11 Total)
- Location of Geotechnical Boring (5 Total)
- Property Boundary
- Electric
- Gas
- Sewer
- Telephone
- Unknown Line
- Water
- Existing Treated Groundwater Infiltration Beds
- Existing Piping to Infiltration Beds - Valves to be Installed to Control Flow of Water
- Existing Piping to Infiltration Beds 4A, 4B, 5A, 5B, 6A, and 6B
- Existing Piping to Infiltration Beds 1A, 1B, 2A, 2B, 3A, and 3B
- Proposed New Horizontal Well on South Side of NYS&W Right-of-Way
- Proposed New Piping to Horizontal Well

FDR

2000 CANNONBALL ROAD
POMPTON LAKES, NJ
07442

0 50 100 200 Feet
1 inch = 100 feet

DATE FEB. 2015
DRAWN BY CA
CHECKED BY GT

NO.	DATE	REVISION	INIT.

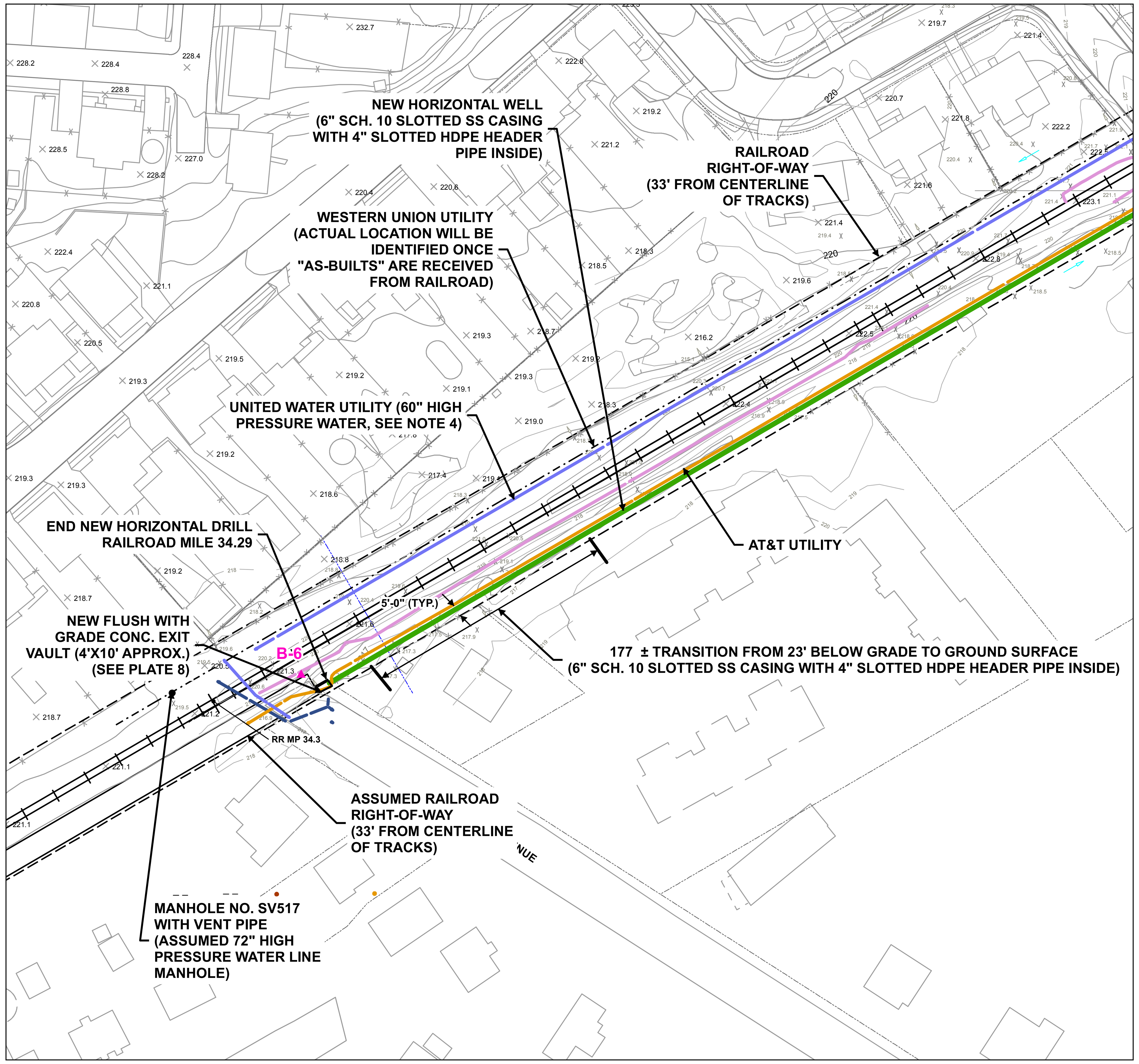
HORIZONTAL WELL LAYOUT PLAN

POMPTON LAKES HORIZONTAL WELL

G-1

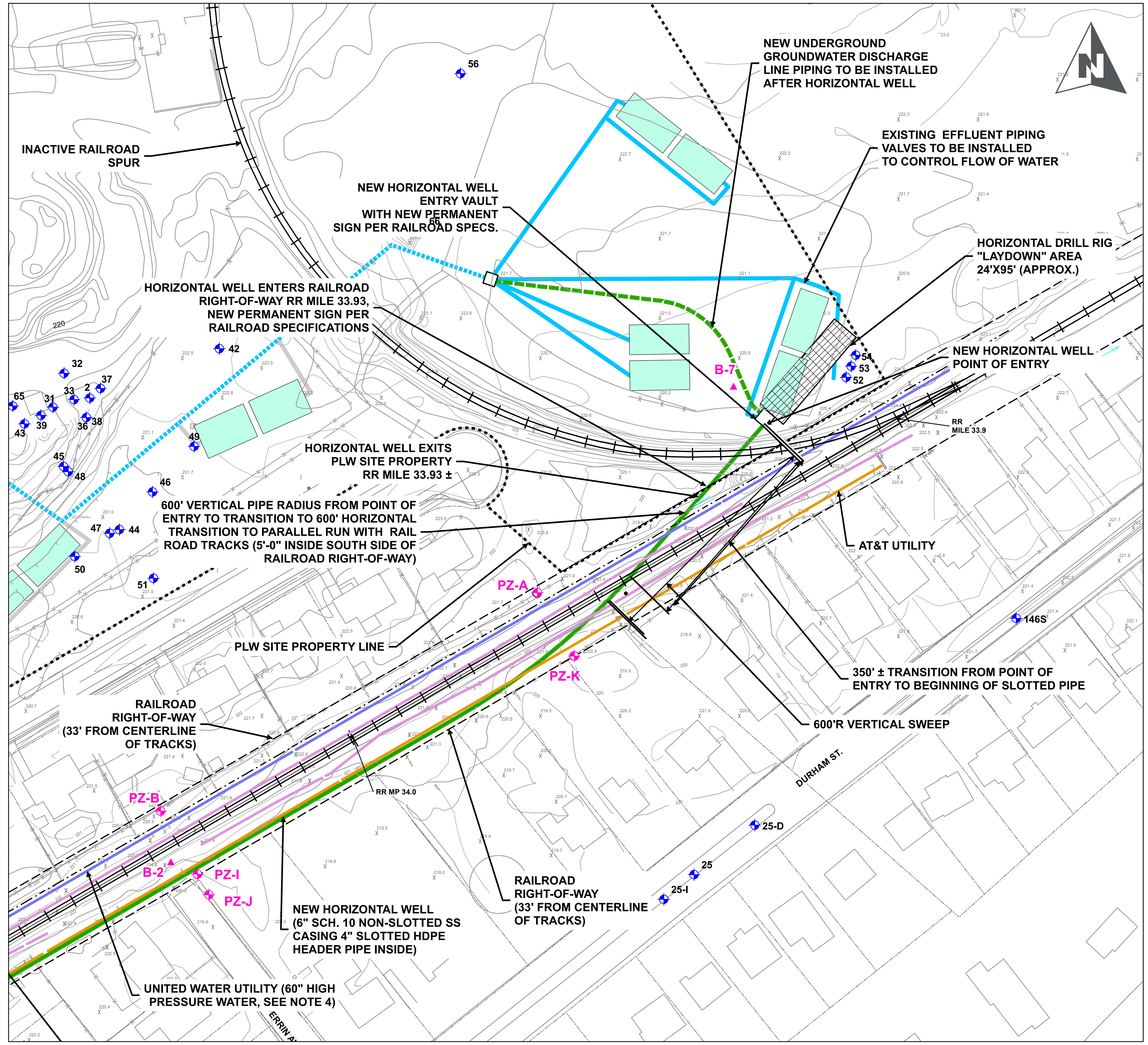
PATH: I:\507881 - OFFSITE GROUNDWATER RD\47723.OFFSITE GW RD - 507881\DOCS\DWG\HORIZONTAL WELL IWP 2016\G_1.MXD - USER: CWEAVER - DATE: 4/29/2016

POMPTON LAKES, NEW JERSEY



PARTIAL PLAN VIEW - END OF HORIZONTAL WELL

1 inch = 50 feet



PARTIAL PLAN VIEW - BEGINNING OF HORIZONTAL WELL

