SUNOCO PIPELINE
An ENERGY TRANSFER Company

535 Fritztown Road
Sinking Spring, PA 19608

May 22, 2018

Via Electronic Mail
Mr. Frank DeFrancesco, Chief
Dams and Waterway Section
Pennsylvania Department of Environmental Protection
2 East Main Street
Norristown, PA 19401

Re: SPLP Response to Comments
Hydrogeological Reevaluation Report
Arch Bishop/South Chester Road HDD (S3-0541)
DEP Permit Nos. E15-862 and E23-524
Westtown and Edgemont Townships
Chester and Delaware Counties, Pennsylvania

Dear Mr. DeFrancesco:

In compliance with the Corrected Stipulated Order dated August 10, 2017 a Reevaluation Report on the above-referenced horizontal directional drill ("HDD") was submitted to the Department on November 27, 2017. In a letter dated December 22, 2017, the Department requested further information to which SPLP responded to on January 2, 2018. In a letter dated February 22, 2018, the Department has requested further information. Please accept this letter as a response. Your requests are bolded below followed by the response.

1. **The initial 7-page narrative of this HDD analysis appears to make interpretations which are not included in any of the attached professional geologist-signed/sealed reports. This section of the Report needs to be signed and sealed by the Pennsylvania-Licensed Professional Geologist who wrote it and made these interpretations.**

   The interpretations presented in the Horizontal Direction Drilling (HDD) Reevaluation Report and subsequent response letters to the Department's request for additional information are the work product of several individuals. These include at minimum a Pennsylvania Professional Geologist (PG), a pipeline engineer licensed in the State of Pennsylvania, and an HDD expert who learned this construction craft through years of experience. A Professional Geologist (PG) is not educated, trained, or otherwise else qualified in the implementation of, or the drilling of, an HDD. Therefore, the information presented in the reevaluation reports is not solely within the professional expertise of a geologist, but rather is the product of a team of individuals. Every HDD Reevaluation Report previously submitted to the Department pursuant to the Order has used the same format as the Reevaluation Report submitted for HDD S3-0541 (*i.e.*, an overall Reevaluation Report attaching a signed and sealed

Hydrogeological Evaluation Report). However, if the Department would prefer, SPLP can have all participating individuals sign the Revaluation Report.

2. **Sunoco's Report states that the HDD "could not affect individual well use during active drilling for wells located within 150 linear ft." Sunoco needs to explain why it focuses only on wells located within 150', and must address whether other water supplies outside of 150' could be affected. Please provide justification sealed by a Pennsylvania-Licensed Professional Geologist that wells outside of the 150' profile will not be impacted.**

   As a result of the Consent Order Agreement executed February 8, 2018, SPLP has authored and DEP has approved a new Operations Plan that provides that SPLP will offer all landowners with only a private water supply source located within 450 foot (ft) of the HDD alignment, an alternative temporary water supply. Accordingly, the previous statement concerning the potential effects within 150 ft is now moot. In accordance with the Operations Plan, SPLP has made this offer via letter to the 33 landowners with identified private water supply wells within 450 ft of the HDD profile. SPLP's offer to the landowners for the temporary supply of water during the HDD operations will remain open until HDD operations are complete. Moreover, in accordance with its Chapter 105 permit, during HDD activities SPLP will address to the satisfaction of the landowner any landowner complaints concerning water supply that are shown to be associated with HDD activities.

3. **With regard to water supplies that might be impacted by these HDD activities, Sunoco must address those impacts in an acceptable manner. Sunoco has the option to enter into written agreements with all private water supply owners whose water supplies may be impacted by this Drill, regardless of their location from the Drill, as part of this reevaluation, and in advance of commencing the HDD. Under the agreements, Sunoco must provide short and long-term replacement potable water supplies adequate in quantity and quality for the purposes served, to the satisfaction of all potentially affected water supply owners. The agreements should provide for Sunoco to conduct water quality and quantity testing of each potentially affected water supply prior to, during, and after the HDD activities. Sunoco needs to provide proof of these agreements to DEP with a response to this letter.**

   In the alternative, if Sunoco chooses not to pursue these agreements with the private water supply owners, it must provide a discussion of actions to be taken by Sunoco to prevent water supply impacts from occurring. Sunoco needs to demonstrate how, in the absence of the agreements described above, Sunoco will avoid impacts to all water supplies. Sunoco's approach should include the utilization of technical and nontechnical measures to avoid and minimize such impacts, including, but not limited to, the conversion of the HDD to a trench installation, use of other trenchless construction methods, the use of American National Standards Institute/National Sanitation

Foundation (ANSI/NSF) Standard 60 approved gels or other approved additives that could prevent such impacts from the Drill, or some combination of all of the above. To the extent Sunoco proposes to use any ANSI/NSF 60 certified HDD additives, consistent with Special Condition NN contained in DEP Permit Nos. E23-524 and E15-862, Sunoco will only be able to use the additives in the manner indicated in the certification of the proposed additive. The manner in which the proposed additive is to be used, as indicated in its ANSI/NSF 60 certification, should be submitted with your response. In addition, Sunoco should indicate whether it will be following all conditions included as part of the additive's certification or, if not, provide an explanation as to why it is not and why that deviation is acceptable.

As stated in the response to Item 2 above, the new Operations Plan provides that SPLP will offer all landowners with only a private water supply source located within 450 ft of the HDD alignment an alternative temporary water supply.

SPLP provided notice and offered temporary water supplies to all water supply owners within 450 feet of HDD profiles. Significantly, the facts regarding water supply wells within 450 feet of the HDD profile are:

(i) There are thirty-three (33) parcels with a water supply well as the sole source within 450 feet of this HDD profile. All have received written notification that they are entitled to temporary water supplies at this time.

(ii) So far, nine (9) of these landowners have agreed to accept temporary water supply during the HDD process; however, SPLP has not re-approached the outstanding well owners recently; but would do so in advance of and before beginning the HDD.

(iii) Eighty-one (81) of these parcels are on public water.

Considering the immediate proximity of public water supplies to the properties reporting private water wells, SPLP is re-contacting these owners to determine if the residence relies on the water wells as the "sole source" of water, or if the water well is for secondary non-consumptive use.

Despite these facts, SPLP's goal is to minimize any potential impacts to water supply wells. To that end, with the Departments approval, SPLP will utilize a blend of standard bentonite and Aquabloc as the drilling fluid blend for use during pilot hole progress as a protective measure for adjacent water wells. Aquabloc is a Department approved NSF/ANSI-60 approved drinking water certified starch based drilling fluid, that enhances the standard bentonite based drilling fluids ability to gel and seal fissures and fractures in rock outside the working bore hole, thereby minimizing the risk of impact to any of the nearby wells in question. SPLP will follow the manufacturers recommended dosage and add Aquabloc at 1.5-2.5 lbs per 100 lbs of bentonite while mixing the drilling fluid for use. The NSF/ANSA-60

certification and Safety Data Sheet for Aquabloc is provided in Attachment 1 for the Department's reference.

4. The Report discusses potential changes in water *quality*, but also needs to discuss potential changes to water *quantity*, as the potential exists for the HDD bore to adversely impact the yield of private water supply wells. Please describe how this will be done consistent with applicable provisions of the latest versions (February 6, 2018) of the Inadvertent Return Assessment, Preparedness, Prevention and Contingency Plan, and the Operations Plan (January 2018).

As an initial matter, it is unclear what the Department has requested in asking for a description as to "how this will be done" with respect to potential adverse effects to water supply well yields. SPLP assumes that the Department has requested a description of what actions SPLP intends to take to address any potential adverse effects on water quantity. To that end, SPLP notes that the water protection measures discussed in the above answer to Item 3 of the Departments letter will also serve to reduce the risk of any potential adverse impacts to water quantity. Specifically, the use of Aquabloc in the pilot phase of the HDD should reduce the risk that HDD activities will create additional preferential pathways for groundwater that could cause groundwater to migrate away from the bore hole towards the recharge zone for each of these water supplies. In addition, both the Inadvertent Return Assessment, Preparedness, Prevention and Contingency Plan ("IR Plan") and the Operations Plan require SPLP to offer alternative water supplies to landowners with water supply wells within 450 ft of the drill profile. The best means to protect a water well during the HDD is non-use. Obviously, to the extent a landowner accepts this offer, their water supply should not be adversely affected during HDD activities. Moreover, even if the landowner does not accept an offer of alternative water supply, the IR Plan requires SPLP to address to the satisfaction of the landowner any complaints associated with water quantity during HDD activities. Finally, if a landowner identifies any impact to a private water supply attributable to pipeline construction after post-construction sampling, including impacts to yield, the IR Plan obligates SPLP to restore or replace the impacted water supply to the satisfaction of the private water supply owner.

5. DEP requests that Sunoco provide the following information related to the project's potential effect on well production zones and water supplies:

a. An analysis of private water supply well production zones and how the proposed HDD activities will interact with them (listing the depths of wells and pumps is insufficient).

As stated in paragraph 3 on page 3 in Reevaluation report for this HDD, *"The production zone for waters wells is from the well bottom to highest point of water inflow from the water bearing seams, joints, and fractures in the rock formation."* Water wells in bedrock can only pump water from inside the surface casing and open rock interval within the well bore,

SPLP believes the intended subject matter of the question listed in Item 5(a) refers to those portions of the surrounding aquifer that "recharge" local wells.

To delineate a well's recharge zone, the area contributing recharge must be defined. In the area of interest, delineation of areas contributing recharge to a specific well is complex because the flow paths within the local aquifer change in response to various factors such as development, local pumping stresses from other wells and heterogeneous aquifer materials. The factors that influence the location of areas contributing recharge to wells are categorized as either dependent on the groundwater system (system boundary conditions, hydrogeologic framework, system transmitting and storage properties, system stresses/withdrawals, and other transient effects), or on the well itself (location, depth of screened zone or open hole section, rate of withdrawal) (USGS Water Supply Paper 2412).

In the area of HDD S3-0541 groundwater is under water table conditions (not confined or semiconfined). As such, most or all the water flows into the system from the water table surface. Therefore, the top boundary of the system is the water table surface, and the remaining boundaries are defined by streamflow from local tributaries. The hydrogeologic conditions are known to be extremely heterogeneous, causing great variations in hydraulic conductivity, transmissivity, and storage properties. As stated in the Reevaluation Report in the Hydrogeology section, *"The Baltimore gneiss unit mapped beneath the HDD S3-0541 location is identified as a unit of poor groundwater production. A limited network of fractures with small apertures generally provides the secondary porosity needed to support low groundwater discharges from this rock formation"*. Thus, available groundwater is stored within, and moves through, discontinuities (fractures, joints, faults) in the bedrock.

In the area of interest, water wells in a bedrock are vertical holes that intercept water-bearing discontinuities and provides an open vertical bore for the water within the bedrock to flow into and fill (recharge). The water within the well will seek a level in equilibrium with the piezometric surface in bedrock aquifer. Water supply or well yield is dependent upon well construction characteristics and resulting well efficiency, and the well bore's relation to the available water-bearing discontinuities.

The effect of the HDD on a given water supply well will depend upon the level of well use and resultant groundwater draw at times when HDD activities are occurring. According to water use data published by Pennsylvania State University (https://extension.psu.edu/water-system-planning-estimating-water-needs), in general, a household will use 50 to 100 gallons per person per day (200 to 400 gallons per day for a family of four). Water supply well bores provides a significant amount of water storage. A typical 6-inch-diameter well will store about 1.5 gallons of water for every foot of standing water in the borehole. Therefore, a 6-inch-diameter well with about 100 feet of standing water in the borehole would contain about 150 gallons of stored water. Use of this water and the resulting draw upon adjacent groundwater within the fractured bedrock is cyclic throughout the day, with the greatest

demand occurring during morning and evening hours and on weekend days and holidays when residents are generally home.

Studies on groundwater recharge in the eastern United States (B. T. Nolan, et al, 2006), including the crystalline rock aquifers of the Piedmont (such as is found at S3-0541), have indicated that modeling of recharge estimates was influenced primarily by mean annual runoff, air temperature, precipitation, and topographic wetness; whereas subsurface characteristics and land use had less influence.

In summary, it is known that the well yield and production can and often does vary greatly over relatively short distances and time periods in complex subsurface conditions such as those present in the area of HDD S3-0541. Individual well production will be influenced by seasonal variability in precipitation, well construction, well consumption rates, recharge rates, infiltration rates, radius of influence of other well systems, multiple production zones, and geologic discontinuities filled with water. Potential subsurface geologic characteristics will be used to predict possible communication pathways between the HDD and water wells in the area. The use of Aquabloc as a component of the drilling fluids will assist in mitigating the movement of drilling fluids outside the bore. In compliance with the SPLP Operations Plan, Water Supply Plan, and IR Plan, and consistent with the permit and incorporated plans as amended, if communication pathways are predicted, it will be discussed during the Notice to Proceed (NTP) meeting, SPLP will offer land owners with water supply wells on properties within 450 feet of the HDD alignment, pre-drill (baseline), active drilling, and post-drilling monitoring. Monitoring will include a sample for laboratory analysis and water quantity testing. This data will be used to evaluate the water chemistry and well yield at the specific well location by comparing results from each of the three monitoring events. If the monitoring indicates that an impact occurred, the permit requires SPLP to provide a replacement water supply to the landowner's satisfaction.

b. A map showing all the private water supplies in the correct, surveyed locations.

The water supply illustration provided as Attachment 2 to this response is an accurate presentation of the known water supply wells. The well locations were recorded by GPS.

c. A description of the following: if there is short tripping of the tooling during the HDD, what are the chances of a plunger-effect occurring during either the drilling or reaming phases or during pipe pullback, and could this affect private water supplies?

The "plunger effect" is only a concern during the complete removal of stem and tooling during the pilot phase of a HDD, since there is only one exit annulus for any pressures created while returning the tool and drive stem to the bedrock face for continued progress.

By contrast, during a routine "short-tripping" of the drilling stem and tooling, the length of tripping is only as long as needed, typically 2-5 joints of drilling stem (60-150 ft long), to ensure that the annulus surrounding the drill stem is not blocked and full circulation of return

is being maintained. As a result, the return trip or "re-insertion" is so minor in extent that it does not create a "plunger effect" since the drilling fluids and cuttings have no settling time for phase separation to occur.

Similarly, there is no plunger effect during the reaming phase of an HDD since an open pathway exists between the entry and exit.

d. Water quality sample results of the private water supplies that may be affected.

Attachment 3 to this response presents a summary of all water quality sample results from water supply wells within 450 ft of the HDD profile that SPLP has obtained to date.

e. Water quantity test results (pump yield tests) of the private water supplies that may be affected.

SPLP has notified each water supply well owner within 450 feet of the HDD profile that they have the option to have water quantity tests of their well. To date, water supply well owners have not asked to perform any water quantity tests at any well location.

6. There are reported intersections of fracture traces with the planned HDD bore path within close proximity to residential supply wells. The HDD alignment crosses six fracture traces mapped as part of reevaluation, but these fracture traces are not discussed as they relate to well locations and proximity to bore path. Further discuss these fracture traces, map them on present day aerial photos, evaluate them for potential problem areas, and provide this information, including the results of the evaluation, to DEP.

A plot of the approximate fracture traces on the HDD profile (**see Attachment 4**) indicates that several residential wells in the 450-foot sampling program may lie on or near a potential fracture. The fracture trace locations were derived from stereographic imagery using aerial photographs from 1943, and then transposed on current aerial maps; thus, a small degree of error in plotting accuracy exists, and the fracture trace locations are described as "approximate." Fracture traces are the surface representation of vertical to near vertical planar zones of fracture concentration, thus a well would have to be very close to a fracture trace to be intersected by it. The wells which are closest to fracture traces are from 54 to approximately 500 feet from the HDD borepath, occurring between Stations 35+00 to 45+00 as shown on the HDD profiles. The use of Aquabloc will mitigate the travel of groundwater through fractures, and of drilling fluids away from the bore path. SPLP will follow the Operations Plan and Water Supply Plan, by adhering to the notification, sampling, and monitoring procedures outlined therein, to ensure all affected residents will have potable drinking water. (Also see answer to 5(a).)