1 inch = 50 feet

NOTES:
1. LOCATIONS OF PROPOSED FEATURES ARE APPROXIMATE AND MAY BE ADJUSTED BASED ON FIELD CONDITIONS.
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7. THE DETAILS OF THE NEW PERMANENT RAILROAD SIGNS FOR THE HORIZONTAL WELL WILL BE SPECIFIED BY THE NYS&W.
8. THE LOCATION AND DESIGN OF THE NEW ONSITE ACCESS VAULT WILL BE SPECIFIED IN THE DESIGN DRAWINGS FOR THE HORIZONTAL WELL TIE-IN WITH THE EXISTING GROUNDWATER TREATMENT SYSTEM.
9. HORIZONTAL WELL ALIGNMENT ON THE SOUTH SIDE OF THE NYS&W RIGHT-OF-WAY WAS APPROVED BY THE NYS&W ON MARCH 21, 2016.

Legend

- Monitoring Wells
- Approximate Location of Proposed Piezometer (11 Total)
- Location of Geotechnical Boring (5 Total)
- Property Boundary
- Electric
- Gas
- Sewer
- Telephone
- Unknown Line
- Water
- Proposed Horizontal Well Pipe Laydown Area
- Former Buildings
- Existing Treated Groundwater Infiltration Beds

HDR

2000 CANNONBALL ROAD
POMPTON LAKES, NJ
07442

0 25 50 100 Feet
1 inch = 50 feet

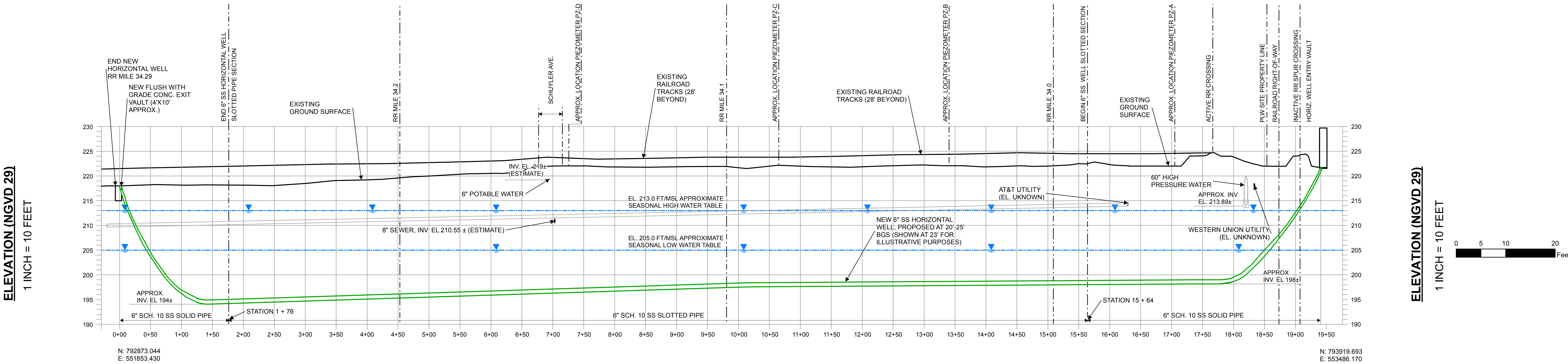
DATE FEB. 2015
DRAWN BY CA
CHECKED BY GT

NO.	DATE	REVISION	INIT.

HORIZONTAL WELL PARTIAL PLANS

POMPTON LAKES HORIZONTAL WELL

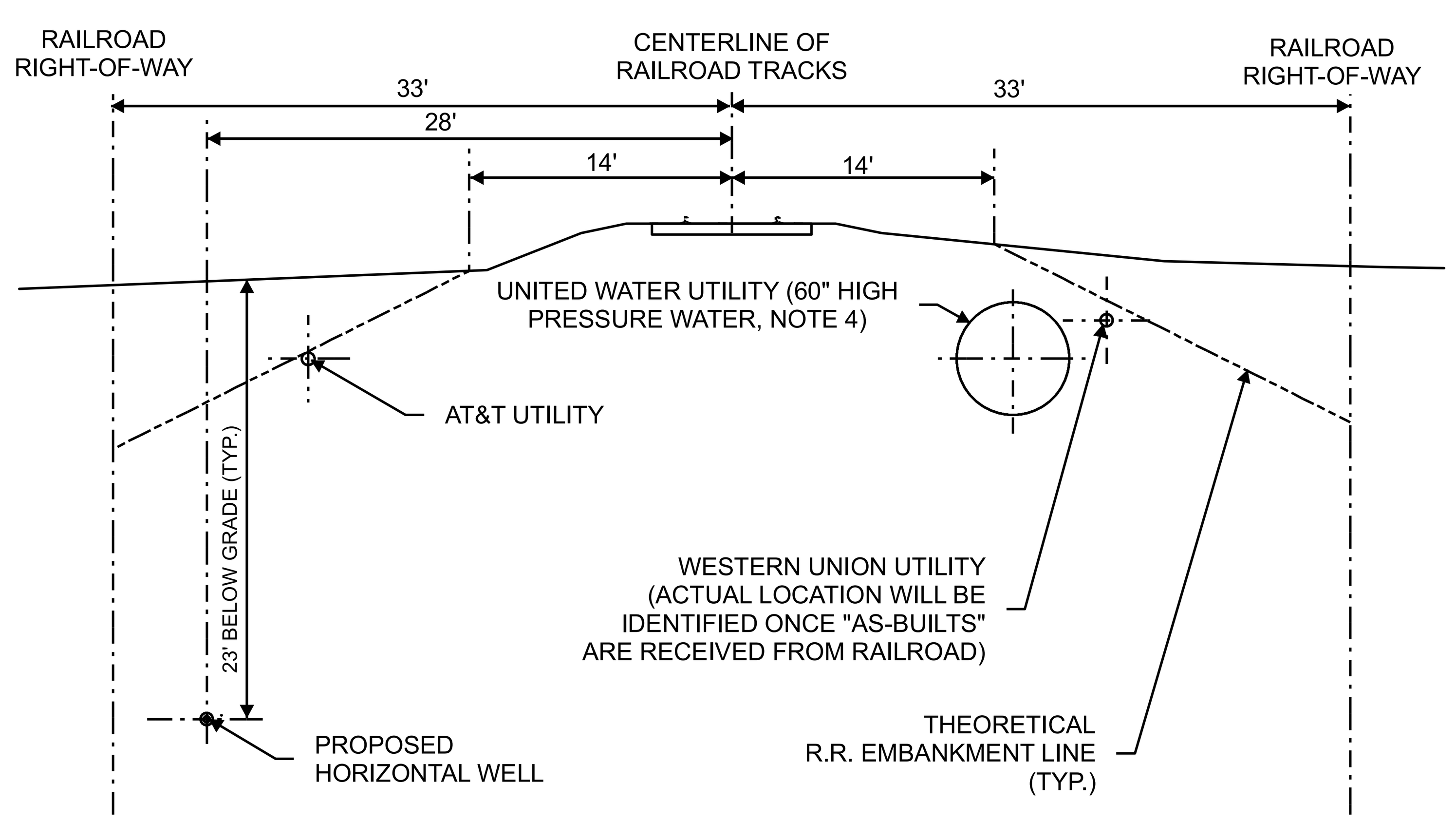
G-2



DISTANCE (FEET)

1 INCH = 80 FEET

PROFILE ALONG CENTERLINE OF PROPOSED HORIZONTAL WELL



TYPICAL SECTION - RAILROAD UNDERGROUND PIPING CONFIGURATION

NOT TO SCALE

NOTES:
1. LOCATIONS OF PROPOSED FEATURES ARE APPROXIMATE AND MAY BE ADJUSTED BASED ON FIELD CONDITIONS.
2. SITE MAPPING ADAPTED FROM AERIAL MAPPING AS PRODUCED BY 3DI, LLC, DATED 1995 AND 1/30/99, PURSUANT TO INFORMATION PROVIDED BY DUPONT.
3. HORIZONTAL COORDINATES BASED ON NEW JERSEY STATE PLANE COORDINATE SYSTEM NAD 83. VERTICAL DATUM IS NGVD 29, (SUBTRACT 0.9 FT FROM NGVD 1929 ELEVATION TO CONVERT TO NAVD 1988 ELEVATION).
4. UTILITIES (WESTERN UNION, MCI, AT&T) SHOWN ARE BASED ON INFORMATION RECEIVED FROM NYS&W ON APRIL 23, 2013 AND GEOPHYSICAL SURVEY COMPLETED IN MAY 2015. 60" HIGH PRESSURE WATER LINE LOCATION BASED ON "AS-BUILT" DRAWINGS PROVIDED BY UNITED WATER NEW JERSEY ON NOV. 8, 2013 AND GEOPHYSICAL SURVEY COMPLETED IN MAY 2015.
5. CONTRACTOR/HORIZONTAL WELL DRILLER SHALL BE RESPONSIBLE FOR VERIFYING LOCATIONS OF ALL UTILITIES PRIOR TO INSTALLATION OF HORIZONTAL WELL.
6. RAILROAD EMBANKMENT GRADIENT/TOPOGRAPHY IS BASED ON SURVEY DATA COLLECTED BY VARGO ASSOCIATES IN MAY 2015.
7. HORIZONTAL WELL ALIGNMENT ON THE SOUTH SIDE OF THE NYS&W RIGHT-OF-WAY WAS APPROVED BY THE NYS&W ON MARCH 21, 2016.

2000 CANNONBALL ROAD
POMPTON LAKES, NJ
07442

0 40 80 160 Feet
1 inch = 80 feet

DATE FEB. 2015
DRAWN BY CA
CHECKED BY GT

NO.	DATE	REVISION	INIT.

HORIZONTAL WELL PROFILE AND SECTION

POMPTON LAKES WORKS HORIZONTAL WELL

G-3

Appendix B. NYSWR Revised Draft Design Package for Installation of Horizontal Well Approval

The New York, Susquehanna and Western Railway Corporation
1 Railroad Avenue
Cooperstown, NY 13326
607-547-2555, Ext. 264 • FAX 607-547-2555 EXT. 269

R. J. HENSEL
VICE- PRESIDENT OF ENGINEERING

March 21, 2016

Mr. Gaetano V. Termini, P.E.
Project Manager
HDR Engineering, Inc.
2000 Cannonball Road
Pompton Lakes, NJ 07442

Re: Revised Draft Design Package for Installation of Horizontal Well
Pompton Lakes Works Site, Pompton Lakes, NJ
NYS&W License Agreement NJ-5455, Entry Permit P-681

Dear Mr. Gaetano,

The NYS&W Railway has reviewed the February 2016 Revised Draft Design Package for the proposed horizontal well at the DuPont site in Pompton Lakes, NJ. We take no exception to the information in the Draft Design Package and proposed horizontal well occupancy of NYS&W property. If you have any questions, then please call me.