7. **More information is needed to provide an adequate site-specific reexamination of the bedrock geology, in addition to the information provided**.

   Further fracture trace analysis, geotechnical bore analysis, and investigation of local hydrogeologic studies have been and will continue to be performed, in addition to attempts to trace well construction information from the nearby residential supply wells. This further analysis, in addition to the analyses already investigated, should be sufficient to predict drilling behavior at this HDD location, and will be provided prior to the NTP meeting for discussion.

   Additional specific information about bedrock geology cannot be determined at a given location in this geology even with extensive geologic coring because the bedrock characteristics for these features and behavior can vary significantly in each core.

8. **Sunoco needs to address how it will ensure that the HDD can be steered accurately, given the subsurface profile, and, if such is not possible, what measures it will take to prevent Inadvertent Returns (IRs), groundwater flowback, and water supply impacts if the Drill veers from its intended path.**

   SPLP's HDD contractors working in this area of the project have completed eleven (11) HDD's with no steering accuracy problems affecting completion.

   The "difficulties in steering" as reported in the Hydrogeologic report are commenting on the tendency of the cutting tool to drift into softer versus harder bedrock, which necessitates steering adjustments. This is a normal occurrence when drilling through rock formations and although it does slow the drilling progress, it does not jeopardize the accuracy of the HDD in following the designed profile.

   Steering of the drilling tool, or mud motor when drilling through rock, is typically done using a Direct Current (DC) tracking system known as Tru-Track. This patented surface tracking method allowed the contractor to know the precise location of the drill bit at any time. By temporarily placing a thin wire on the land surface, in a somewhat rectangle shape along the planned drill path, and inducing a momentary DC current, which creates a known magnetic field, the HDD operator can use a stand-alone HDD survey profile and verify the magnetic steering tool's precise location on this profile at any time. The DC charged magnetic field basically triangulates the down-hole steering tool position in relation to the magnetic field from each side of the looped wire which is then shown on the HDD operator's computer and recorded.

9. Additional evaluation of the overburden strength needs to be provided, including grain size analyses, a narrative discussion of all data related to the overburden, and how this data was used in the overall reevaluation. Provide a detailed description of the processes and procedures that will be implemented if void spaces are encountered during drilling activity.

Overburden characteristics have little value to an HDD analysis or design. The HDD design is based on pipe free-stress and operating stress allowances primarily, and then the depth of the horizontal run based upon the target geologic layer below the ground surface. Based on the geotechnical core data, overburden depth on this HDD varies from 0.3 to 22 ft of depth. During the pilot hole phase, each HDD will enter initial bedrock within 10 to 50 ft of the entry point along the profile path.

During these HDDs, if relatively large open fractures or voids in the bedrock are encountered, these geologic features would be identified during the pilot phase by Loss of Circulation (LOC) of drilling fluids and cuttings to the HDD entry point, and possibly loss of pressure on the pilot tool face while advancing.

Minor LOC events, indicative of fractures in the bedrock, can be effectively treated using a combination of NFS 60 certified polymer and fiber additives such as “SuperSwell” and “Magma Fiber”. Set time requirements are relatively low before re-advancement of the tool can commence.

Significant fractures or voids will require multiple grout injections before a plug could be set, and advance of the drill could recommence. Where fractures and voids are sufficiently large, the typical grout injection only fills the bottom of the opening because of gravity and size of the opening.

The recommended treatment procedure for large fractures and voids during this HDD will be the use of a low mobility grout based on bentonite types of products including “Hole Plug” and “Bore Grout”. Grout placement would utilize standard mixing and pumping techniques. The objective of the grouting program is to get as much of the bentonite chips into the fracture as possible but limiting the individual placement volumes to between 3 and 5 times the theoretical hole volume using a ‘packer’ system to prevent grouting areas that are not in the immediate vicinity of the fracture or void. Filling of the voids by the use of multiple limited volume injections will allow the grout to layer up in the crack or void and eventually fill the opening sufficiently for a seal to develop. Sealing of the opening will be identified when the pump pressure increases during the next grout placement. When backpressure is identified on the last grout injection, the hole has been sealed and drilling may resume after allowing for set time.

10. The Report indicates that groundwater levels indicate potential for “excessive groundwater discharges.” Evaluation of water levels needs to be performed prior to

initiating the HDD bore to provide information regarding potential diminution of flow issues and the ability to determine if any future potential impact is related to head differentials or plugging of a potential water-bearing zone. Given the developed nature of this area and proximity of residential groundwater supply wells, further discussion is warranted regarding this topic. Potential actions could include the following:

a. Review "Groundwater Resources of Delaware County, Pennsylvania" (Plate 1, Water Resources Report 66, Balmer & Davis, 1996) for more recent and specific geologic and hydrogeologic information pertaining to the potential yields of residential supply wells in the area.

Water levels and groundwater conditions will be re-evaluated at the time of HDD initiation, during construction, and after construction. Specific capacity of nearby wells will be measured before and after construction to verify that aquifer "plugging" has not occurred. Currently, based on review of the literature, it is known that this area is prone to high seasonal fluctuations in water levels, and highest water table conditions occur during winter and early spring. Well yields in hillsides and hilltops, such as in the area of HDD S3-0541, tend to range from 12-15 gpm in Chester County gneisses, versus 30 gpm for valley gneisses, with a median well depth of 104 feet and a median depth to water in all formations in Chester County between 17-42 feet below ground surface (Low, Hippe, Yanacci, 2002). In Delaware County, well yields in hillsides and hilltops ranged from 0-150 gpm, versus 3-300 gpm for wells in valleys, with a median well depth of 142 feet in similar felsic gneiss (Balmer & Davis, 1996).

b. Project water wells depths, casing depths and water-level depths (based on a water-level survey) on cross sections/profile views.

Attachment 4 presents a set of the HDD profiles with water well depths and water levels if known represented in the cross-section view.

c. Identify zones of fractures or fracture trace intercepts on the profile views, along with residential water supply well locations.

The set of HDD profiles in Attachment 4 has the fracture trace intercepts included on the plan view.

d. Plan for temporary supply replacements, as the bedrock is highly fractured, even at depth, and residential water supply wells are located as close as 47 feet from the planned bore path. To limit potential impact on residential water well users, there should be a well-conceived response plan in place and ready to execute. Please describe how such a plan will be done to be consistent with applicable provisions of the latest versions (February 6, 2018) of the IR Assessment, Preparedness, Prevention and Contingency Plan, and the Operations Plan.

As stated in the response to Items 2 and 4 above, the new Operations Plan provides that SPLP will offer all landowners with only a private water supply source located within 450 ft of the HDD alignment an alternative temporary water supply. Moreover, even if the landowner does not accept an offer of alternative water supply, the IR Plan requires SPLP to address to the satisfaction of the landowner any complaints associated with water quantity during HDD activities. Finally, if a landowner identifies any impact to a private water supply attributable to pipeline construction after post-construction sampling, including impacts to yield, the IR Plan obligates SPLP to restore or replace the impacted water supply to the satisfaction of the private water supply owner.

If a landowner notifies SPLP of a water quality or quantity issue during active drilling, agents for SPLP will immediately respond to the compliant by delivering bottled water for consumption and arrange for potable water deliveries at SPLP expense. The temporary water supply could include a bottled water delivery service and if necessary based on the nature of the complaint temporary bulk water service by a water buffalo. The SPLP response team also notifies the project Professional Geologist to perform an evaluation of the problem so that solutions can be identified and proposed to the landowner. All of these steps are in conformance with the Operations Plan and April 2018 version of the IR Plan.

11. Considering that this plan is to address a specific HDD bore at a specific location, additional details need to be included in addition to the information already provided. Specifically, Sunoco needs to provide information on items such a pilot bore and reaming diameters, annular pressures, mud viscosities, action levels, and specific IR response actions.

The typical mud motor cutting tool diameter used for HDDs of this extent vary from 10.5-12.3 inches in diameter.

The ultimate reaming diameter for the 20-diameter pipeline is 30 inches. The reaming could be done in incremental diameters ranging from 16 to 24-inches before progressing to a 30-inch diameter ream. The ultimate reaming diameter for the 16-inch pipeline is 24-inches in diameter, which typically is not pre-reamed at a smaller diameter. The decision to pre-ream, or not, is based upon real time data acquired during the pilot hole phase.

Annular pressures vary by depth of profile due to the effect of gravity, increasing as the depth of profile increases. At profile depth the annular pressure could vary between 50 and 90 pounds per square inch varying on drilling conditions encountered, and pressures required to maintain the flow of returns.

Mud viscosity is measured using a “Marsh Funnel” which is based on time in seconds for 1-quart of fluids to pass through the funnel. In real world terminology, viscosity typically varies from 5-15% percent varying the nature of the material being drilled through so that continued removal of the cuttings within the annulus is efficient. What is actively managed in the

drilling process is the mud weight so that the cuttings removal is verified before recycling the drilling fluids into the HDD process. The target cleaning level of the drilling fluids is 9.5-10.5 lbs per gallon.

There are no pre-set "action levels" in an HDD except as discussed above. An HDD is an actively managed process.

Responses to an IR event would adhere to the procedures of the latest version (April, 2018) of the *"Pennsylvania Pipeline Project: HDD Inadvertent Return Assessment, Preparedness, Prevention and Contingency Plan* (IR Plan)".

12. The Report states that loss control materials (LCM) can be used to manage the loss of fluids during the pilot hole phase. As bedrock is generally highly fractured to 55 or more feet below the existing ground surface, the use of LCMs during drilling appears appropriate. Provide an explanation of where and how Sunoco plans to use LCMs during drilling. Please describe how this will be done consistent with applicable provisions of the latest versions (February 6, 2018) of the IR Assessment, Preparedness, Prevention and Contingency Plan, and the Operations Plan.

The use of Loss Control Materials (LCMs) cannot be "pre-planned" since it is impossible using existing technologies to precisely determine where below ground conditions occur that would warrant an application of LCMs in advance.

Due to this inability to "pre-determine" a location in an HDD profile where an application of LCMs would be appropriate, the HDD operator uses tooling, the Annular Pressure Monitor (APM), to actively observe conditions in the profile while drilling. An abrupt drop in annular pressure, which is indicative of a potential IR event, and in accordance with the IR Plan, requires the drilling to stop, assess down hole conditions, and implement a cure to the problem based upon the drilling data.

LCMs are mixed as a "pill" to use the industry term. A pill is a tank mixed LCM volume of drilling fluids with the LCM introduced, typically 1,000 to 2,000 gallons in volume that is pumped through the stem to the point of injection, then followed by a batch of normal drilling fluids to set the pill and clear the stem. LCMs work best in minor fissures and bedding plan partings.

13. The discussion also states that loss of fluids may be managed by grouting. Grouting of highly fractured zones of rock or fracture traces as a preventative measure may be prudent, whereas, grouting after an IR already occurs may not be desirable. Provide a conceptual description of the proposed grouting program and its timing, and describe how such a program could be implemented consistent with the applicable provisions of

the latest versions (February 6, 2018) of the IR Assessment, Preparedness, Prevention and Contingency Plan, and Operations Plan.

The use of grouting cannot be "pre-planned" since it is impossible using existing technologies to precisely determine where below ground conditions occur that would warrant a grout injection in advance. The APM tool is used for this purpose. Depending on the specific circumstances while drilling, a grout injection may be the only solution to resolve an occurrence of an IR. SPLP does not "desire" any IRs and the whole objective of the Reevaluation process is to eliminate or minimize the potential occurrence of an IR during an HDD.

The determination for the use of grouting or LCM's is all based upon the downhole data recorded while drilling. Minor Loss of Circulation (LOC) events, indicative of fractures or larger bedding plan partings in the bedrock, can be effectively treated using a combination of NFS 60 certified fluids with control properties such as "SuperSwell" and "Magma Fiber". Set time requirements are relatively short before re-advancement of the tool can commence.

Significant fractures or voids can require multiple grout injections before a plug could be set, and advance of the drill could recommence. Where fractures and voids are sufficiently large, the typical grout injection only fills the bottom of the opening because of gravity and size of the opening.

The recommended treatment procedure for large fractures and voids during this HDD will be the use of a low mobility grout based on bentonite types of products such as "Hole Plug" and "Bore Grout". Grout placement would utilize standard mixing and pumping techniques. The objective of the grouting program is to get as much of the bentonite chips into the fracture as possible but limiting the individual placement volumes to between 3 and 5 times the theoretical hole volume using a 'packer' system to prevent grouting areas that are not in the immediate vicinity of the fracture or void. Fill of the voids using multiple limited volume injections will allow the grout to layer up in the crack or void and eventually fill the opening sufficiently for a seal to develop. Sealing of the opening will be identified when the pump pressure increases during the next grout placement. When backpressure is identified on the last grout injection, the hole has been sealed and drilling may resume after allowing for set time.

14. IR prevention typically includes linking the respective proposed HDD geometry with site-specific geotechnical data. This approach will allow the HDD designer and driller to understand what specific HDD station ranges will be most vulnerable to IRs. We have the following questions regarding the linking of the proposed HDD geometry and the site-specific geotechnical data for this specific bore:

Numerous experts in the field of geology have stated that the geologic variations in this area of Pennsylvania are too complex to accurately predict at a specific location. This complexity is validated by SPLP's geologic investigations and experiences encountered during the completion of HDDs in this area of the project.

Furthermore, SPLP's consultations with geologic experts, and results of some geotechnical core completed, has resulted in our conclusion that even an attempt to vertically perforate the entire HDD profile at 20-foot intervals would result in substantial variations between each core hole, not counting the resulting creation of numerous potential pathways for the movement of drilling fluids within the overlying geology above the HDD profile.

a. Construction plans appear to call for a minimum of 10 feet of separation from adjacent utilities. Has the possibility of IRs via weak subsurface soil backfill zones or blasted/fractured rock at existing utility trenches (if present) been considered? If so, explain how it has been considered and how this was taken into account in Sonoco's construction plans.

SPLP cannot discern if the Department is referencing vertical or horizontal separation with this question; however, for the purposes of responding to the question, SPLP assumes the Department is referencing vertical separation. Existing utility lines would be undercrossed by the HDD as follows:

- Three existing Sunoco pipelines from Station 0+76 to 1+51. The HDD is at 15 to 32 feet of depth below ground surface (bgs), with 12 to 29 ft of vertical separation;
- A Sunoco pipeline, storm sewer, and municipal sewer line from Station 6+55 to 13+06. The HDD is at 100-113 ft bgs;
- A Sunoco pipeline at Station 31+49 with the HDD at 185 ft bgs;
- Telephone and storm sewer at Station 44+56 to 47+05, with the HDD at 131-148 ft bgs;
- A Sunoco pipeline at Station 61+08, with the HDD at 50 ft bgs;
- Two Sunoco pipelines from Station 62+60 to 62+83, with the HDD at 26-50 ft bgs.

The only location of possible concern is at the undercrossing of the existing Sunoco pipelines near the entry point of the HDD, and the HDD operator takes the presence of all features into account while progressing the HDD. These pipelines are in near proximity to the entry pit, which is not a point of high pressure once the pilot phase has passed this point in the profile.

b. The top of rock level appears to be 22 feet below ground surface at Boring B6-1W and there is likely shallow depth-of-cover over the HDD bore at the existing Sunoco pipeline crossing (Station 1+06) as well as at Wickerton Road (Station 1+75). The Report explicitly states that casing is being provided for the pilot hole at the SE entry, but does not state the same for the NW entry. This needs to be clarified.

As shown on the HDD profiles, the occurrence of a Sunoco pipeline at Station 1+06 is on the proposed 16-inch profile (Station 0+76 on the 20-inch profile). On both profiles, the area

around Station 1+75 is noting "edge of road". Wickerton Road occurs at Station 7+48 on the 16-inch profile and Station 7+46 on the 20-inch profile.

The purpose of the casing at the SE entry is to mitigate IR potential due to the extended length of profile at shallow depths with weak overburden and weathered rock as indicated by the geotechnical data. Even though the exit radius is the same on both ends of the HDD profile, the angle of exit to the lands surface at the SE entry is 9.8 degrees versus 16 degrees at the NW exit. The rapid ascent and angle at the exit point is why casing is not proposed at that location.

c. Has a preliminary station number been assigned where the casing will terminate? Provide this information.