Very truly yours,

Richard J. Hensel

Richard J. Hensel
Vice President of Engineering

cc: Nathan Fenno
R. J. Hensel
Todd Dragland
Rick Howard
Engltr.361

Appendix C. Draft Discharge to Groundwater Permit-by-Rule Package and Public Notice

New Jersey Department of Environmental Protection
Site Remediation Program

DISCHARGE TO GROUND WATER (DGW) PERMIT-BY-RULE AUTHORIZATION REQUEST

☐ LSRP ☐ Subsurface Evaluator (UHOT)

Date Stamp (For Department use only)

SECTION A. SITE NAME AND LOCATION

Site Name: Pompton Lakes Works Site
AKAs: DuPont Pompton Lakes Works Site
Street Address: 2000 Cannonball Rd
Municipality: Pompton Lakes (*Township, Borough or City*)
County: Passaic Zip Code: 07442
Program Interest (PI) Number(s): 007411
Case Tracking Number(s) for this submission: ____________

Municipal block(s) and lot(s) where the **proposed discharge(s)** would occur:
Block # 2400 Lot #(s) 1 and 2 Block # ______ Lot #(s) ______
Block # ______ Lot #(s) ______ Block # ______ Lot #(s) ______

SECTION B. FEE AND DISCHARGE INFORMATION

DGW Proposal Review Fee $350.00
(Relevant fee will be submitted upon approval of this draft package.)

Discharge Type *(check all that apply)*

☒ Discharge of Recovered Ground Water
Will the discharge be a result of dewatering only? .... ☐ Yes ☒ No
☐ Discharge that is part of an *In situ* Remediation
☐ Discharges other than those above *(see instructions for more information)*

Facility Type *(check all that apply)*

☒ Underground Injection Control (UIC) facility (i.e., any type of injection)
☐ Non-UIC (e.g., surface application) *(see instructions for more information)*

Attach a Discharge to Ground Water Proposal to this form *(see instructions)*

SECTION C. PUBLIC NOTICE PROVISIONS *(Does not apply to residential heating oil tank cases)*

Is the proposed discharge lasting greater than 180 days? .... ☒ Yes ☐ No
If "Yes," attach a copy of the public notice written as you intend it to be published. *(see instructions)*

SECTION D. SITE USE AND GROUND WATER CLASSIFICATION

Current Site Use *(check all that apply)*

☒ Industrial
☐ Residential
☐ Commercial
☐ School or child care
☐ Other ____________
☐ Agricultural
☐ Park or recreational use
☐ Vacant
☐ Government

Intended Future Site Use *(check all that apply)*

☒ Industrial
☐ Residential
☐ Commercial
☐ School or child care
☐ Park or recreational use
☐ Vacant
☐ Government
☐ Future site use unknown

What is the ground water classification for this site as per N.J.A.C. 7:9C? *(check all that apply)*

☐ Class I-A
☐ Class I-PL Pinelands Protection Area
☐ Class I-PL Pinelands Preservation Area
☒ Class II-A
☐ Class III-A
☐ Class III-B

SECTION E. RECEPTOR EVALUATION SUMMARY

Non-UHOT Cases

1. Have any of the following been identified on the site or within 200 feet of the site boundary?

   Check all that apply.

   ☒ Residences
   ☐ Public and private schools (K-12)
   ☒ Other occupied buildings
   ☐ Child care facilities
   ☒ Surface water
   ☒ Public parks and playgrounds

2. Did the well search conducted as a part of the receptor evaluation show any well use (potable, industrial, or irrigation)? ☐ Yes ☒ No

   If "Yes," indicate the type of use and approximate distance (closest occurrence) from site: *(Check all that apply)*

   ☐ Potable Distance from site: ______________ feet

   ☐ Industrial Distance from site: ______________ feet

   ☐ Irrigation Distance from site: ______________ feet

3. Have any of these receptors been impacted? ☒ Yes ☐ No

   If "Yes," Do you have an NJDEP assigned Case Manager? ☒ Yes ☐ No

   If "Yes," please list the Case Manager: Mr. Anthony Cinque

UHOT Cases

1. Is ground water contamination above the Ground Water Remediation Standards? ☐ Yes ☐ No
   If "Yes," answer questions 2 and 3.
2. Has a potable well been identified within 100 feet of the contamination? ☐ Yes ☐ No
3. Have any potable wells been impacted? ☐ Yes ☐ No
   If "Yes," has the NJDEP been notified? ☐ Yes ☐ No

SECTION F. PERSON RESPONSIBLE FOR CONDUCTING THE REMEDIATION INFORMATION AND CERTIFICATION

Full Legal Name of the Person Responsible for Conducting the Remediation: The Chemours Company FC, LLC

Representative First Name: Sheryl Representative Last Name: Telford

Title: Director, Environment, Health, Safety and Remediation

Telephone Number: (302) 773-2597 Ext.: ______ FAX: ______

Mailing Address: 2000 Cannonball Rd

City/Town: Pompton Lakes State: NJ Zip Code: 07442

Email Address: Sheryl.A.Telford@chemours.com

This certification shall be signed by the person responsible for conducting the remediation who is submitting this notification in accordance with Administrative Requirements for the Remediation of Contaminated Sites rule at N.J.A.C. 7:26C-1.5(a).

I certify under penalty of law that I have personally examined and am familiar with the information submitted herein, including all attached documents, and that based on my inquiry of those individuals immediately responsible for obtaining the information, to the best of my knowledge, I believe that the submitted information is true, accurate and complete. I am aware that there are significant civil penalties for knowingly submitting false, inaccurate or incomplete information and that I am committing a crime of the fourth degree if I make a written false statement which I do not believe to be true. I am also aware that if I knowingly direct or authorize the violation of any statute, I am personally liable for the penalties.

Signature: (Upon approval of this draft package, appropriate signature will be obtained.) Date: ______________

Name/Title: Director, Environment, Health, Safety and Remediation

☒ Check this box if the person above is also the property owner of the site or their representative. If this person is not the site property owner, please ensure the site property owner's name and address is included in the DGW Proposal, and also indicate that the property owner has been informed about the proposed discharge.