There is no assigned station or length for the casing installation. The anticipated extent is greater than 200 ft. To install the casing, the driller will follow the pilot profile and drill to competent rock based upon data recorded while drilling. The pilot hole is then reamed to the same depth and linear extent. The tooling is removed from the hole and the casing is pushed and hammered into place.

15. Page 2 of the Terracon Report states: "When laboratory soil testing results are available, we will submit a complete data report for the subject crossing." This Report appears to be preliminary, and an update may be available by now. Provide any final report(s) from Terracon.

The November 30, 2017 version of the Terracon report is the most up to date version in our possession. SPLP is checking with this contractor on a final report with these results as referenced.

16. Borings B6-1W and SB-05/B6-1E are more than 6,300 feet apart and terminate below the HDD path. Borings SB-01 through SB-04 both terminate above the HDD path. Exploratory boring spacing to the depth of the proposed HDD is typically much closer than provided in this instance. In addition, the test boring locations do not appear to correspond with fracture traces as identified by GES. Additional subsurface information in these areas is necessary to understand (and mitigate) potential IR risks. Provide a geophysical survey to help interpolate between boring points, and in delineating/characterizing the fractures identified by GES.

SPLP believes it has enough information from the geotechnical borings already performed, supplemented by the peer-reviewed literature, the fracture trace analysis, and research of local hydrogeological studies, to understand, predict, and minimize potential IR risks. SPLP believes that the risk of creating new preferential pathways for fluid migration through the

installation of a suite of boreholes along the drill path significantly outweighs the marginal utility of any additional information that could be derived from additional borings.

17. The top-of-rock level was documented to be as deep as 68.3 feet in exploratory boring SB-03. Rock was not sampled to quantify weathering in SB-03. The test boring results suggest that the rock is differentially weathered. If rock is near this depth between Stations 60+00 and 65+10, then the HDD cover may consist of only soil. Considering that this plan is to address a specific HDD bore at a specific location, provide additional information on the sufficient depth of soil cover versus maximum allowable mud pressure for portions of the HDD where the HDD path may not penetrate rock.

SPLP does not believe that the data on the HDD profiles and geotechnical information provides any evidence that the HDD cover may consist of only soil. The SB-03 core was obtained at approximately Station 40+50 on the HDD profiles and the approximate bedrock level is presented in the cross-section view. To assist the Department in understanding, core SB-03 was taken at a location with an elevation of 448 ft above mean sea level (msl). The 20-inch HDD profile at this station is at an elevation of 263 msl, and the 16-inch is at an elevation of 288 msl. Using these elevations and subtracting the depth of auger refusal for SB-03 results in a thickness of bedrock over the profile of 117 ft for the 20-inch profile, and 92 ft for the 16-inch profile.

18. The Report states "No geophysical studies were recommended or performed for the reevaluation of HDD S3-0541 as the alignment is not in a karst area." Geophysical surveys should not be limited to karst environments, as they may be useful and provide valuable data in this instance. Specifically, a geophysical survey needs to be provided to help interpolate between geotechnical boring points (as noted in previous comment), identifying areas of soft soils, and in delineating/characterizing the fractures identified by GES.

As noted in the response to Item 17, as referenced here in Item 18, the Department has incorrectly interpreted the information provided. In addition, geophysical assessments provide only limited data below bedrock levels even in karst formations, and are utilized more appropriately as a "tool" to identify locations for core investigations of suspect fractures and voids in karst formations. Identifying areas of "soft soils" when the HDD profile is below the bedrock will provide no usable information.

Furthermore, to date on the Mariner II project, SPLP has performed a suite of geophysics studies at nine (9) locations. These were performed at eight (8) locations with karst geology, and one (1) location of non-karst geology. At the eight karst locations, the results of the geophysics provided usable data to a depth of 15 ft to 60 ft bgs. At the non-karst location, the geophysics indicated voids and soft spots were subsequently investigated by cone

penetrometers and geologic coring. The physical investigation resulted in complete invalidation of the geophysics data that indicated soft spots and voids.

Considering that the 20-inch profile has an average horizontal depth of 130 ft bgs, and the 16-inch profile has an average horizontal depth of 97 ft bgs, based on SPLP's experiences, geophysics will provide no functional information.

19. The Report indicates that Sunoco will monitor downhole pressures, viscosities, mud loss and nearly water wells. However, there are no specific values or action levels such as how often mud loss is calculated, or what viscosity would be maintained during the bore, or at what point an IR contingency plan would be implemented (i.e., if there is X pressure increase or X mud loss, an IR contingency plan would be started). Define and document the specific viscosities and action values and pressures to facilitate prompt actions during the HDD bore.

SPLP is committed to following the practices and procedures of the April 2018 version of the IR Plan. The IR plan contains procedures for monitoring and reporting on Loss of Circulation (mud loss). As answered in Item 11 above, mud viscosity typically varies from 5-15% percent varying the nature of the material being drilled through so that continued removal of the cuttings within the annulus is efficient. What is actively managed in the drilling process is the mud weight so that the cuttings removal is verified before recycling the drilling fluids into the HDD process. The target cleaning level of the drilling fluids is 9.5-10.5 lbs per gallon.

Loss of circulation or returns (mud loss) is continually observed during active drilling. Water use, bentonite volumes added, and mud volume pump rates are tracked during active drilling.

The drilling operator monitors the APM data while drilling. There are no "preset" pressure values. An abrupt pressure spike indicates a clogged annulus and the operator will stop the mud pump to relieve pressure, and the take corrective action, such as tripping back the drill string and tool at minimum pressure to attempt clearing of the blockage, or further actions as necessary, including if needed, the complete removal of the drill string and tooling to clear the hole. An abrupt drop in pressure indicates the penetration of a significant fracture or void or potentially a tool failure. If a loss of circulation occurs at the same time, then that is positive evidence of penetrating a fracture or void. If the data indicates a fracture or void, then the operator will attempt corrective action to seal the feature and restore circulation by using an LCM or grout injection.

20. The IR contingency plan seems to be limited to adding LCM. The Report needs to: (1) specifically note that drilling would stop in the event of an IR; and (2) include an outlined plan for addressing drilling mud on the surface.

SPLP assumes the Department is referring to the HDD best management practices listed in the conclusion of the Reevaluation report. SPLP is committed to following the practices and procedures of the April 2018 version of "*HDD Inadvertent Return Assessment, Preparedness, Prevention and Contingency Plan"* (IR Plan). The IR plan includes parameters for the use of LCMs, grouting, and the response actions in event of an IR, cleanup, and disposal.

21. The rock quality designation (RQD) is reported to range from 60-80, but a review of the core information suggests there is notable weathered rock and the lower competent rock includes several fractures. Based on the geotechnical data, designate in the Report the depth at which full mud pressure can be used to power the motor without blowing out the low RQD weathered rock on top.

The Departments statement of "blowing out the low RQD weathered rock on top" would seem to indicate the Department believes the bedrock at HDD profile depth is analogous to a balloon, which can withstand a certain pressure level and then suddenly pops. This scenario is associated with "hydraulic fracturing" for oil and gas production, which is an induced pressure event, not horizontal drilling for pipeline installation which has the opposite objective.

Typical drilling fluid loss during an HDD occurs as a result of one or a combination of "leakage" or "Hydraulic Jacking". In these cases, the drill fluid finds an alternative path to the design drill path annulus that requires a lower pressure to move the drill fluid. Drill fluid pressure at any point along a drill path is a function of the elevation and dynamic head. The elevation head pressure is the difference in elevation between the entry pit drill fluid elevation and the measurement elevation multiplied by the weight of the drill fluid in the annular space. The dynamic head is the pressure required to move the drill fluid from the measurement location to the drill entry location when drilling is underway. The dynamic pressure required to make the drill fluid flow must be added to the elevation pressure head. Leakage occurs when there is an open pathway that intersects the drill path. Hydraulic jacking occurs when there are cracks in the formation such as rock joints or relatively high permeability zones contained within a relatively low permeability zone into which the drill fluid can flow and exert hydraulic pressure because of the confinement. When the drill fluid pressure exceeds the weight or force restraining the materials on the sides of the crack or higher permeability zone, the confining material will be hydraulically jacked further open resulting in an enlarged opening with more fluid volume capacity and eventually, the possibility of a new flow path for the fluid.

There is no set level of "full mud pressure" since an HDD pumping unit easily has the pump pressure capability to inject pressures well beyond bedrock strength at maximum depth of profile. Rather the drilling operator operates at the minimum pressure required to have "good return flows" to the entry pit, and then monitors that pressure for spikes or drops. Typical

annulus pressure during this drill at maximum profile depth could vary from 60-90 pounds per square inch (psi) varying by the weight of return fluids.

22. Although the drilling practices are intended to minimize the risk of an IR occurring, there is a possibility that an IR could reach the ground surface. Given the highly developed nature of this area and the close proximity of the HDD to residential water supply wells, provide "specific" standard practices for containing and controlling an IR, and note that IR response materials/equipment will be maintained in readiness at the drilling site. The IR response materials/equipment may include, but are not be limited to:

a. Materials to contain any IR that reaches the ground surface, including materials such as straw bales, sand bags, plywood or planking, silt fence, or other materials to create temporary berms or prevent movement of surfaced drilling fluids.

The Department is aware from inspection of the HDDs completed and ongoing, that SPLP's contractors maintain IR response materials on-site or in immediate vicinity in case of need.

b. If monitoring or surface observations indicate an IR has occurred, drilling operations will be immediately paused to verify the location and extent of the IR, and to prevent additional fluid surfacing.

This is a requirement of the IR plan and a standard practice.

c. The IR will be contained using best practices and materials to prevent migration or fluid from the immediate area and into sensitive habitats.

This is a statement and does not require a response.

d. Contained drilling fluid will be conveyed back to the drill rig mud supply using pumps and hoses, buckets, wet or dry vacuums, or other appropriate means. Please describe how this will be done consistent with applicable provisions of the latest versions (February 6, 2018) of the IR Assessment, Preparedness, Prevention and Contingency Plan, and the Operations Plan.

The text of Item 22d describes the methods that SPLP employs to contain, remove, and cleanup an IR event. Removed materials are either returned to the drilling unit for recycling and reuse, or they are disposed of at a licensed facility in accordance with state regulations.

23. The terms pressure, fluid pressure, drilling pressure, mud pressure, etc., may refer to either the injection pressure of the drilling fluid (mud) inside the drill string or to the pressure outside the drill string but within the borehole. Most HDD drillers measure

the injection pressure of the mud/drilling fluid within the drill string and do not measure the pressure of the bore outside the drill string but within the borehole. Clarify in the Report which pressure values are being monitored as part of this proposed HDD bore.

SPLP has mandated that Annular Pressure Monitors will be used on every HDD project wide during the pilot hole phase. The April 2018 version of the IR plan includes this requirement as well. The drilling operator also routinely records pump/stem pressure as part of their standard record keeping.

SPLP submits that we have been, and are, in complete compliance with the agreed terms and requirements of analysis of the Order, as agreed to by the Department, and that no further analysis is required for the Department to consent to the start of this HDD. SPLP therefore requests that the Department approve the Reevaluation Report for Arch Bishop/South Chester Road HDD (S3-0541) as soon as possible.

Sincerely,

Larry J. Gremminger, CWB
Geotechnical Evaluation Leader
Mariner II Pipeline Project

Attachments:
1 – Aquabloc Information
2 – Water Supply Illustration
3 – Water Well Testing Results
4 – HDD Plan and Profiles, with fracture trace lines, and well/water data

ATTACHMENT 1

AQUABLOC INFORMATION

Water Well Drilling Products

730 North Anderson Road
Rock Hill, South Carolina 29730
P: 803.327.3833
F: 866.402.0133
www.AquaSolCorp.com

AquaSol's Water Well Drilling Products provide bio-based innovative solutions for fluid loss control, and shale inhibition when drilling in reactive shales and clays. All products are NSF approved for use in potable water well drilling drilling and water treatment. Dispersible forms of these products are also offered.

- Residential
- Commercial/Industrial
- Municipal

Our products are field proven to provide significant benefits to groundwater drilling operations over competitive products:

- Increased productivity
- Improved drilling performance
- Lower cost

Available Products:

- Aquabloc LC and Aquadril LC- provide fluid loss control and more cost effective performance than CMC's or PACs. Both products are NSF certified.
- Aquabloc D and Aquadril D—provide dispersibility in addition to fluid loss for limited mixing applications and when more rapid hydration is desired. Both products are NSF certified.
- ClayCutter - a shale inhibitor that prevents bit balling and delivers faster drilling performance in reactive shales and clays.

Characteristics

Appearance	Off White Powder
Ionic Character	Cationic and anionic
Moisture	<12%
pH	8-10
Density	1.2

Applications

- River crossings
- Horizontal drilling
- Water well drilling
- Mining
- Construction

Environmental

- Fully biodegradable

Packaging and Product Form

- 50 lb paper sacks
- 25 lb pails

The Public Health and Safety Organization

NSF Product and Service Listings

These NSF Official Listings are current as of **Friday, April 20, 2018** at 12:15 a.m. Eastern Time. Please contact NSF International to confirm the status of any Listing, report errors, or make suggestions.

Alert: NSF is concerned about fraudulent downloading and manipulation of website text. Always confirm this information by clicking on the below link for the most accurate information: http://info.nsf.org/Certified/PwsChemicals/Listings.asp?TradeName=Aquabloc&

NSF/ANSI 60
Drinking Water Treatment Chemicals - Health Effects

AquaSol Corporation

730 North Anderson Road
Rock Hill, SC 29730
United States
803-327-3833
Visit this company's website (http://www.aquasolcorp.com)

The recommended dosage by the manufacturer is 1.5-2.5 lbs of Aquabloc LC or D per 100 gallons with 25 lbs/100 gallon of standard bentonite.

Facility : Rock Hill, SC

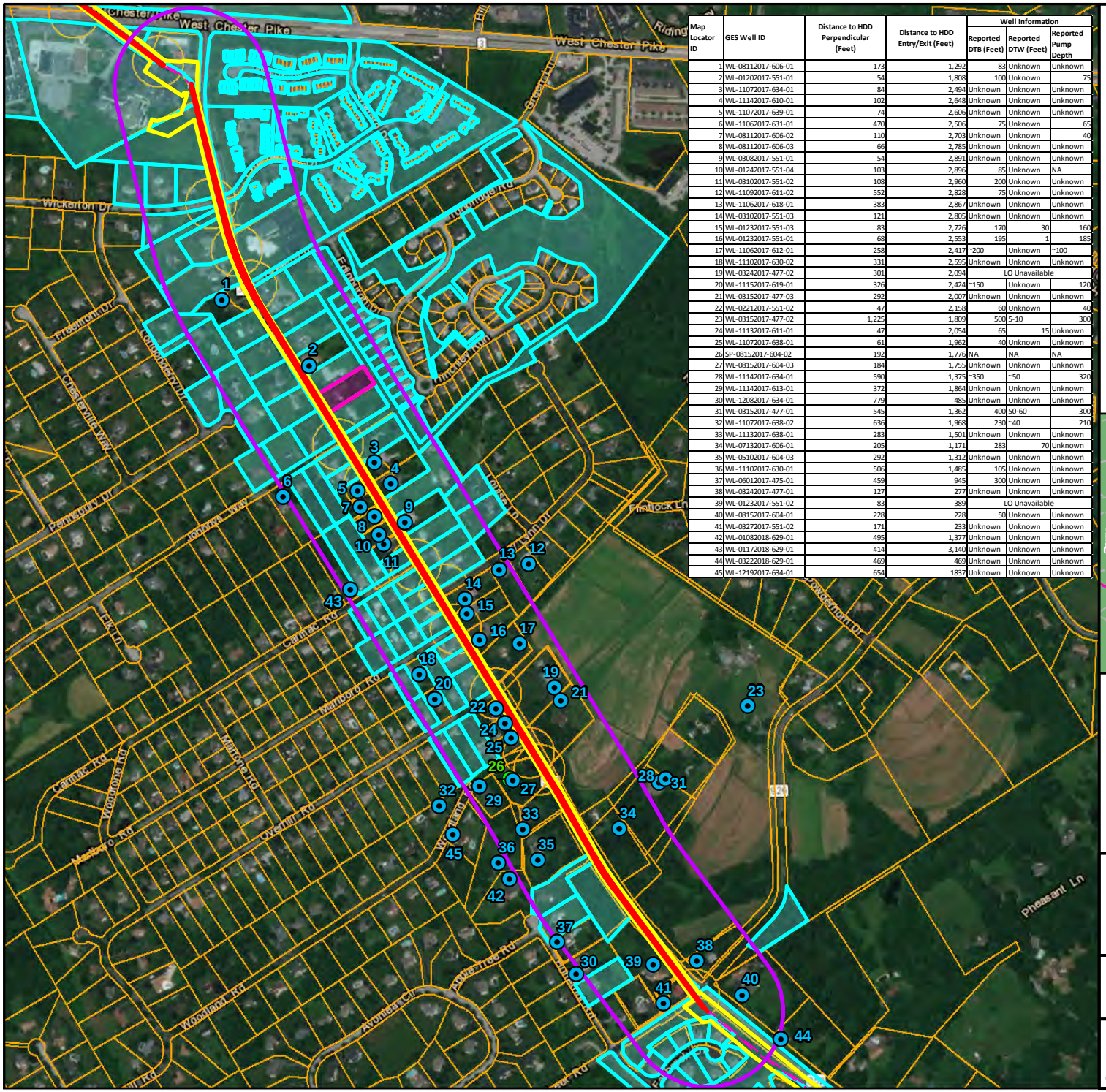
Miscellaneous Water Supply Products[1]

Trade Designation	*Product Function*	*Max Use*
Aquabloc D	Well Drilling Aid Drilling Fluid	NA
Aquabloc LC	Well Drilling Aid Drilling Fluid	NA

[1] These products are designed to be flushed out prior to using the system for drinking water. Before being placed into service, the well is to be properly flushed according to the manufacturer's use instructions. Certification of these products is based on well drilling model with the following assumptions:
- The amount of well drilling fluid used to 3780 L (1000 U.S. gallons) to which the drilling fluid has been added at the manufacturer's recommended level.
- The aquifer contains 3.1 million liters of water (815,000 gallons) based on a 0.5 acre aquifer of 6.1 meter depth (20 ft.) and 25% porosity.
- The bore hole is 61 meters in total depth (200 ft.), the screen is 6.1 meters in length (20 ft.), and the bore hole is 25.4 cm in diameter (10 in.).
- The amount of well drilling fluid removed from the well during construction is equal to the combined volumes of the casing and the screen, plus an additional amount removed through the well disinfection and development

ATTACHMENT 2

WATER SUPPLY ILLUSTRATION



Map Locator ID	GES Well ID	Distance to HDD Perpendicular (Feet)	Distance to HDD Entry/Exit (Feet)	Well Information		
				Reported DTB (Feet)	Reported DTW (Feet)	Reported Pump Depth
1	WL-08112017-606-01	173	1,292	83	Unknown	Unknown
2	WL-01202017-551-01	54	1,808	100	Unknown	75
3	WL-11072017-634-01	84	2,494	Unknown	Unknown	Unknown
4	WL-11142017-610-01	102	2,648	Unknown	Unknown	Unknown
5	WL-11072017-639-01	74	2,606	Unknown	Unknown	Unknown
6	WL-11062017-631-01	470	2,506	75	Unknown	65
7	WL-08112017-606-02	110	2,703	Unknown	Unknown	40
8	WL-08112017-606-03	66	2,785	Unknown	Unknown	Unknown
9	WL-03082017-551-01	54	2,891	Unknown	Unknown	Unknown
10	WL-01242017-551-04	103	2,896	85	Unknown	NA
11	WL-03102017-551-02	108	2,960	200	Unknown	Unknown
12	WL-11092017-611-02	552	2,828	75	Unknown	Unknown
13	WL-11062017-618-01	383	2,867	Unknown	Unknown	Unknown
14	WL-03102017-551-03	121	2,805	Unknown	Unknown	Unknown
15	WL-01232017-551-03	83	2,726	170	30	160
16	WL-01232017-551-01	68	2,553	195	1	185
17	WL-11062017-612-01	258	2,417	~200	Unknown	~100
18	WL-11102017-630-02	331	2,595	Unknown	Unknown	Unknown
19	WL-03242017-477-02	301	2,094	LO Unavailable		
20	WL-11152017-619-01	326	2,424	~150	Unknown	120
21	WL-03152017-477-03	292	2,007	Unknown	Unknown	Unknown
22	WL-02212017-551-02	47	2,158	60	Unknown	40
23	WL-03152017-477-02	1,225	1,809	500	5-10	300
24	WL-11132017-611-01	47	2,054	65	15	Unknown
25	WL-11072017-638-01	61	1,962	40	Unknown	Unknown
26	SP-08152017-604-02	192	1,776	NA	NA	NA
27	WL-08152017-604-03	184	1,755	Unknown	Unknown	Unknown
28	WL-11142017-634-01	590	1,375	~350	~50	320
29	WL-11142017-613-01	372	1,864	Unknown	Unknown	Unknown
30	WL-12082017-634-01	779	485	Unknown	Unknown	Unknown
31	WL-03152017-477-01	545	1,362	400	50-60	300
32	WL-11072017-638-02	636	1,968	230	~40	210
33	WL-11132017-638-01	283	1,501	Unknown	Unknown	Unknown
34	WL-07132017-606-01	205	1,171	283	70	Unknown
35	WL-05102017-604-03	292	1,312	Unknown	Unknown	Unknown
36	WL-11102017-630-01	506	1,485	105	Unknown	Unknown
37	WL-06012017-475-01	459	945	300	Unknown	Unknown
38	WL-03242017-477-01	127	277	Unknown	Unknown	Unknown
39	WL-01232017-551-02	83	389	LO Unavailable		
40	WL-08152017-604-01	228	228	50	Unknown	Unknown
41	WL-03272017-551-02	171	233	Unknown	Unknown	Unknown
42	WL-01082018-629-01	495	1,377	Unknown	Unknown	Unknown
43	WL-01172018-629-01	414	3,140	Unknown	Unknown	Unknown
44	WL-03222018-629-01	469	469	Unknown	Unknown	Unknown
45	WL-12192017-634-01	654	1837	Unknown	Unknown	Unknown

Legend

- LOD
- Parcel
- PPP Centerline
- HDD
- 450 foot buffer of HDD alignment
- Public Water Supply/Landowner Confirmed No Well
- Testing Refused

****Testing locations current as of 04/09/2018**

- GES Testing Location
- GES Spring Testing Location

Location

N

0 500 1,000 Feet

Well Location Map
HDD# PA-CH-0421.0000-RD
Chester County, PA.

Prepared By: TETRA TECH

Date: 4/10/2018

Base Map;
ESRI World Imagery, 09/24/2015

Coordinate System: NAD 83 Stateplane, PA South, Feet

P:\GIS\projects\112c0398-PPP\MXD\WellLocations\WellLocation_PA_CH_0421_0000.mxd LN

ATTACHMENT 3

WATER WELL TEST RESULTS

Water Testing Results
Arch Bishop/South Chester Road HDD (S3-0541)
DEP Permit Nos. E15-862 and E23-524
Westtown and Edgemont Townships
Chester and Delaware Counties, Pennsylvania

Landowner:														
Parcel Number:			670301384300		670301390000		44-00-00227-00		44-00-00228-00		67-02-0042.0500		6703 00460000	
Location Code:			WL-11062017-618-01		WL-11062017-612-01		WL-08152017-604-01		DW-03222018-629-01		WL-08112017-606-01		WL-11062017-631-01	
Sample Phase:			Pre-Construction		Pre-Construction		Pre-Construction		Pre-Construction		Pre-Construction		Pre-Construction	
Sample Treatment:			Pre-Treatment		Pre-Treatment		Pre-Treatment		No Treatment		No Treatment		No Treatment	
Treatment Type (Post-Treatment Samples Only):			-		-		-		-		-		-	
Lab Sample ID			L948712-01		L948730-01		L929649-01		L979835-01		L929038-01		L948728-01	
Client Sample ID			11062017-618-01		11062017-612-01		08152017-604-01		03222018-629-01		08112017-606-01		11062017-631-01	
Date Collected			11/06/2017		11/06/2017		08/15/2017		03/22/2018		08/11/2017		11/06/2017	
Method	Analyte	Units	Result	Qualifier	Result	Qualifier	Result	Qualifier	Result	Qualifier	Result	Qualifier	Result	Qualifier
130.1	HARDNESS	mg/l	230		<30.0		133		182		260	B	182	
2130 B-2011	TURBIDITY	NTU	4.80		33.1		0.110	B	46.0		116		95.4	
2320 B-2011	ALKALINITY	mg/l	24.3		823		48.2		50.0		25.7	B	60.0	
2540 C-2011	DISSOLVED SOLIDS	mg/l	535		1190		265		597		615		342	
2540 D-2011	SUSPENDED SOLIDS	mg/l	2.50		9.40		<2.50		63.7		73.5		79.5	
6010B	BARIUM	mg/l	0.537		0.0492		0.142		0.127		0.278		0.243	
6010B	CALCIUM	mg/l	52.9		2.26		32.6		47.6		50.6		43.5	
6010B	IRON	mg/l	0.563		0.833		<0.100		1.70		31.5		35.3	
6010B	MAGNESIUM	mg/l	18.9		<1.00		10.3		12.6		30.5		14.1	
6010B	MANGANESE	mg/l	<0.0100		<0.0100		<0.0100		0.0122		0.0229		0.189	
6010B	POTASSIUM	mg/l	4.99		472		2.26		2.86		7.27		2.43	
6010B	SODIUM	mg/l	64.3		48.2		15.7		54.2		46.1		18.7	
8260B	BENZENE	mg/l	<0.00100		<0.00100		<0.00100		<0.00100		<0.00100		<0.00100	
8260B	TOLUENE	mg/l	<0.00100		<0.00100		<0.00100		<0.00100		<0.00100		<0.00100	
8260B	ETHYLBENZENE	mg/l	<0.00100		<0.00100		<0.00100		<0.00100		<0.00100		<0.00100	
8260B	XYLENES, TOTAL	mg/l	<0.00300		<0.00300		<0.00300		<0.0030		<0.00300		<0.00300	
9040C	pH	su	6.67	T8	9.54	T8	6.82	T8	6.57	T8	7.93	T8	7.01	T8
9050A	SPECIFIC CONDUCTANCE	umhos/cm	878		1820		357		839		851		504	
9056A	BROMIDE	mg/l	<1.00		<1.00		<1.00		<1.00		<1.00		<1.00	
9056A	CHLORIDE	mg/l	213		3.76		33.3		196		217		83.8	
9056A	SULFATE	mg/l	17.4		48.8		38.4		25.2		28.9		9.76	
9222D	COLIFORM,FECAL	col/100ml	<1		<1		9.00		<1		1.00		<1	
9223 B-1997	E.COLI	MPN/100ml	<1	U	<1	U	60.9		<1		<1		<1	U
9223 B-1997	COLIFORM,TOTAL	MPN/100ml	10.9	U	<1	U	2,420		24.1		261		10.9	U
RSK175	METHANE	mg/l	<0.0100		<0.0100		<0.0100		<0.0100		<0.0100		<0.0100	
RSK175	ETHANE	mg/l	<0.0130		<0.0130		<0.0130		<0.0130		<0.0130		<0.0130	
RSK175	ETHENE	mg/l	<0.0130		<0.0130		<0.0130		<0.0130		<0.0130		<0.0130	
RSK175	PROPANE	mg/l	<0.0190		<0.0190		<0.0190		<0.0190		<0.0190		<0.0190	

Qualifiers:

T8: Sample(s) received past/too close to holding time expiration.
U: Below Detectable Limits: Indicates that the analyte was not detected.
B: The same analyte is found in the associated blank.
J3: The associated batch QC was outside the established quality control range for precision.
J4: The associated batch QC was outside the established quality control range for accuracy.
J6: The sample matrix interfered with the ability to make any accurate determination; spike value is low.
V: The sample concentration is too high to evaluate accurate spike recoveries.
NA: Not Analyzed
Positive bacteria detections are shaded as gray

Water Testing Results
Arch Bishop/South Chester Road HDD (S3-0541)
DEP Permit Nos. E15-862 and E23-524
Westtown and Edgemont Townships
Chester and Delaware Counties, Pennsylvania

Landowner:														
Parcel Number:			6703 00490000		6703 00960000		6703 01230000		6703 01240000		6703 01251100		6703 01253200	
Location Code:			WL-11072017-639-01		WL-11102017-630-02		WL-11132017-611-01		WL-11072017-638-01		WL-11072017-638-02		WL-12192017-634-01	
Sample Phase:			Pre-Construction		Pre-Construction		Pre-Construction		Pre-Construction		Pre-Construction		Pre-Construction	
Sample Treatment:			Pre-Treatment		No Treatment		Pre-Treatment		No Treatment		No Treatment		Pre-Treatment	
Treatment Type (Post-Treatment Samples Only):			-		-		-		-		-		-	
Lab Sample ID			L949059-01		L950213-01		L950572-01		L949054-01		L949057-01		L958685-01	
Client Sample ID			11072017-639-01		11102017-630-02		11132017-611-01		11072017-638-01		11072017-638-02		12192017-634-01	
Date Collected			11/07/2017		11/10/2017		11/13/2017		11/07/2017		11/07/2017		12/19/2017	
Method	Analyte	Units	Result	Qualifier	Result	Qualifier	Result	Qualifier	Result	Qualifier	Result	Qualifier	Result	Qualifier
130.1	HARDNESS	mg/l	196		75.3		107		125		114		184	
2130 B-2011	TURBIDITY	NTU	0.501	B	<0.300		16.5		19.9		0.434	B	8.21	
2320 B-2011	ALKALINITY	mg/l	<20.0		52.7		34.2		39.0		25.9		69.1	
2540 C-2011	DISSOLVED SOLIDS	mg/l	629		170		350		322		210		333	
2540 D-2011	SUSPENDED SOLIDS	mg/l	4.00		<2.50		24.8		5.80		<2.50		<2.50	
6010B	BARIUM	mg/l	1.02		0.123		0.334		0.328		0.139		0.0936	
6010B	CALCIUM	mg/l	56.5		16.8		28.3		31.6		26.7		58.3	
6010B	IRON	mg/l	<0.100		<0.100		0.712		1.9		<0.100		1.10	
6010B	MAGNESIUM	mg/l	15.2		8.35		9.57		9.90		9.73		13.6	
6010B	MANGANESE	mg/l	<0.0100		<0.0100		0.0129		0.0597		<0.0100		0.188	
6010B	POTASSIUM	mg/l	3.94		1.72		3.09		3.06		4.37		6.45	
6010B	SODIUM	mg/l	70.3		9.23		56.7		46.3		10.1		14.0	
8260B	BENZENE	mg/l	<0.00100		<0.00100		<0.00100		<0.00100		<0.00100		<0.00100	
8260B	TOLUENE	mg/l	<0.00100		<0.00100		<0.00100		<0.00100		<0.00100		<0.00100	
8260B	ETHYLBENZENE	mg/l	<0.00100		<0.00100		<0.00100		<0.00100		<0.00100		<0.00100	
8260B	XYLENES, TOTAL	mg/l	<0.00300		<0.00300		<0.00300		<0.00300		<0.00300		<0.00300	
9040C	pH	su	6.00	T8	6.39	T8	5.81	T8	6.26	T8	6.41	T8	7.14	T8
9050A	SPECIFIC CONDUCTANCE	umhos/cm	858		239		539		514		308		493	
9056A	BROMIDE	mg/l	<1.00		<1.00		<1.00		<1.00		<1.00		<1.00	
9056A	CHLORIDE	mg/l	233		23.3		109		98.0		45.9		88.5	
9056A	SULFATE	mg/l	<5.00		13.8		21.2		18.6		18.1		41.3	
9222D	COLIFORM,FECAL	col/100ml	<1		<1		<1		<1		<1		<1	
9223 B-1997	E.COLI	MPN/100ml	<1		<1		<1		<1		<1		<1	
9223 B-1997	COLIFORM,TOTAL	MPN/100ml	<1		<1		1.00		<1		<1		3.10	
RSK175	METHANE	mg/l	<0.0100	J3 J4	<0.0100		<0.0100		0.0681		<0.0100	J3 J4	<0.0100	
RSK175	ETHANE	mg/l	<0.0130		<0.0130		<0.0130		<0.0130		<0.0130		<0.0130	
RSK175	ETHENE	mg/l	<0.0130		<0.0130		<0.0130		<0.0130		<0.0130		<0.0130	
RSK175	PROPANE	mg/l	<0.0190		<0.0190		<0.0190		<0.0190		<0.0190		<0.0190	