SECTION G. LICENSED SITE REMEDIATION PROFESSIONAL INFORMATION AND STATEMENT

LSRP ID Number: ______________________

First Name: ______________________ Last Name: ______________________

Phone Number: ______________________ Ext: ____________ Fax: ______________

Mailing Address: ____

City/Town: ______________________ State: ______________ Zip Code: __________

Email Address: ____

This statement shall be signed by the LSRP who is submitting this notification in accordance with SRRA Section 16 d. and Section 30 b.2.

I certify that I am a Licensed Site Remediation Professional authorized pursuant to N.J.S.A. 58:10C to conduct business in New Jersey. As the Licensed Site Remediation Professional of record for this remediation, I:

[SELECT ONE OR BOTH OF THE FOLLOWING AS APPLICABLE]:

☐ *directly oversaw and supervised all of the referenced remediation, and\or*

☐ *personally reviewed and accepted all of the referenced remediation presented herein.*

I believe that the information contained herein, and including all attached documents, is true, accurate and complete.

It is my independent professional judgment and opinion that the remediation conducted at this site, as reflected in this submission to the Department, conforms to, and is consistent with, the remediation requirements in N.J.S.A. 58:10C-14.

My conduct and decisions in this matter were made upon the exercise of reasonable care and diligence, and by applying the knowledge and skill ordinarily exercised by licensed site remediation professionals practicing in good standing, in accordance with N.J.S.A. 58:10C-16, in the State of New Jersey at the time I performed these professional services.

I am aware pursuant to N.J.S.A. 58:10C-17 that for purposely, knowingly or recklessly submitting false statement, representation or certification in any document or information submitted to the board or Department, etc., that there are significant civil, administrative and criminal penalties, including license revocation or suspension, fines and being punished by imprisonment for conviction of a crime of the third degree.

LSRP Signature: ______________________ Date: ______________

LSRP Name/Title: ______________________

Company Name: ______________________

Completed forms should be sent to:

Bureau of Case Assignment & Initial Notice
Site Remediation Program
NJ Department of Environmental Protection
401-05H
PO Box 420
Trenton, NJ 08625-0420

Not Applicable - Pompton Lakes Works is a non-LSRP Site.

SECTION G. SUBSURFACE EVALUATOR UST REPORT CERTIFICATION FORM

I certify under penalty of law that the work was performed under my oversight and I have reviewed the report and all attached documents, and the submitted information is true, accurate and complete in accordance with the requirements of N.J.A.C. 7:14B and N.J.A.C. 7:26E. I am aware that there are significant civil and criminal penalties for submitting false, inaccurate or incomplete information including fines and/or imprisonment.

Name: ______________________ UST Cert. No.: ______________

Firm: ______________________ Firm's UST Cert. Number: ______________

Firm Address: ______________________

City/Town: ______________ State: ______________ Zip Code: ______________

Phone Number: ______________ Ext: ______________ Fax: ______________

Signature: ______________________ Date: ______________

Completed forms should be sent to:

Bureau of Case Assignment & Initial Notice
Site Remediation Program
NJ Department of Environmental Protection
401-05H
PO Box 420
Trenton, NJ 08625-0420

Not Applicable - Pompton Lakes Works is a non-UHOT Site.

NJDEP Discharge to Groundwater Permit-by-Rule Authorization Request
Discharge to Groundwater Proposal
Horizontal Well/Hydraulic Surcharging Pilot Study
Pompton Lakes Works Site
Pompton Lakes, New Jersey
PI# 007411

May 2016

Introduction

This Discharge to Groundwater (DGW) proposal was prepared for the hydraulic surcharging pilot study proposed at the Pompton Lakes Works (PLW) Site. The Site is located at 2000 Cannonball Road in Pompton Lakes, Passaic County, New Jersey which was formerly operated by E. I. du Pont de Nemours and Company (DuPont). In 2015, DuPont transferred the PLW Site to The Chemours Company FC, LLC (Chemours).

The purpose of conducting the hydraulic surcharging pilot study is to collect data on the efficacy of optimizing groundwater flow rates within the shallow aquifer in the western portion of the groundwater plume near the Site boundary through the design and installation of a water delivery system (i.e., horizontal well). A DGW permit-by-rule (PBR) greater than 180 days is required for the discharge of treated groundwater via a horizontal well from the existing onsite groundwater extraction and treatment (GWET) system during pilot study testing. Treated groundwater is currently discharged through a series of infiltration beds located along the southern/southeastern Site boundary in accordance with the July 1993 New Jersey Department of Environmental Protection (NJDEP)-approved *Groundwater Remedial Action Work Plan* (GRAWP) and New Jersey Pollutant Discharge Elimination System (NJPDES) DGW Permit No. NJ001851.

As part of the DGW PBR, this DGW proposal has been prepared in accordance with N.J.A.C. 7:26E-5.6 and the NJDEP DGW PBR Authorization Request Form to provide relevant information related to the DGW for the hydraulic surcharging pilot study.

Current Groundwater Remediation Program

To date, the scope of the overall groundwater program at the PLW Site has included investigation and monitoring activities both onsite and offsite in groundwater (not only the shallow portion of the alluvial aquifer but also the intermediate and deep zones) as well as remedial technology studies. Onsite groundwater is withdrawn from the unconsolidated alluvium aquifer (the Late Wisconsinan Glacial Delta Formation) along the southern boundary of the Site via six recovery wells (see Figure 1) to establish a hydraulic capture zone that prevents groundwater containing chlorinated volatile organic compounds (VOCs) from migrating offsite. In accordance with the existing NJPDES DGW permit, water that is withdrawn is treated and re-introduced into the aquifer via a series of six infiltration beds (see Figure 1) located along the southern/southeastern Site boundary that are partially within the capture zone of the GWET system and entirely within the Classification Exception Area (CEA) established for offsite groundwater (CEA #4).

Recovered groundwater (influent) and treated groundwater (effluent) being discharged to the infiltration beds is sampled on a monthly basis for the 10 Site constituents of concern (COCs) and lead. The total concentration of VOCs in the influent groundwater is approximately 220 micrograms per liter (ug/l) and lead is below detection (less than 0.13 ug/l). The total concentrations of VOCs and lead in the effluent groundwater is below detection (less than 0.1 ug/l total VOCs and less than 0.13 ug/l lead). The total VOC and lead concentrations presented are based on the most recent sampling event conducted in April 2015. The effluent limits are the Groundwater Quality Standards (GWQS) for Class IIA groundwater. Operation of the GWET system (including the collection of monthly water levels from select wells) and analytical results from influent/effluent sampling are reported to NJDEP and the U.S. Environmental Protection Agency (USEPA) on a quarterly basis.