Qualifiers:

T8: Sample(s) received past/too close to holding time expiration.
U: Below Detectable Limits: Indicates that the analyte was not detected.
B: The same analyte is found in the associated blank.
J3: The associated batch QC was outside the established quality control range for precision.
J4: The associated batch QC was outside the established quality control range for accuracy.
J6: The sample matrix interfered with the ability to make any accurate determination; spike value is low.
V: The sample concentration is too high to evaluate accurate spike recoveries.
NA: Not Analyzed
Positive bacteria detections are shaded as gray

Water Testing Results
Arch Bishop/South Chester Road HDD (S3-0541)
DEP Permit Nos. E15-862 and E23-524
Westtown and Edgemont Townships
Chester and Delaware Counties, Pennsylvania

Landowner:														
Parcel Number:			**6703 01254300**		**6703 013813A0**		**6703 01384200**		**67-03-0050.0000**		**67-03-0051.0000**		**67-03-0052.0000**	
Location Code:			**-**		**WL-11072017-634-01**		**WL-11092017-611-02**		**WL-08112017-606-02**		**WL-08112017-606-03**		**WL-01242017-551-04**	
Sample Phase:			**Pre-Construction**		**Pre-Construction**		**Pre-Construction**		**Pre-Construction**		**Pre-Construction**		**Pre-Construction**	
Sample Treatment:			**Pre-Treatment**		**Pre-Treatment**		**No Treatment**		**Unsure**		**Pre-Treatment**		**Post-Treatment**	
Treatment Type (Post-Treatment Samples Only):			**-**		**-**		**-**		**Softening, UV Light**		**-**		**Sediment Filter**	
Lab Sample ID			L950215-01		L949021-01		L949800-01		L929035-01		L929033-01		L885836-01	
Client Sample ID			11102017-630-03		11072017-634-01		11092017-611-02		08112017-606-02		08112017-606-03		01242017-551-04	
Date Collected			11/10/2017		11/07/2017		11/09/2017		8/11/2017		08/11/2017		01/24/2017	
Method	Analyte	Units	Result	Qualifier	Result	Qualifier	Result	Qualifier	Result	Qualifier	Result	Qualifier	Result	Qualifier
130.1	HARDNESS	mg/l	264		268		106	J6	130		161		126	
2130 B-2011	TURBIDITY	NTU	271		15.3		0.441	B	<0.100		16.7		3.20	
2320 B-2011	ALKALINITY	mg/l	31.4		38.0		27.4		23.6	B	56.8		<20.0	
2540 C-2011	DISSOLVED SOLIDS	mg/l	585		771		286		400		276		367	
2540 D-2011	SUSPENDED SOLIDS	mg/l	103		18.0		<2.50		<2.50		35.6		<2.50	
6010B	BARIUM	mg/l	0.306		0.551		0.364		0.582		0.251		0.257	
6010B	CALCIUM	mg/l	64.2		70.8		27.1		28.7		31.9		29.2	
6010B	IRON	mg/l	33.2		4.30		<0.100		<0.100		12.2		<0.100	
6010B	MAGNESIUM	mg/l	27.4		21.5		8.67		12.5		18.5		11.3	
6010B	MANGANESE	mg/l	0.927		0.0395		<0.0100		0.0120		0.271		0.0284	
6010B	POTASSIUM	mg/l	4.45		4.16		2.62		2.78		4.89		4.77	
6010B	SODIUM	mg/l	20.1		60.4		22.6		33.6		11.1		63.5	
8260B	BENZENE	mg/l	<0.00100		<0.00100		<0.00100		<0.00100		<0.00100		<0.00100	
8260B	TOLUENE	mg/l	<0.00100		<0.00100		<0.00100		<0.00100		<0.00100		<0.00100	
8260B	ETHYLBENZENE	mg/l	<0.00100		<0.00100		<0.00100		<0.00100		<0.00100		<0.00100	
8260B	XYLENES, TOTAL	mg/l	<0.00300		<0.00300		<0.00300		<0.00300		<0.00300		<0.00300	
9040C	pH	su	6.28	T8	6.37	T8	6.19	T8	5.82	T8	6.91	T8	5.63	T8
9050A	SPECIFIC CONDUCTANCE	umhos/cm	715		946		380		496		419		626	
9056A	BROMIDE	mg/l	<1.00		<1.00		<1.00		<1.00		<1.00		<1.00	
9056A	CHLORIDE	mg/l	167		229		66.2		105		70.8		148	
9056A	SULFATE	mg/l	24.7		15.4		10.1		<5.00		23.4		18.4	
9222D	COLIFORM,FECAL	col/100ml	<1		<1		<1		<1		<1		NA	
9223 B-1997	E.COLI	MPN/100ml	<1		<1		<1		<1		<1		NA	
9223 B-1997	COLIFORM,TOTAL	MPN/100ml	69.1		<1		<1		<1		19.7		NA	
RSK175	METHANE	mg/l	<0.0100		<0.0100	J3 J4	<0.0100		<0.0100		0.0424		<0.0100	
RSK175	ETHANE	mg/l	<0.0130		<0.0130		<0.0130		<0.0130		<0.0130		<0.0130	
RSK175	ETHENE	mg/l	<0.0130		<0.0130		<0.0130		<0.0130		<0.0130		<0.0130	
RSK175	PROPANE	mg/l	<0.0190		<0.0190		<0.0190		<0.0190		<0.0190		<0.0190	

Qualifiers:

T8: Sample(s) received past/too close to holding time expiration.

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J4: The associated batch QC was outside the established quality control range for accuracy.

J6: The sample matrix interfered with the ability to make any accurate determination; spike value is low.

V: The sample concentration is too high to evaluate accurate spike recoveries.

NA: Not Analyzed

Positive bacteria detections are shaded as gray

Water Testing Results
Arch Bishop/South Chester Road HDD (S3-0541)
DEP Permit Nos. E15-862 and E23-524
Westtown and Edgemont Townships
Chester and Delaware Counties, Pennsylvania

Landowner:														
Parcel Number:			67-03-0053.0000		67-03-0122.0000		67-03-0125.0000		67-03-0125.2200				67-03-0125.36A0	
Location Code:			WL-03102017-551-02		WL-02212017-551-02		WL-01232017-551-02		SP-08152017-604-02		WL-08152017-604-03		WL-05102017-604-03	
Sample Phase:			Pre-Construction		Pre-Construction		Pre-Construction		Pre-Construction		Pre-Construction		Pre-Construction	
Sample Treatment:			Pre-Treatment		No Treatment		No Treatment		No Treatment		Pre-Treatment		No Treatment	
Treatment Type (Post-Treatment Samples Only):			-		-		-		-		-		-	
Lab Sample ID			L895448-01		L891552-01		L885588-01		L929647-01		L929644-01		L908573-01	
Client Sample ID			03102017-551-02		02212017-551-02		01232017-551-02		08152017-604-02		08152017-604-03		05102017-604-03	
Date Collected			03/10/2017		02/21/2017		01/23/2017		08/15/2017		08/15/2017		05/10/2017	
Method	Analyte	Units	Result	Qualifier	Result	Qualifier	Result	Qualifier	Result	Qualifier	Result	Qualifier	Result	Qualifier
130.1	HARDNESS	mg/l	122		121		93.4		129		171		151	
2130 B-2011	TURBIDITY	NTU	1.20		0.489		1.86		1.78		22.4		0.523	
2320 B-2011	ALKALINITY	mg/l	21.0	B	31.2		38.7		30.4		60.9		115	
2540 C-2011	DISSOLVED SOLIDS	mg/l	297		308		191		372		323		234	
2540 D-2011	SUSPENDED SOLIDS	mg/l	30.3		<2.50		29.8		<2.50		25.3		<2.50	
6010B	BARIUM	mg/l	0.150		0.161		0.125		0.310		0.231		0.124	
6010B	CALCIUM	mg/l	27.5		29.0		21.3		31.8		44.9		39.8	
6010B	IRON	mg/l	4.85		<0.100		12.4		<0.100		11.9		<0.100	
6010B	MAGNESIUM	mg/l	11.9		9.82		7.53		10.2		14.9		12.0	
6010B	MANGANESE	mg/l	0.0440		<0.0100		0.138		0.0247		0.285		<0.0100	
6010B	POTASSIUM	mg/l	5.06		3.49		2.47		2.92		6.11		4.66	
6010B	SODIUM	mg/l	48.0		21.1		14.0		41.3		13.7		9.55	
8260B	BENZENE	mg/l	<0.00100		<0.00100		<0.00100		<0.00100		<0.00100		<0.00100	
8260B	TOLUENE	mg/l	<0.00100		<0.00100		<0.00100		<0.00100		<0.00100		<0.00100	
8260B	ETHYLBENZENE	mg/l	<0.00100		<0.00100		<0.00100		<0.00100		<0.00100		<0.00100	
8260B	XYLENES, TOTAL	mg/l	<0.00300		<0.00300		<0.00300		<0.00300		<0.00300		<0.00300	
9040C	pH	su	6.04	T8	6.02	T8	6.72	T8	6.71	T8	6.32	T8	6.53	T8
9050A	SPECIFIC CONDUCTANCE	umhos/cm	526		393		268		507		472		347	
9056A	BROMIDE	mg/l	<1.00		<1.00		<1.00		<1.00		<1.00		<1.00	
9056A	CHLORIDE	mg/l	110		67.2		27.3		97.2		76.8		10.6	
9056A	SULFATE	mg/l	21.2		22.8		24.0		20.3		41.2		33.9	
9222D	COLIFORM,FECAL	col/100ml	NA		NA		NA		5.00		17.0		NA	
9223 B-1997	E.COLI	MPN/100ml	NA		NA		NA		3.10		5.20		NA	
9223 B-1997	COLIFORM,TOTAL	MPN/100ml	NA		NA		NA		1,990		85.7		NA	
RSK175	METHANE	mg/l	<0.0100		<0.0100		<0.0100		<0.0100		<0.0100		<0.0100	
RSK175	ETHANE	mg/l	<0.0130		<0.0130		<0.0130		<0.0130		<0.0130		<0.0130	
RSK175	ETHENE	mg/l	<0.0130		<0.0130		<0.0130		<0.0130		<0.0130		<0.0130	
RSK175	PROPANE	mg/l	<0.0190		<0.0190		<0.0190		<0.0190		<0.0190		<0.0190	

Qualifiers:

T8: Sample(s) received past/too close to holding time expiration.
U: Below Detectable Limits: Indicates that the analyte was not detected.
B: The same analyte is found in the associated blank.
J3: The associated batch QC was outside the established quality control range for precision.
J4: The associated batch QC was outside the established quality control range for accuracy.
J6: The sample matrix interfered with the ability to make any accurate determination; spike value is low.
V: The sample concentration is too high to evaluate accurate spike recoveries.
NA: Not Analyzed
Positive bacteria detections are shaded as gray

Water Testing Results
Arch Bishop/South Chester Road HDD (S3-0541)
DEP Permit Nos. E15-862 and E23-524
Westtown and Edgemont Townships
Chester and Delaware Counties, Pennsylvania

Landowner:														
Parcel Number:			67-03-0125.3900		67-03-0125.4100		67-03-0127.0000		67-03-0138.0800		67-03-0138.1400		67-03-0138.1700	
Location Code:			WL-06012017-475-01		WL-12082017-634-01		WL-03272017-551-02		WL-01202017-551-01		WL-03082017-551-01		WL-01232017-551-03	
Sample Phase:			Pre-Construction		Pre-Construction		Pre-Construction		Pre-Construction		Pre-Construction		Pre-Construction	
Sample Treatment:			Pre-Treatment		Pre-Treatment		No Treatment		No Treatment		Pre-Treatment		Pre-Treatment	
Treatment Type (Post-Treatment Samples Only):			-		-		-		-		-		-	
Lab Sample ID			L913121-01		L956430-01		L898563-01		L885374-01		L894776-01		L885584-01	
Client Sample ID			06012017-475-01		12082017-634-01		03272017-551-02		01202017-551-01		03082017-551-01		01232017-551-03	
Date Collected			06/01/2017		12/08/2017		03/27/2017		01/20/2017		03/08/2017		01/23/2017	
Method	Analyte	Units	Result	Qualifier	Result	Qualifier	Result	Qualifier	Result	Qualifier	Result	Qualifier	Result	Qualifier
130.1	HARDNESS	mg/l	173		185		183	B	166		148		186	
2130 B-2011	TURBIDITY	NTU	3.47		918		0.258		16.3		2.70		0.427	
2320 B-2011	ALKALINITY	mg/l	108		63.9		39.4		46.4		<20.0		<20.0	
2540 C-2011	DISSOLVED SOLIDS	mg/l	283		238		555		295		424		595	
2540 D-2011	SUSPENDED SOLIDS	mg/l	21.3		86.5		<2.50		3.30		7.00		<2.50	
6010B	BARIUM	mg/l	0.173		0.201		0.133		0.0677		0.461		0.517	
6010B	CALCIUM	mg/l	50.1		42.1		45.7		34.5		34.3		43.2	
6010B	IRON	mg/l	0.534		41.1		<0.100		2.45		5.67		<0.100	
6010B	MAGNESIUM	mg/l	11.8		16.5		16.8		18.7		14.6		19.2	
6010B	MANGANESE	mg/l	<0.0100		0.0595		<0.0100		<0.0100		0.241		0.0330	
6010B	POTASSIUM	mg/l	3.65		2.34		5.24		4.13		6.05		4.42	
6010B	SODIUM	mg/l	9.14		13.4		65.5		15.4		83.2		80.1	
8260B	BENZENE	mg/l	<0.00100		<0.00100		<0.00100		<0.00100		<0.00100		<0.00100	
8260B	TOLUENE	mg/l	<0.00100		<0.00100		<0.00100		<0.00100		<0.00100		<0.00100	
8260B	ETHYLBENZENE	mg/l	<0.00100		<0.00100		<0.00100		<0.00100		<0.00100		<0.00100	
8260B	XYLENES, TOTAL	mg/l	<0.00300		<0.00300		<0.00300	T8	<0.00300		<0.00300		<0.00300	
9040C	pH	su	6.89	T8	6.25	T8	6.00		6.31	T8	6.33	T8	6.44	T8
9050A	SPECIFIC CONDUCTANCE	umhos/cm	565		485		767		461		769		881	
9056A	BROMIDE	mg/l	<1.00		<1.00		<1.00		<1.00		<1.00		<1.00	
9056A	CHLORIDE	mg/l	47.5		82.1		174		84.3		190		215	
9056A	SULFATE	mg/l	32.8		23.0		28.6		22.6		34.0		14.7	
9222D	COLIFORM,FECAL	col/100ml	NA		<4		NA		NA		NA		NA	
9223 B-1997	E.COLI	MPN/100ml	NA		<1		NA		NA		NA		NA	
9223 B-1997	COLIFORM,TOTAL	MPN/100ml	NA		4.10		NA		NA		NA		NA	
RSK175	METHANE	mg/l	<0.0100		0.258		<0.0100		<0.0100		<0.0100		<0.0100	
RSK175	ETHANE	mg/l	<0.0130		<0.0130		<0.0130		<0.0130		<0.0130		<0.0130	
RSK175	ETHENE	mg/l	<0.0130		<0.0130		<0.0130		<0.0130		<0.0130		<0.0130	
RSK175	PROPANE	mg/l	<0.0190		<0.0190		<0.0190		<0.0190		<0.0190		<0.0190	

Qualifiers:

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Water Testing Results
Arch Bishop/South Chester Road HDD (S3-0541)
DEP Permit Nos. E15-862 and E23-524
Westtown and Edgemont Townships
Chester and Delaware Counties, Pennsylvania

Landowner:														
Parcel Number:			67-03-0138.2100		67-03-0140.0100		67-03-0140.0200				67-03-0140.02A0		67-03-0140.02B0	
Location Code:			WL-03102017-551-03		WL-03242017-477-01		WL-03152017-477-01		WL-03152017-477-02		WL-03242017-477-02		WL-03152017-477-03	
Sample Phase:			Pre-Construction		Pre-Construction		Pre-Construction		Pre-Construction		Pre-Construction		Pre-Construction	
Sample Treatment:			Pre-Treatment		Pre-Treatment		Pre-Treatment		Pre-Treatment		Pre-Treatment		Post-Treatment	
Treatment Type (Post-Treatment Samples Only):			-		-		-		-		-		Softening, Sediment Filter, UV Light	
Lab Sample ID			L895449-01		L898277-01		L896252-01		L896251-01		L898278-01		L896250-01	
Client Sample ID			03102017-551-03		03242017-477-01		03152017-477-01		03152017-477-02		03242017-477-02		03152017-477-03	
Date Collected			03/10/2017		03/24/2017		03/15/2017		03/15/2017		03/24/2017		03/15/2017	
Method	Analyte	Units	Result	Qualifier	Result	Qualifier	Result	Qualifier	Result	Qualifier	Result	Qualifier	Result	Qualifier
130.1	HARDNESS	mg/l	120		360		97.7		81.4		301		<30.0	
2130 B-2011	TURBIDITY	NTU	0.232		2.21		12.3		10.5		2.45	B	0.150	
2320 B-2011	ALKALINITY	mg/l	<20.0		61.8		54.0		47.9		21.5		53.7	
2540 C-2011	DISSOLVED SOLIDS	mg/l	319		1,110		184		154		657		235	
2540 D-2011	SUSPENDED SOLIDS	mg/l	<2.50		<2.50		7.18		4.10		76.8		<2.50	
6010B	BARIUM	mg/l	0.316		0.318		0.108		0.127		0.369		<0.00500	
6010B	CALCIUM	mg/l	27.8		87.4		23.7		16.9		67.8		<1.00	
6010B	IRON	mg/l	<0.100		0.348		3.86		5.11		2.57		<0.100	
6010B	MAGNESIUM	mg/l	12.1		34.4		7.97		8.45		32.0		<1.00	
6010B	MANGANESE	mg/l	0.0148		0.0407		0.0966		0.267		0.0299		<0.0100	
6010B	POTASSIUM	mg/l	3.03		8.33	V	3.68	B	4.40	B	4.56		2.25	B
6010B	SODIUM	mg/l	49.5		143		8.03		7.41		16.3		73.1	
8260B	BENZENE	mg/l	<0.00100		<0.00100		<0.00100		<0.00100		<0.00100		<0.00100	
8260B	TOLUENE	mg/l	<0.00100		<0.00100		<0.00100		<0.00100		<0.00100		<0.00100	
8260B	ETHYLBENZENE	mg/l	<0.00100		<0.00100		<0.00100		<0.00100		<0.00100		<0.00100	
8260B	XYLENES, TOTAL	mg/l	<0.00300		<0.00300	T8	<0.00300		<0.00300		<0.00300	T8	<0.00300	
9040C	pH	su	6.00	T8	6.43		6.87	T8	6.75	T8	6.14		7.09	T8
9050A	SPECIFIC CONDUCTANCE	umhos/cm	549		1,440		244		223		728		363	
9056A	BROMIDE	mg/l	<1.00		<1.00		<1.00		<1.00		<1.00		<1.00	
9056A	CHLORIDE	mg/l	117		388		18.5		8.19		172		45.1	
9056A	SULFATE	mg/l	18.2		24.5		29.5		40.4		17.2		38.5	
9222D	COLIFORM,FECAL	col/100ml	NA		NA		NA		NA		NA		NA	
9223 B-1997	E.COLI	MPN/100ml	NA		NA		NA		NA		NA		NA	
9223 B-1997	COLIFORM,TOTAL	MPN/100ml	NA		NA		NA		NA		NA		NA	
RSK175	METHANE	mg/l	<0.0100		<0.0100		<0.0100		<0.0100		<0.0100		<0.0100	
RSK175	ETHANE	mg/l	<0.0130		<0.0130		<0.0130		<0.0130		<0.0130		<0.0130	
RSK175	ETHENE	mg/l	<0.0130		<0.0130		<0.0130		<0.0130		<0.0130		<0.0130	
RSK175	PROPANE	mg/l	<0.0190		<0.0190		<0.0190		<0.0190		<0.0190		<0.0190	

Qualifiers:

T8: Sample(s) received past/too close to holding time expiration.

U: Below Detectable Limits: Indicates that the analyte was not detected.

B: The same analyte is found in the associated blank.

J3: The associated batch QC was outside the established quality control range for precision.

J4: The associated batch QC was outside the established quality control range for accuracy.

J6: The sample matrix interfered with the ability to make any accurate determination; spike value is low.

V: The sample concentration is too high to evaluate accurate spike recoveries.

NA: Not Analyzed

Positive bacteria detections are shaded as gray

Water Testing Results
Arch Bishop/South Chester Road HDD (S3-0541)
DEP Permit Nos. E15-862 and E23-524
Westtown and Edgemont Townships
Chester and Delaware Counties, Pennsylvania

Landowner:														
Parcel Number:			67-03-0142.0000		67-03-0180.1800		67-3-102		67-3-125.34		67-3-125.35		67-3-125.36	
Location Code:			WL-07132017-606-01		WL-01232017-551-01		WL-11152017-619-01		WL-11142017-613-01		WL-11132017-638-01		WL-01082018-629-01	
Sample Phase:			Pre-Construction		Pre-Construction		Pre-Construction		Pre-Construction		Pre-Construction		Pre-Construction	
Sample Treatment:			Not Sure		Post-Treatment		No Treatment		Pre-Treatment		Pre-Treatment		Pre-Treatment	
Treatment Type (Post-Treatment Samples Only):			Sediment Filter		Sediment Filter		-		-		-		-	
Lab Sample ID			L922400-01		L885591-01		L951335-01		L950894-01		L950552-01		L961761-01	
Client Sample ID			07132017-606-01		01232017-551-01		11152017-619-01		11142017-613-01		11132017-638-01		01082018-629-01	
Date Collected			07/13/2017		01/23/2017		11/15/2017		11/14/2017		11/13/2017		01/08/2018	
Method	Analyte	Units	Result	Qualifier	Result	Qualifier	Result	Qualifier	Result	Qualifier	Result	Qualifier	Result	Qualifier
130.1	HARDNESS	mg/l	126		113		101	J6	120		144		128	
2130 B-2011	TURBIDITY	NTU	5.25		0.659		<0.300		2.14		8.15		2.41	
2320 B-2011	ALKALINITY	mg/l	81.9		33.8		<20.0		29.3		69.7		57.4	
2540 C-2011	DISSOLVED SOLIDS	mg/l	191		248		255		262		234		193	
2540 D-2011	SUSPENDED SOLIDS	mg/l	<2.50		<2.50		<2.50		3.50		<2.50		21.2	
6010B	BARIUM	mg/l	0.118		0.131		0.262		0.327		0.151		0.181	
6010B	CALCIUM	mg/l	30.3		26.6		24.0		32.0		42.4		27.2	
6010B	IRON	mg/l	1.36		<0.100		<0.100		0.215		2.41		0.900	
6010B	MAGNESIUM	mg/l	8.52		8.85		10.8		10.1		11.2		10.6	
6010B	MANGANESE	mg/l	0.232		<0.0100		0.0150		<0.0100		0.256		0.0150	
6010B	POTASSIUM	mg/l	4.01		3.68		2.81		4.31		5.30		5.68	
6010B	SODIUM	mg/l	8.02		19.9		18.8		31.4		10.8		12.8	
8260B	BENZENE	mg/l	<0.00100		<0.00100		<0.00100		<0.00100		<0.00100		<0.00100	
8260B	TOLUENE	mg/l	<0.00100		<0.00100		<0.00100		<0.00100		<0.00100		<0.00100	
8260B	ETHYLBENZENE	mg/l	<0.00100		<0.00100		<0.00100		<0.00100		<0.00100		<0.00100	
8260B	XYLENES, TOTAL	mg/l	<0.00300		<0.00300		<0.00300		<0.00300		<0.00300		<0.00300	
9040C	pH	su	7.13	T8	6.54	T8	5.87	T8	5.88	T8	6.96	T8	6.22	T8
9050A	SPECIFIC CONDUCTANCE	umhos/cm	181		347		340		448		373		309	
9056A	BROMIDE	mg/l	<1.00		<1.00		<1.00		<1.00		<1.00		<1.00	
9056A	CHLORIDE	mg/l	12.1		43.9		38.2		86.3		51.1		22.7	
9056A	SULFATE	mg/l	33.7		24.5		20.2		17.7		39.3		25.3	
9222D	COLIFORM,FECAL	col/100ml	NA		NA		<1		<1		<1		<1	
9223 B-1997	E.COLI	MPN/100ml	NA		NA		<1		<1		<1		<1	
9223 B-1997	COLIFORM,TOTAL	MPN/100ml	NA		NA		2.00		17.3		<1		<1	
RSK175	METHANE	mg/l	<0.0100		<0.0100		0.0229		<0.0100		<0.0100		<0.0100	
RSK175	ETHANE	mg/l	<0.0130		<0.0130		<0.0130		<0.0130		<0.0130		<0.0130	
RSK175	ETHENE	mg/l	<0.0130		<0.0130		<0.0130		<0.0130		<0.0130		<0.0130	
RSK175	PROPANE	mg/l	<0.0190		<0.0190		<0.0190		<0.0190		<0.0190		<0.0190	

Qualifiers:

T8: Sample(s) received past/too close to holding time expiration.
U: Below Detectable Limits: Indicates that the analyte was not detected.
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J3: The associated batch QC was outside the established quality control range for precision.
J4: The associated batch QC was outside the established quality control range for accuracy.
J6: The sample matrix interfered with the ability to make any accurate determination; spike value is low.
V: The sample concentration is too high to evaluate accurate spike recoveries.
NA: Not Analyzed
Positive bacteria detections are shaded as gray

Water Testing Results
Arch Bishop/South Chester Road HDD (S3-0541)
DEP Permit Nos. E15-862 and E23-524
Westtown and Edgemont Townships
Chester and Delaware Counties, Pennsylvania

Landowner:										
Parcel Number:			**67-3-125.36B**		**67-3-138.13B**		**67-3-141**		**67-3-57**	
Location Code:			**WL-11102017-630-01**		**WL-11142017-610-01**		**WL-11142017-634-01**		**WL-01172018-629-01**	
Sample Phase:			**Pre-Construction**		**Pre-Construction**		**Pre-Construction**		**Pre-Construction**	
Sample Treatment:			**No Treatment**		**No Treatment**		**Pre-Treatment**		**Pre-Treatment**	
Treatment Type (Post-Treatment Samples Only):			**-**		**-**		**-**		**-**	
Lab Sample ID			L950216-01		L950910-01		L950953-01		L963882-01	
Client Sample ID			11102017-630-01		11142017-610-01		11142017-634-01		01172018-629-01	
Date Collected			11/10/2017		11/14/2017		11/14/2017		01/17/2018	
Method	Analyte	Units	Result	Qualifier	Result	Qualifier	Result	Qualifier	Result	Qualifier
130.1	HARDNESS	mg/l	78.5		62.0		80.4		157	
2130 B-2011	TURBIDITY	NTU	9.78		0.718		7.14		2.57	
2320 B-2011	ALKALINITY	mg/l	30.6		28.5		46.2		68.6	
2540 C-2011	DISSOLVED SOLIDS	mg/l	167		148		114		339	
2540 D-2011	SUSPENDED SOLIDS	mg/l	6.24		2.90		2.67		117	
6010B	BARIUM	mg/l	0.260		0.249		0.104		0.252	
6010B	CALCIUM	mg/l	18.5		15.9		20.9		48.5	
6010B	IRON	mg/l	1.15		0.104		1.27		3.24	
6010B	MAGNESIUM	mg/l	7.87		5.55		7.38		13.0	
6010B	MANGANESE	mg/l	<0.0100		<0.0100		0.0806		0.990	
6010B	POTASSIUM	mg/l	2.21		1.86		3.35		5.21	
6010B	SODIUM	mg/l	9.38		9.05		7.95		34.0	
8260B	BENZENE	mg/l	<0.00100		<0.00100		<0.00100		<0.00100	
8260B	TOLUENE	mg/l	<0.00100		<0.00100		<0.00100		<0.00100	
8260B	ETHYLBENZENE	mg/l	<0.00100		<0.00100		<0.00100		<0.00100	
8260B	XYLENES, TOTAL	mg/l	<0.00300		<0.00300		<0.00300		<0.00300	
9040C	pH	su	6.27	T8	5.70	T8	6.76	T8	6.74	T8
9050A	SPECIFIC CONDUCTANCE	umhos/cm	242		200		229		548	
9056A	BROMIDE	mg/l	<1.00		<1.00		<1.00		<1.00	
9056A	CHLORIDE	mg/l	23.1		36.7		18.2		94.5	
9056A	SULFATE	mg/l	21.9		<5.00		30.2		29.0	
9222D	COLIFORM,FECAL	col/100ml	<1		<1		<1		<1	
9223 B-1997	E.COLI	MPN/100ml	<1		<1		<1		<1	
9223 B-1997	COLIFORM,TOTAL	MPN/100ml	<1		11.0		4.10		152	
RSK175	METHANE	mg/l	<0.0100		<0.0100		<0.0100		<0.0100	
RSK175	ETHANE	mg/l	<0.0130		<0.0130		<0.0130		<0.0130	
RSK175	ETHENE	mg/l	<0.0130		<0.0130		<0.0130		<0.0130	
RSK175	PROPANE	mg/l	<0.0190		<0.0190		<0.0190		<0.0190	

Qualifiers:

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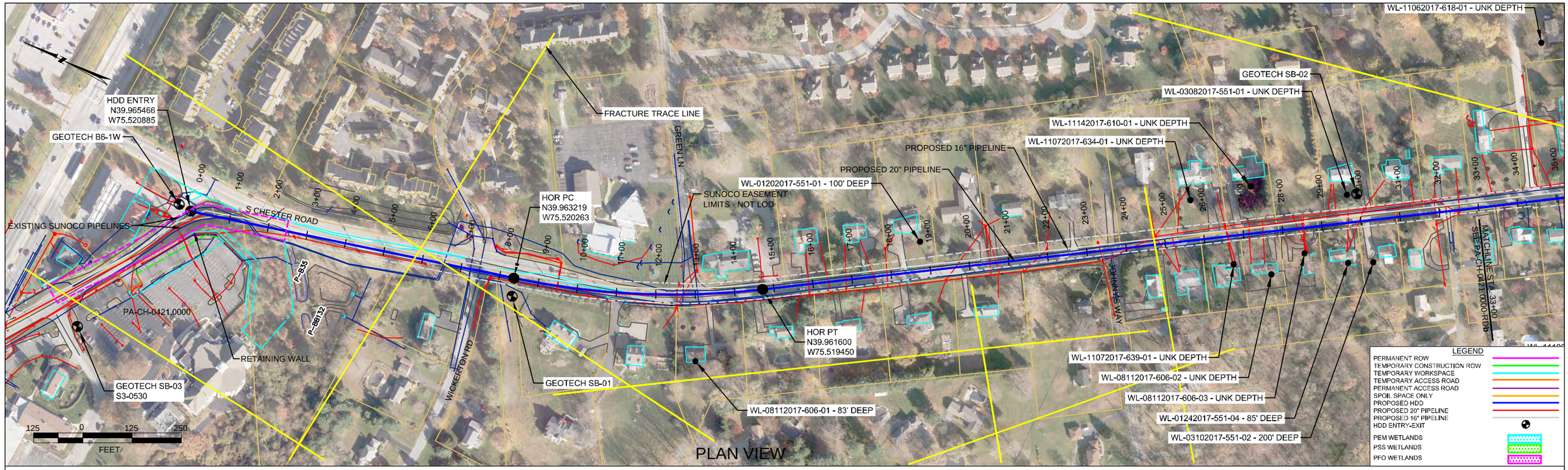
V: The sample concentration is too high to evaluate accurate spike recoveries.