Geology

The Site is situated within the Highlands Physiographic Province adjacent to the northwestern boundary of the Newark Basin. Bedrock beneath the Site consists of Precambrian gneiss and diabase. Previous studies show that two primary geologic units, crystalline bedrock and alluvial deposits consisting of colluviums and stratified glacial drift, underlie the Site. The crystalline bedrock is comprised of deformed and metamorphosed high-grade gneisses. The alluvial deposits are up to 170 feet thick. The texture of the alluvial deposits is a fining downward stratified glacial sequence which can generally be divided into three depositional types.

- The shallow alluvial depositional type is comprised of fill, colluvium, and glacial deposits. These deposits are generally poorly sorted, coarse to medium-grained sand and gravel and may contain layers of very coarse-grained gravel. This shallow zone ranges from approximately 5 to 20 feet thick.

- The intermediate alluvial deposits are generally comprised of very fine to medium-grained sand, and range from 15 to 80 feet thick. These deposits are considered to represent glacial fluvial and deltaic deposits.

- The deep alluvial deposits are generally comprised of very fine-grained silty sand and very fine-grained sandy silt, which represent glacial lacustrine deposits. The thickness of this zone is highly variable and can be up to 90 feet thick in bedrock surface structural lows.

Hydrogeology

The groundwater table is encountered between 5 and 15 feet below the ground surface (bgs). The alluvial deposits comprise a single aquifer system in that no layer of low permeability has been found that would act as a confining unit. However, because of varying permeability in the stratified deposits, the alluvium has been divided into three hydrogeologic zones which generally coincide with the geologic units described above. The horizontal well is being installed in the shallow hydrogeologic zone which is located at approximately 10 to 30 feet bgs. The hydraulic conductivity of this zone generally ranges from 43 to 82 feet/day.

Groundwater elevations range from approximately 206 feet mean sea level (msl) near the recovery wells to approximately 202 feet msl near Pompton Lake. Currently, offsite groundwater flow in the alluvial aquifer is generally to the south and southeast towards Pompton Lake. Groundwater recharge to the alluvial aquifer occurs both onsite and offsite. Onsite groundwater pumping and infiltration have altered the onsite groundwater flow patterns. To the north of the pumping wells, groundwater flow is toward the south and southeast (to the wells). To the south of the pumping wells, the infiltration beds have created a groundwater divide under the beds such that part of the groundwater flows to the pumping wells and part flows toward Pompton Lake.

Groundwater Quality Summary

Groundwater investigations have shown that there is VOC-impacted groundwater both onsite and offsite. As stated in the November 1995 *Comprehensive Groundwater Monitoring Program*, the following ten chlorinated VOCs have been identified as Site COCs for groundwater: tetrachloroethene, trichloroethene, 1,1,1-trichloroethane, 1,1-dichloroethane, 1,2-dichloroethane, 1,1-dichloroethene, cis-1,2-dichloroethene, trans-1,2-dichloroethene, carbon tetrachloride, and vinyl chloride. In the shallow hydrogeologic zone, total concentrations of these VOCs ranged from below detection (less than 0.1 ug/l) to approximately 25 ug/l (at well 132) during 2015 (latest round of groundwater monitoring).

Hydraulic surcharging, through the operation of the existing GWET system, has reduced VOC concentrations in the eastern portion of the offsite plume area; and natural reductive dechlorination is occurring in the western portion of the offsite plume area which has also reduced concentrations. Groundwater from the areas of former lagoons 1, 2, 3, and 4 is no longer flowing offsite. VOC concentrations in groundwater downgradient of the Site and the vicinity of the infiltration beds have decreased by one or more orders of magnitude since the GWET system began operation, as evidenced by monitoring results over time. The treated water flowing from the infiltration beds is creating a zone of cleaner water downgradient of the beds. The zone of cleaner water is larger in the shallow zone because the shallow zone is more permeable and, as such, preferentially transports the water from the infiltration beds. The zone of cleaner water is progressively smaller in the intermediate and deep zones, based on their limited ability to transmit water.

Groundwater Modeling

The effect of discharge of treated groundwater to water levels within the aquifer was evaluated as part of the NJDEP-approved GRAWP. The maximum discharge rate of the GWET was based on groundwater modeling, pump tests, and routine measurements of groundwater elevations in the area of discharge (which currently includes the western portion of the plume area). Based on this data, it has been shown that discharge of treated groundwater to the aquifer has not caused water levels to rise to a point at which groundwater would enter the basements of structures located in this area. Additional simulations have been performed to assist with horizontal well design and provide further characterization of the water table response for the selected infiltration location and method. These additional simulations have considered the depths of basements, utilities, and other features that could be impacted by water table increases. The results of the additional simulations indicated the added infiltration by the horizontal well will not cause groundwater to intersect the residential basements upgradient along Barbara Drive or downgradient at the residences close to the proposed horizontal well.

PBR Scope of Work for Horizontal Well/Hydraulic Surcharging Pilot Study

The objective of the horizontal well pilot study is to collect the necessary engineering and hydrogeologic data to evaluate the effectiveness and implementability of optimizing groundwater flow rates within the shallow aquifer in the western portion of the plume near the Site boundary as a remedial technology.

The existing GWET system discharges water to the shallow aquifer along the southern boundary of the Site into shallow infiltration beds. This water moves through the unsaturated portion of the aquifer until it reaches the saturated zone (i.e., water table) of the shallow aquifer which is present at approximately 10 to 12 feet bgs. The process of adding water to the shallow aquifer can be referred to as hydraulically surcharging the aquifer. A review of data collected from monitoring wells in the offsite plume area and GWET system operational information over the last 18 years indicates that the surcharging process is a main factor that has resulted in the significant reduction of VOC concentrations at locations within the offsite plume area.

A detailed modeling analysis was completed to evaluate the efficacy of hydraulically surcharging the shallow aquifer over a larger area. This analysis estimated aquifer flushing rates for various hydraulic surcharging options. This evaluation indicated that this surcharging process should provide results similar to those observed in the areas downgradient from the GWET system, which is increased flushing of the shallow aquifer. Based on the data collected, a pilot study has been designed that will enable the collection of the necessary engineering and hydrogeologic data to evaluate the effectiveness and implementability of the horizontal well as a remedial technology in optimizing groundwater flow rates within the shallow aquifer in the western portion of the plume near the Site boundary.

The objective will be to distribute treated groundwater at relatively low pressures and low flow rates along an approximate 1,410 linear foot alignment. In order to facilitate the distribution of water along the entire horizontal well length, an inner manifold of smaller diameter high density polyethylene (HDPE) pipe will be placed within the outer stainless-steel well screen. Perforations spaced along the length of this manifold will permit treated water to be uniformly metered out along the length of the screen. A 6-inch diameter, Schedule 10 stainless-steel will be used for the permanent well, with an inner metering manifold of 4-inch diameter HDPE. The stainless-steel well screen will have 12 longitudinal slots per foot with each slot 2 inches long and a slot diameter of 0.012 inches. The addition of the inner manifold will also provide greater accuracy and flexibility in operating the system.

The injection will occur at an estimated depth of 20 to 25 feet bgs (approximately 5 feet below the seasonally low water table elevation), in areas of elevated VOC concentrations within the shallow aquifer. Surcharging will result in an increase in the groundwater flow (i.e., increase in the aquifer flushing rate) in the higher permeability interval of the local shallow aquifer (located between approximately 10 to 30 feet bgs).

As depicted on Figure 1, the horizontal well will be installed within the New York Susquehanna & Western Railway Corporation's (NYSWR) right-of-way (ROW), adjacent to the southern side of the railroad tracks. The NYSWR approved the installation of the horizontal well within the NYSWR ROW in a letter dated March 21, 2016. Drilling will be initiated in the area where infiltration bed sets 4, 5, and 6 are located and extend westward to the area near Grant Avenue. Treated groundwater currently discharged to the existing infiltration beds will be utilized as the supply of water to be discharged to the horizontal well. The anticipated flow rates/discharges from the GWET system to the horizontal well will be in the range of normal operations of the GWET system (typically between approximately 120 and 140 gpm) and will not exceed the permitted discharge rate of 280 gpm. The pilot study is expected to run for approximately one year and the shallow aquifer will be monitored during that period.

Monitoring Program

The pilot study is expected to run for approximately one year and the shallow aquifer will be monitored during that period. The goals of the system monitoring are to:

- Monitor the groundwater table in the vicinity of the horizontal well to evaluate the degree of mounding that occurs due to the injected groundwater. The rationale for this monitoring requirement is to evaluate whether groundwater mounding is occurring to a degree that it may impact nearby infrastructures (e.g., utilities and residential basements upgradient along Barbara Drive or downgradient at the residences close to the proposed horizontal well).

- Monitor the groundwater table in the vicinity of the horizontal well to evaluate the change in hydraulic gradient that occurs due to the injected groundwater. The rationale for this monitoring requirement is to evaluate the increases in pore volume flushing rates in shallow groundwater.

Piezometer Installation

Following installation of the horizontal well, shallow piezometers will be installed on the northern side of the tracks and horizontal well and on the southern side of the horizontal well. Horizontal piezometer clusters are being proposed along the horizontal well flow path as opposed to vertical clusters since the purpose of this pilot study is focused on evaluating horizontal flow across the shallow zone. The horizontal clusters will be able to show the head drop moving away from the horizontal well, which will be part of the plan for monitoring the potential for basement flooding.

Four shallow piezometers will be installed along the well alignment on the northern side of the railroad tracks in the ROW. These piezometers will be located at Schuyler Avenue, Jefferson Avenue, Perrin Avenue, and north of well 25 (located on Durham Street). Four additional piezometers will be installed perpendicular to these piezometers on the southern side of the horizontal well (immediately adjacent to). With the exception of the easternmost piezometer location since the well 25 cluster is nearby (on Durham Street), another piezometer will be installed approximately 20 feet south of these "southern side of tracks" piezometers to assess the change in hydraulic gradient over time. The locations of the piezometers are shown on Figure G-1 within Appendix A.

The elevation of each piezometer screen interval will be approximately the same elevation as the horizontal well. The location and top of casing elevation of these piezometers will be surveyed following installation (along with the entry and exit points of the horizontal well).

<u>Groundwater Elevation Measurements</u>

The primary performance metric for the hydraulic surcharging pilot study is a change in the hydraulic gradient in the shallow aquifer in the area of the horizontal well, which will be used to calculate the increase in pore surcharging rates. This metric can be effectively evaluated in a reasonable timeframe by documenting changes in groundwater elevations, changes in hydraulic gradients, and evaluations of pore flushing times. Groundwater elevations in the shallow groundwater zone will respond relatively rapidly to the horizontal well discharge. These shallow groundwater elevation changes will be used to evaluate the changes in hydraulic gradients and the expected change in pore flushing times. Therefore, the proposed monitoring will focus on groundwater elevations in the vicinity of the horizontal well and extending outward from the well.

The newly-installed piezometers shown on Figure G-1 will be used in conjunction with existing monitoring wells to measure groundwater elevations during the start-up and commissioning of the horizontal well, as well as for long-term operation as part of the pilot study evaluation. Existing monitoring wells that will be monitored include the Well 25 cluster and 146-S located on Durham Street, Well 128 cluster and shallow wells associated with the enhanced in-situ bioremediation pilot study located on Barbara Drive/Schuyler Avenue, and 150-S located on Grant Avenue. In addition, the water level within the horizontal well will be monitored.

Groundwater elevation monitoring during start-up and commissioning will be performed at a minimum of twice per week. This twice weekly monitoring will continue for a minimum of three months. After three months, the groundwater elevation monitoring will occur monthly.

During operation, the groundwater elevation monitoring data will be used to optimize the injection and (if necessary) the pumping to meet the objective of increasing shallow zone flushing rates in the western portion of the offsite plume area near the Site boundary.

The full-time pilot study operation will include continued evaluation of groundwater elevations as it relates to nearby basements along the well alignment. Transducers will be placed in select piezometers as well as the horizontal well to collect groundwater elevation data on a continual basis as well as to assess elevations over time. Data will be downloaded from the transducers on a weekly basis to assess conditions. There have been no basement issues to date with the existing infiltration beds. The horizontal well will surcharge the same amount of water currently going to the beds but along a larger lateral extent. Based on 18 years of operating the existing GWET system and the modeling of the horizontal well, there should be no issues with regards to potential flooding of basements.

Target groundwater elevations have been established for the monitoring program to address the potential for flooding of basements. If groundwater elevations in one or more of the piezometers adjacent to the horizontal well equal or exceed 213 feet (NGVD 1988), which is approximately 2 feet below the minimum basement elevation, then monitoring will be completed weekly and the horizontal well operation will be evaluated. If groundwater elevations in one or more of these piezometers adjacent to the horizontal well equal or exceed 214.5 feet (NGVD 1988), then the horizontal well discharge rate will be reduced until the groundwater elevations decline below 213 feet.

Data collected during the pilot study will also be used to update, if necessary, the groundwater model created for the Site. The model will be used to evaluate observations and understand the potential effects of groundwater mounding in the area of the horizontal well and to evaluate the change in the pore flushing rate.