NA: Not Analyzed

Positive bacteria detections are shaded as gray

ATTACHMENT 4

HDD PROFILES WITH WELL LOCATIONS, WATER LEVELS, AND FRACTURE TRACE LINES



PLAN VIEW

CHESTER/DELAWARE COUNTY PENNSYLVANIA, WESTTOWN/EDGMONT TOWNSHIP
S3-0541

PROFILE VIEW

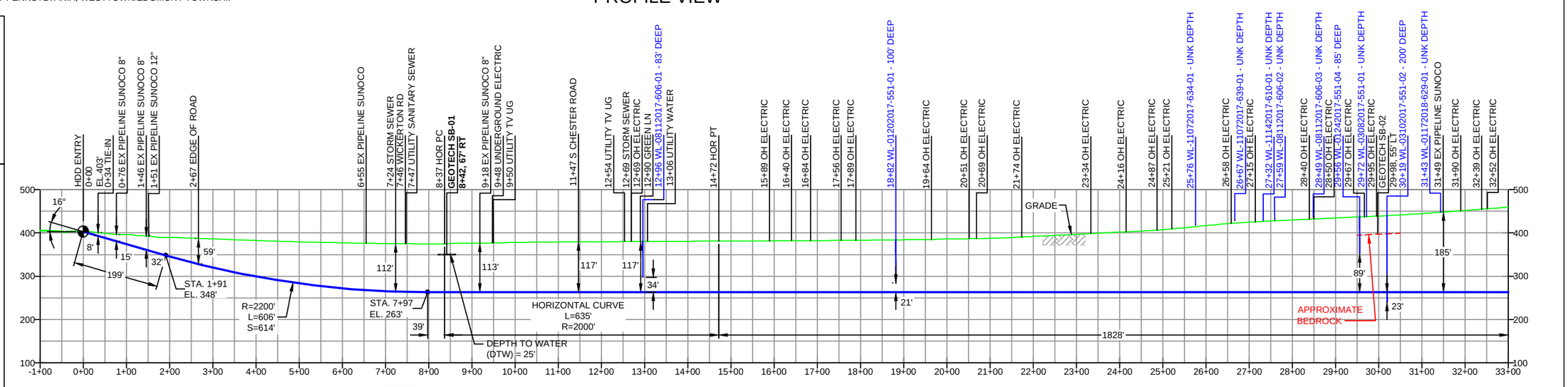
GEOTECH B6-1W
- NG EL. 405'
- -ASPHALT (0.0' - 0.3')
- -GRAVEL (0.3' - 1.5')
- -WEATHERED ROCK (1.5' - 22.0')
- -GNEISS (22.0' - 158.3')
- -BORING TERMINATED EL.246.7'

NOTE: REFER TO TEST BORING LOG B6-1W TERRACON PROJECT #J217P078 FOR COMPLETE SOIL MATERIAL DESCRIPTION

GEOTECH SB-01
- NG EL. 376'
- -TOPSOIL (0' - 0.3')
- -SM (0.3' - 30.0')
- -GROUNDWATER (25.0')
- -COMPLETION DEPTH EL. 346'

GEOTECH SB-02
- NG EL. 439'
- -TOPSOIL (0' - 0.3')
- -SM (0.3' - 11.5')
- -SM (11.5' - 23.5')
- -SM / GM (23.5' - 32.0')
- -AUGER REFUSAL (32.0')
- -FELSIC GNEISS (32.0' - 42.0')
- -COMPLETION DEPTH EL. 397'

NOTE: REFER TO TEST BORING LOG S3-0541 FOR COMPLETE SOIL MATERIAL DESCRIPTION



DESIGN AND CONSTRUCTION:
1. CONTRACTOR SHALL FIELD VERIFY DEPTH OF ALL EXISTING UTILITIES SHOWN OR NOT SHOWN ON THIS DRAWING.
2. THE MINIMUM SEPARATION DISTANCE FROM EXISTING SUBSURFACE UTILITIES SHALL NOT BE LESS THAN 10 FEET AS MEASURED FROM THE OUTSIDE EDGE OF THE UTILITY TO OUTSIDE OF PROPOSED PIPELINE.
3. DESIGNED IN ACCORDANCE WITH CFR 49 195 & ASME B31.4
4. CROSSING PIPE SPECIFICATION:
   HDD HORZ. LENGTH (L=):6510'
   HDD PIPE LENGTH (S=):6534'
   20" x 0.456" W.T., X-65, APISL, PSL2, ERW, BFW
   COATING: 14-16 MILS FBE WITH 30-35 MIL ARO (POWERCRETE OR ENGINEER APPROVED EQUAL)
5. INTERNAL DESIGN PRESSURE 1480 PSIG (SEAM FACTOR 1.0, DESIGH FACTOR 0.50).
6. INSTALLATION METHOD: HORIZONTAL DIRECTIONAL DRILL (HDD).
7. PIPELINE WARNING MARKERS SHALL BE INSTALLED ON BOTH SIDES OF ALL ROAD, RAILWAY, AND STREAM CROSSINGS.
8. CARRIER PIPE NO ENCASED.
9. PIPE / AMBIENT TEMPERATURE MUST BE NO LESS THAN 30°F DURING PULLBACK WITHOUT PRIOR WRITTEN APPROVAL FROM THE ENGINEER.
10. CONDUCT 4-HOUR PRE-INSTALLATION HYDROTEST OF HDD PIPE STRING TO MINIMUM 1850 PSIG.

FOR GEOLOGIC ANALYSIS ONLY

NOTES
1. ALL COORDINATES SHOWN ARE IN LATITUDE AND LONGITUDE. ALL MSL ELEVATIONS ARE NAD83
2. STATIONING IS BASED ON HORIZONTAL DISTANCES.
3. ROONEY ENGINEERING, INC. AND SUNOCO PIPELINE, LP ARE NOT RESPONSIBLE FOR LOCATION OF FOREIGN UTILITIES SHOWN IN PLOT PLAN OR PROFILE. THE INFORMATION SHOWN HEREON IS FURNISHED WITHOUT LIABILITY ON THE PART OF ROONEY ENGINEERING, INC. AND SUNOCO PIPELINE, LP, FOR ANY DAMAGES RESULTING FROM ERRORS OR OMISSIONS THEREIN.
4. CONTRACTOR IS RESPONSIBLE FOR LOCATING ALL UTILITIES. CONTACT ONE CALL AT 811 PRIOR TO DIGGING.
5. SUNOCO EMERGENCY HOTLINE NUMBER IS #1-800-786-7440.

REF. DRAWING

ES-6.70	TO	ES-6.01	EROSION & SEDIMENT PLAN	
SHEET 46	TO	SHEET 1	AERIAL SITE PLAN	
DWG NO		DWG NO	DESCRIPTION	

REVISIONS

NO.	DESCRIPTION	BY	DATE	CHK	DATE	APP	DATE
EP6	ADDED DEPTH TO WATER (DTW) INFORMATION PER CLIENT REQUEST	MRS	04/19/18	RMB	04/19/18	AMC	04/19/18
EP5	ADDED FRACTURE TRACE LINE AND WELL DATA PER CLIENT REQUEST	MRS	04/09/18	RMB	04/09/18	AMC	04/09/18
EP4	UPDATED GEOTECH INFO PROVIDED BY DPS	MRS	11/27/17	RMB	11/27/17	AMC	11/27/17
EP3	UPDATED TO 20" PIPE SPEC AND CENTERLINE LOCATION PER PM, ADDED DPS GEOTECH	MRS	11/08/17	RMB	11/08/17	AMC	11/08/17
EP2	REVISED PER PADEP COMMENTS RECEIVED 09-06-16	MRS	09/30/16	RMB	09/30/16	AAW	09/30/16
EP1	REVISED PER PADEP COMMENTS	JTW	05/10/16	RMB	05/10/16	AAW	05/10/16

Sunoco Logistics Partners L.P.

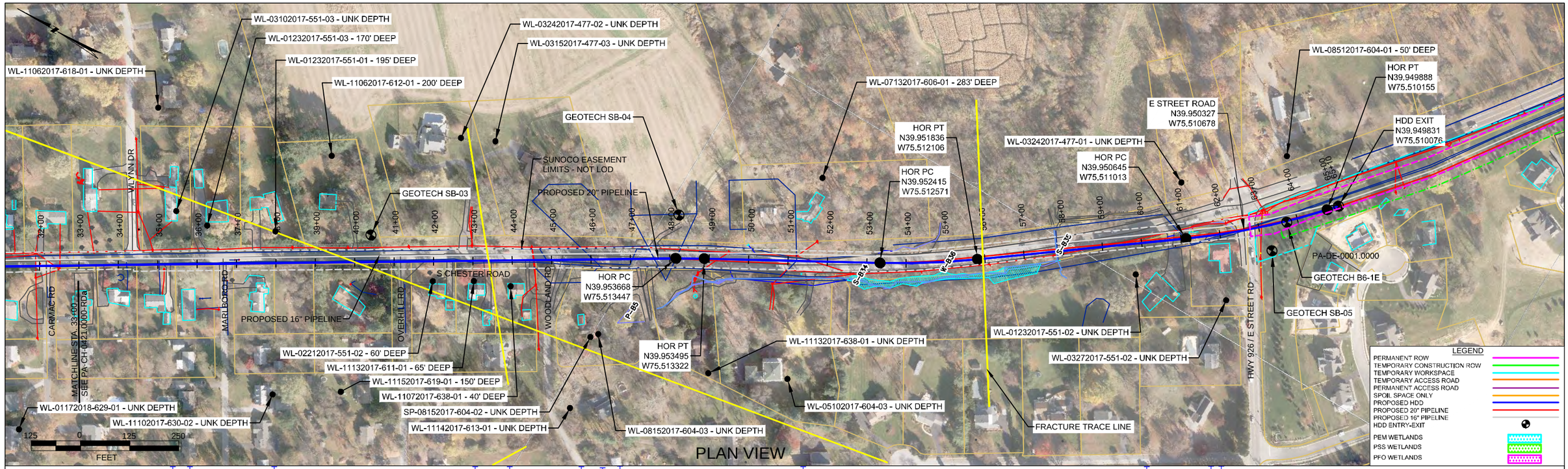
TETRA TECH ROONEY
(303) 792–5911

SUNOCO PIPELINE, L.P.

HORIZONTAL DIRECTIONAL DRILL
S CHESTER ROAD / HWY 926
PENNSYLVANIA PIPELINE PROJECT

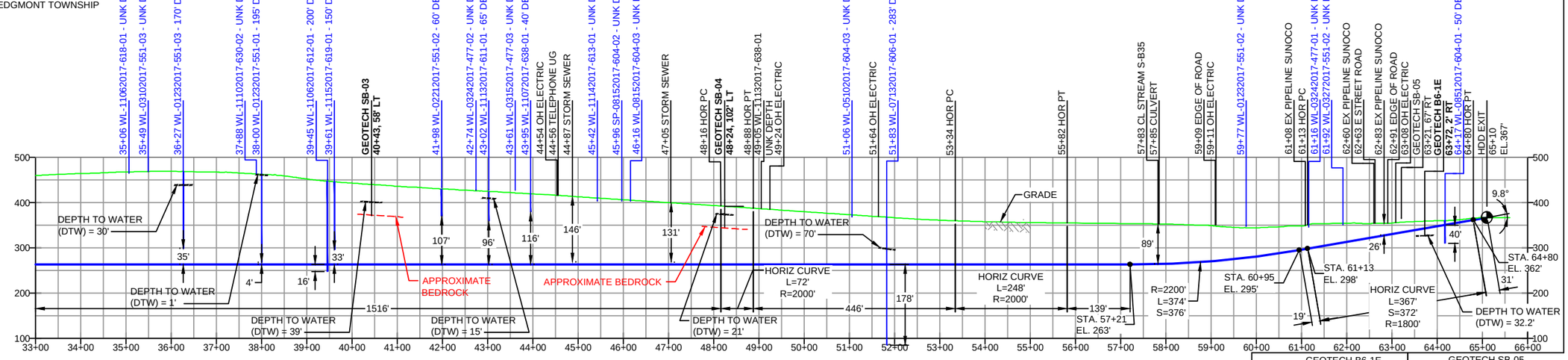
SCALE: 1"=250'

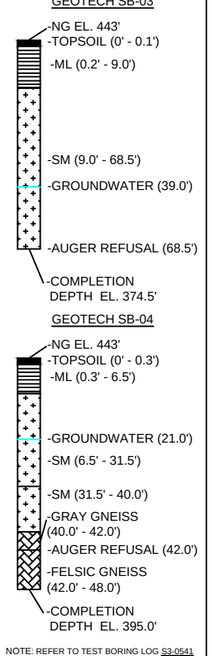
DWG. NUMBER: PA-CH-0421.0000-RDa

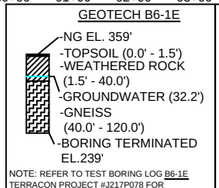


PLAN VIEW

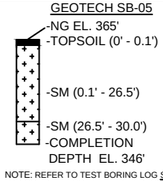
PROFILE VIEW







NOTE: REFER TO TEST BORING LOG B6-1E TERRACON PROJECT #J217P078 FOR COMPLETE SOIL MATERIAL DESCRIPTION



NOTE: REFER TO TEST BORING LOG S3-0541 FOR COMPLETE SOIL MATERIAL DESCRIPTION

NOTE: REFER TO TEST BORING LOG S3-0541 FOR COMPLETE SOIL MATERIAL DESCRIPTION

FOR GEOLOGIC ANALYSIS ONLY

DESIGN AND CONSTRUCTION:

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3. DESIGNED IN ACCORDANCE WITH CFR 49 195 & ASME B31.4
4. CROSSING PIPE SPECIFICATION:
   HDD HORZ. LENGTH (L=):6510'
   HDD PIPE LENGTH (S=):6534'
   20" x 0.456" W.T., X-65, APISL, PSL2, ERW, BFW
   COATING: 14-16 MILS FBE WITH 30-35 MIL ARO (POWERCRETE OR ENGINEER APPROVED EQUAL)
5. INTERNAL DESIGN PRESSURE 1480 PSIG (SEAM FACTOR 1.0, DESIGH FACTOR 0.50).
6. INSTALLATION METHOD: HORIZONTAL DIRECTIONAL DRILL (HDD).
7. PIPELINE WARNING MARKERS SHALL BE INSTALLED ON BOTH SIDES OF ALL ROAD, RAILWAY, AND STREAM CROSSINGS.
8. CARRIER PIPE NO ENCASED.
9. PIPE / AMBIENT TEMPERATURE MUST BE NO LESS THAN 30°F DURING PULLBACK WITHOUT PRIOR WRITTEN APPROVAL FROM THE ENGINEER.
10. CONDUCT 4-HOUR PRE-INSTALLATION HYDROTEST OF HDD PIPE STRING TO MINIMUM 1850 PSIG.

CHESTER/DELAWARE COUNTY
PENNSYLVANIA,
WESTTOWN/EDGMONT TOWNSHIP
S3-0541

NOTES

1. ALL COORDINATES SHOWN ARE IN LATITUDE AND LONGITUDE. ALL MSL ELEVATIONS ARE NAD83
2. STATIONING IS BASED ON HORIZONTAL DISTANCES.
3. ROONEY ENGINEERING, INC. AND SUNOCO PIPELINE, LP ARE NOT RESPONSIBLE FOR LOCATION OF FOREIGN UTILITIES SHOWN IN PLOT PLAN OR PROFILE. THE INFORMATION SHOWN HEREON IS FURNISHED WITHOUT LIABILITY ON THE PART OF ROONEY ENGINEERING, INC. AND SUNOCO PIPELINE, LP, FOR ANY DAMAGES RESULTING FROM ERRORS OR OMISSIONS THEREIN.
4. CONTRACTOR IS RESPONSIBLE FOR LOCATING ALL UTILITIES. CONTACT ONE CALL AT 811 PRIOR TO DIGGING.
5. SUNOCO EMERGENCY HOTLINE NUMBER IS #1-800-786-7440.