Groundwater Quality

Groundwater quality (i.e., VOC concentrations), in the vicinity of the horizontal well, will be monitored as part of the ongoing semi-annual groundwater monitoring program to document the potential effects of the anticipated enhanced flushing in the shallow aquifer zone (approximately 10 to 30 feet bgs).

Shallow groundwater VOC concentrations are affected by many factors and the timeframe of this pilot study (approximately one year) may not allow for reliable evaluation of VOC concentration trends. The elevation of the water table, groundwater recharge rates, seasonal variations in groundwater flow rates and directions, and changes in extraction well pumping rates and the groundwater discharge rates to the horizontal well and infiltration beds are just some of the factors that affect shallow groundwater VOC concentrations. Shallow groundwater flow rates, though higher than the intermediate and deep zones, are still relatively slow. Groundwater modeling suggests that the steady state time required for a single pore flush of discrete areas around monitoring wells in the shallow groundwater in the horizontal well area ranges from about two months to a year. The time to define VOC concentration trends will be significantly longer based on modeling results. The ongoing semi-annual monitoring program has documented decreases in VOC concentrations of over an order of magnitude in the eastern offsite shallow zone. The ongoing semi-annual groundwater monitoring program should continue to provide sufficient groundwater quality data over time to document changes, and should be sufficient to demonstrate the effect of flushing of the shallow zone in the vicinity of the horizontal well.

Reporting

Status updates will be provided to NJDEP and USEPA during the course of the pilot study.

Quarterly status reports will be submitted to NJDEP and USEPA which summarizes pilot study activities for the reporting period. These reports, submitted as an attachment to the quarterly Site progress reports, will be submitted on the 30th day of the month following the reporting quarter.

Monitoring of the GWET system and treated groundwater discharge will continue to be reported in the quarterly operating reports submitted to NJDEP and USEPA.

A pilot study technical memorandum will be prepared after one year of full-time pilot study operation. This report will be submitted within 90 days following completion of the one-year operation period and will include any recommendations based on the evaluation of the collected data over the one-year study.

Schedule of Pilot Testing

The PBR is requested to begin on the day that treated groundwater is first introduced (discharged) and not on the date when the discharge approval letter is issued by NJDEP or received by Chemours. A record of the date discharging begins will be made in the field operation log and NJDEP will be notified within 24 hours of that first discharge day.

It is understood that, since this PBR request is for greater than 180 days, public notification will be required as part of the NJDEP approval process. A draft of the public notification is attached to this DGW proposal. In addition to review and approval of the DGW PBR by NJDEP, Chemours requests NJDEP review and approve the public notification prior to publication. Chemours will continue to work with NJDEP and USEPA during this public notification and approval process and provide support, as needed.

NJDEP Discharge to Groundwater Permit-by-Rule Authorization Request
Draft Public Notice
Horizontal Well/Hydraulic Surcharging Pilot Study
Pompton Lakes Works Site
Pompton Lakes, New Jersey
PI# 007411

May 2016

Take notice that, as part of the hydraulic surcharging pilot study for the Pompton Lakes Works Site at 2000 Cannonball Road, Block: 100 Lots: 3, 6.01, and 7, in Pompton Lakes, Passaic County, a proposal has been submitted to the New Jersey Department of Environmental Protection (Department) to discharge to ground water in accordance with a permit issued pursuant to the provisions of the New Jersey Water Pollution Control Act, N.J.S.A. 58:10A-1 et seq., its implementing regulations the New Jersey Pollutant Discharge Elimination System, N.J.A.C. 7:14A; the Ground Water Quality Standards, N.J.A.C. 7:9C; and the Technical Requirements for Site Remediation, N.J.A.C. 7:26E. The Department's Site Remediation Program is reviewing the proposal to discharge to ground water for the purpose of remediating a contaminated site with the program interest # 007411.

Brief description of the proposed discharge: A hydraulic surcharging pilot study will be completed to collect data on the efficacy of optimizing groundwater flow rates within the shallow aquifer (the Late Wisconsinan Glacial Delta Formation) in the western portion of the offsite groundwater plume near the Pompton Lakes Works Site boundary through the design and installation of a horizontal well. Treated groundwater from the existing onsite groundwater extraction and treatment system will be discharged to the shallow aquifer via the horizontal well during pilot study testing. A copy of this public notice has been sent to the Municipal Clerk and designated local health official for Pompton Lakes.

A copy of the discharge to ground water proposal is available from the person responsible for conducting the remediation [Sheryl Telford, 2000 Cannonball Road in Pompton Lakes, Passaic County, New Jersey], or as part of the administrative record which is on file at the offices of the Department, Site Remediation Program, located at 401 East State Street, Trenton, Mercer County, New Jersey. The file may be reviewed under the New Jersey Open Public Records Act ("OPRA"), N.J.S.A. 47:1A-1 et seq. Information regarding the OPRA procedures is available at www.state.nj.us/dep/opra/oprainfo.html.

Interested persons may submit written comments regarding the discharge to ground water proposal to the Department at the address listed below and to the owner or operator of the facility at [David Epps, 2000 Cannonball Road in Pompton Lakes, Passaic County, New Jersey]. All comments shall be submitted within 30 calendar days after the date of this public notice, or the end of any public hearing that the Department may schedule that occurs after that date. All persons who believe that the discharge to ground water proposal is inappropriate, must raise all reasonably ascertainable issues and submit in writing to the Department all reasonably available arguments and factual grounds supporting their position, including all supporting material, by the close of the public comment period. The Department will consider all public comments that relate to the discharge to ground water proposal, provided that the Department receives the comments by the close of the public comment period. After the close of the public comment period, the Department will render a decision regarding the proposed discharge to ground water.

The Department will respond to all significant and timely comments with its decision regarding the discharge to ground water proposal. Each person who has submitted written comments will receive notice of the Department's decision.

Any person may request in writing that the Department hold a non-adversarial public hearing on the discharge to ground water proposal. This request shall state the nature of the issues to be raised in the proposed hearing and shall be submitted within 30 calendar days of the date of this public notice to the address cited below. A public hearing will be conducted whenever the Department determines that there is a significant degree of public interest in the discharge to ground water decision. If a public hearing is held, the public comment period in this notice shall automatically be extended to the close of the public hearing.

Comments and written requests for a non-adversarial public hearing shall be sent to:

NJ Department of Environmental Protection
Site Remediation Program
Bureau Case Assignment and Initial Notice
Mail Code 401-05H
401 East State Street
P.O. Box 420
Trenton, NJ 08625-0420
ATTN: DGW proposal