REF. DRAWING

DWG NO		DWG NO	DESCRIPTION
ES-6.70	TO	ES-6.01	EROSION & SEDIMENT PLAN
SHEET 46	TO	SHEET 1	AERIAL SITE PLAN

REVISIONS

NO.	DESCRIPTION	BY	DATE	CHK	DATE	APP	DATE
EP6	ADDED DEPTH TO WATER (DTW) INFORMATION PER CLIENT REQUEST	MRS	04/19/18	RMB	04/19/18	AMC	04/19/18
EP5	ADDED FRACTURE TRACE LINE AND WELL DATA PER CLIENT REQUEST	MRS	04/09/18	RMB	04/09/18	AMC	04/09/18
EP4	UPDATED GEOTECH INFO PROVIDED BY DPS	MRS	11/27/17	RMB	11/27/17	AMC	11/27/17
EP3	UPDATED TO 20" PIPE SPEC AND CENTERLINE LOCATION PER PM, ADDED DPS GEOTECH	MRS	11/08/17	RMB	11/08/17	AMC	11/08/17
EP2	REVISED PER PADEP COMMENTS RECEIVED 09-06-16	MRS	09/30/16	RMB	09/30/16	AAW	09/30/16
EP1	REVISED PER PADEP COMMENTS	JTW	05/10/16	RMB	05/10/16	AAW	05/10/16

Sunoco Logistics Partners L.P.

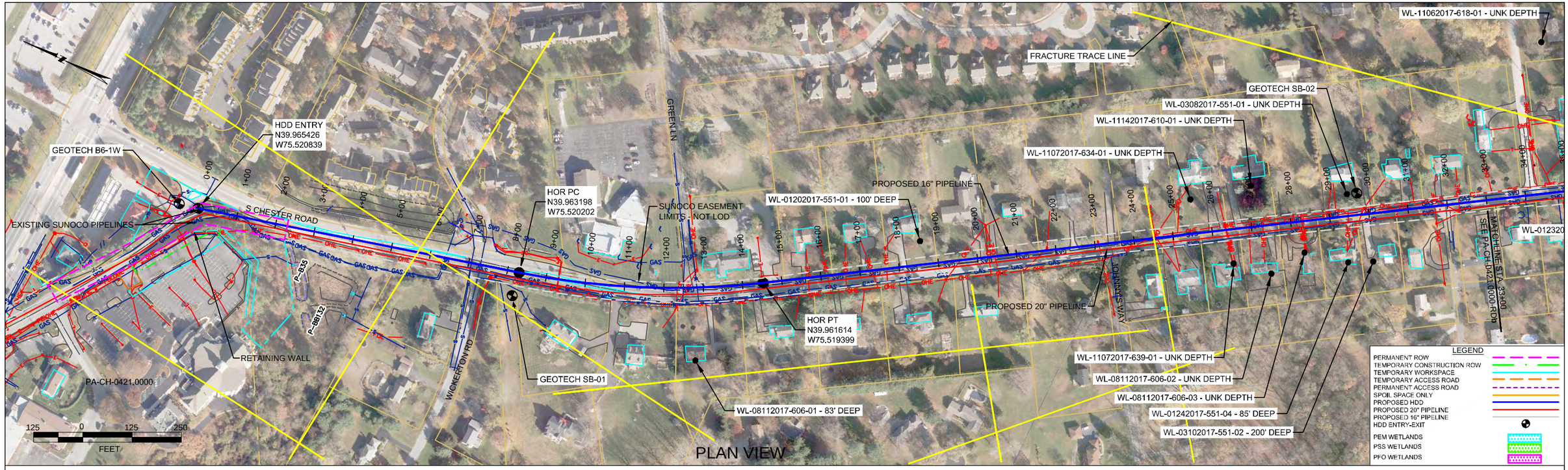
TETRA TECH ROONEY
(303) 792–5911

SUNOCO PIPELINE, L.P.

HORIZONTAL DIRECTIONAL DRILL
S CHESTER ROAD / HWY 926
PENNSYLVANIA PIPELINE PROJECT

SCALE: 1"=250'

DWG. NUMBER: PA-CH-0421.0000-RDb



PLAN VIEW

PROFILE VIEW

CHESTER/DELAWARE COUNTY PENNSYLVANIA, WESTTOWN/EDGMONT TOWNSHIP
S3-0541-16

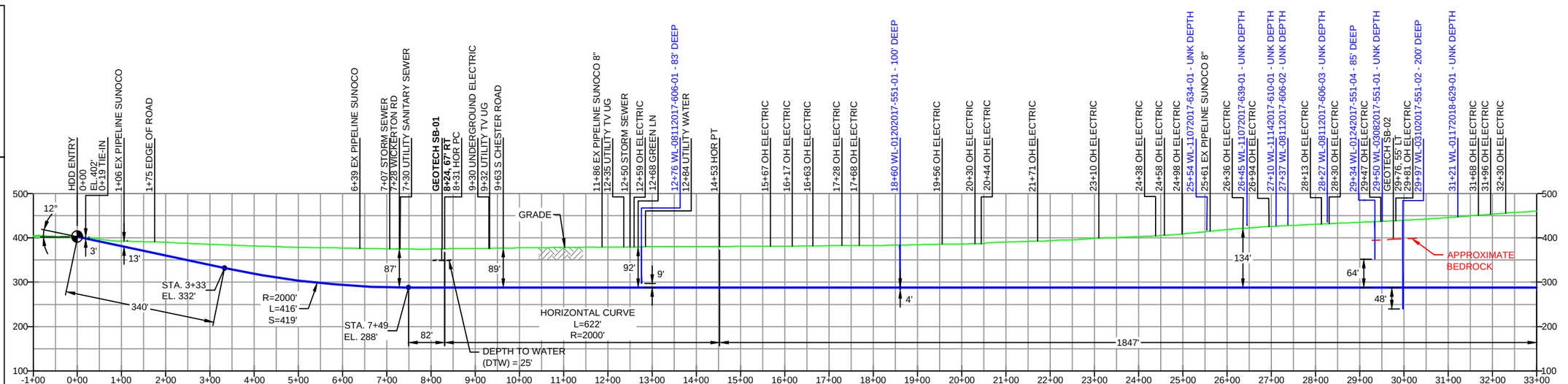
GEOTECH B6-1W
-NG EL. 405'
-ASPHALT (0.0' - 0.3')
-GRAVEL (0.3' - 1.5')
-WEATHERED ROCK (1.5' - 22.0')
-GNEISS (22.0' - 158.3')
-BORING TERMINATED EL.246.7'

NOTE: REFER TO TEST BORING LOG B6-1W TERRACON PROJECT #J217P078 FOR COMPLETE SOIL MATERIAL DESCRIPTION

GEOTECH SB-01
-NG EL. 376'
-TOPSOIL (0' - 0.3')
-SM (0.3' - 30.0')
-GROUNDWATER (25.0')
-COMPLETION DEPTH EL. 346'

GEOTECH SB-02
-NG EL. 439'
-TOPSOIL (0' - 0.3')
-SM (0.3' - 11.5')
-SM (11.5' - 23.5')
-SM / GM (23.5' - 32.0')
-AUGER REFUSAL (32.0')
-FELSIC GNEISS (32.0' - 42.0')
-COMPLETION DEPTH EL. 397'

NOTE: REFER TO TEST BORING LOG S3-0541 FOR COMPLETE SOIL MATERIAL DESCRIPTION



DESIGN AND CONSTRUCTION:
1. CONTRACTOR SHALL FIELD VERIFY DEPTH OF ALL EXISTING UTILITIES SHOWN OR NOT SHOWN ON THIS DRAWING.
2. THE MINIMUM SEPARATION DISTANCE FROM EXISTING SUBSURFACE UTILITIES SHALL NOT BE LESS THAN 10 FEET AS MEASURED FROM THE OUTSIDE EDGE OF THE UTILITY TO OUTSIDE OF PROPOSED PIPELINE.
3. DESIGNED IN ACCORDANCE WITH CFR 49 195 & ASME B31.4
4. CROSSING PIPE SPECIFICATION:
   HDD HORZ. LENGTH (L=):6548'
   HDD PIPE LENGTH (S=):6562'
   16" x 0.438" W.T., X-70, APISL, PSL2, ERW, BFW
   COATING: 14-16 MILS FBE WITH 30-35 MIL ARO (POWERCRETE OR ENGINEER APPROVED EQUAL)
5. INTERNAL DESIGN PRESSURE 2100 PSIG (SEAM FACTOR 1.0, DESIGH FACTOR 0.50).
6. INSTALLATION METHOD: HORIZONTAL DIRECTIONAL DRILL (HDD).
7. PIPELINE WARNING MARKERS SHALL BE INSTALLED ON BOTH SIDES OF ALL ROAD, RAILWAY, AND STREAM CROSSINGS.
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10. CONDUCT 4-HOUR PRE-INSTALLATION HYDROTEST OF HDD PIPE STRING TO MINIMUM 2625 PSIG.

FOR GEOLOGIC ANALYSIS ONLY

NOTES
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5. SUNOCO EMERGENCY HOTLINE NUMBER IS #1-800-786-7440.

REF. DRAWING

DWG NO		DWG NO	DESCRIPTION
ES-6.70	TO	ES-6.01	EROSION & SEDIMENT PLAN
SHEET 46	TO	SHEET 1	AERIAL SITE PLAN

REVISIONS

NO.	DESCRIPTION	BY	DATE	CHK	DATE	APP	DATE
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EP5	ADDED FRACTURE TRACE LINE AND WELL DATA. UPDATED NOTE 5 AND 10 PER INCREASED 16" MOP	MRS	04/10/18	RMB	04/10/18	AMC	04/10/18
EP4	UPDATED GEOTECH INFO PROVIDED BY DPS	MRS	11/27/17	RMB	11/27/17	AMC	11/27/17
EP3	UPDATED TO 16" PIPE SPEC AND CENTERLINE LOCATION PER PM, ADDED DPS GEOTECH	MRS	11/08/17	RMB	11/08/17	AMC	11/08/17
EP2	REVISED PER PADEP COMMENTS RECEIVED 09-06-16	DLM	10/07/16	RMB	10/07/16	AAW	10/07/16
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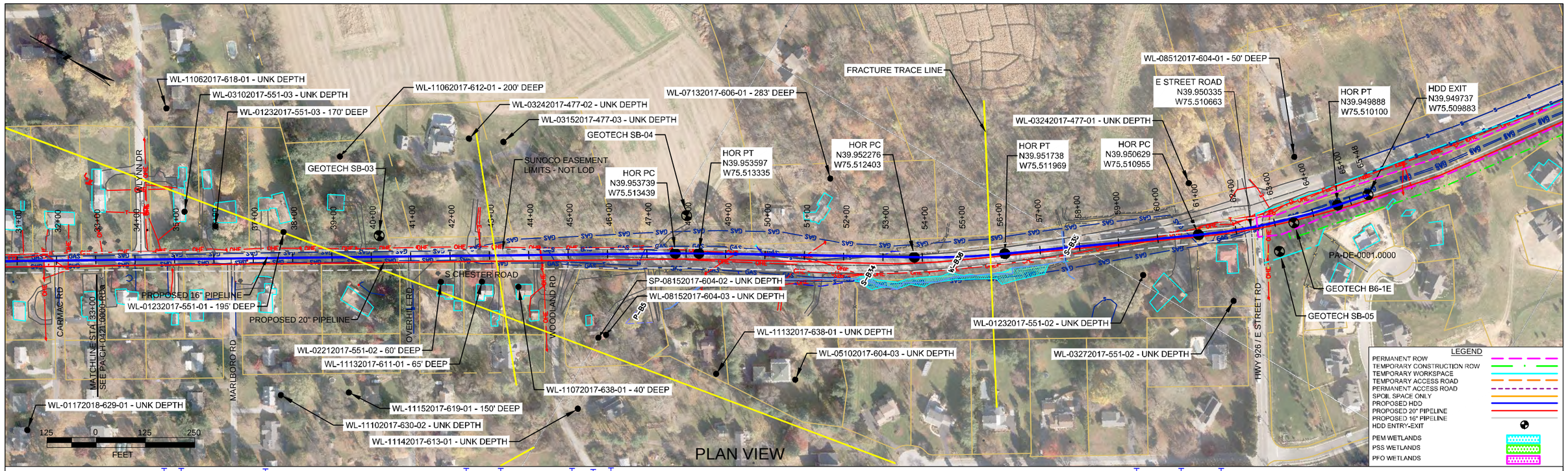
SUNOCO PIPELINE, L.P.

HORIZONTAL DIRECTIONAL DRILL
S CHESTER ROAD / HWY 926
PENNSYLVANIA PIPELINE PROJECT

SCALE: 1"=250'

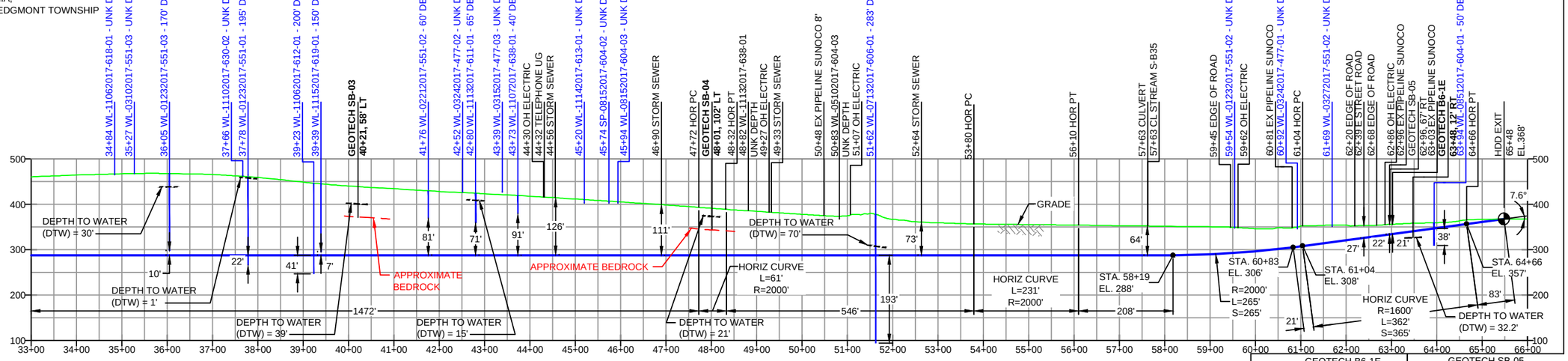
DWG. NUMBER: PA-CH-0421.0000-RDa-16



PLAN VIEW

PROFILE VIEW

CHESTER/DELAWARE COUNTY
PENNSYLVANIA,
WESTTOWN/EDGMONT TOWNSHIP
S3-0541-16



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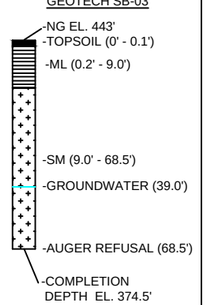
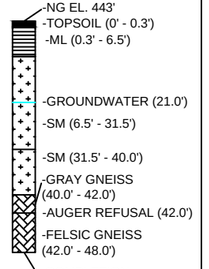
GEOTECH SB-03

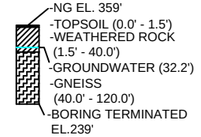


GEOTECH SB-04



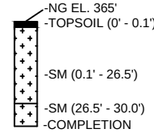
NOTE: REFER TO TEST BORING LOG S3-0541 FOR COMPLETE SOIL MATERIAL DESCRIPTION

GEOTECH B6-1E



NOTE: REFER TO TEST BORING LOG B6-1E TERRACON PROJECT #J217P078 FOR COMPLETE SOIL MATERIAL DESCRIPTION

GEOTECH SB-05



NOTE: REFER TO TEST BORING LOG S3-0541 FOR COMPLETE SOIL MATERIAL DESCRIPTION

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