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APPROVED

Comprehensive Investigation Report
Andover Release Site
Andover, Kansas

Prepared for:
NuStar Pipeline Operating Partnership L.P.

February 4, 2014
(Revised April 30, 2014 per KDHE comments)
1641-04

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The objectives of the CI were met. The data collected for this CI indicate that the magnitude and extent of gasoline constituents in soil and groundwater are delineated and expected to further decrease since source materials (soil and SPH) have been removed and irrigation wells have been deactivated.

NuStar will continue to collect additional data to further refine the understanding of Site conditions. Proposed future activities include: (1) collection of additional soil samples in the immediate vicinity of the release; (2) continuation of groundwater monitoring; and (3) collection of additional soil vapor samples. Ongoing or planned interim remedial measures include: (1) continuation of SPH removal, if present, from the irrigation well at 2006 N Colt Court using vacuum and manual methods; and (2) further evaluation of the SVE pilot test data and, if applicable, preparation of an SVE design for further remediating petroleum hydrocarbons at the Site.

Executive Summary

This Comprehensive Investigation (CI) Report was prepared on behalf of NuStar Pipeline Operating Partnership L.P. (NuStar) as part of a response to a pipeline release in the Quail Crossing neighborhood in Andover, Kansas (the Site; Figure 1). Separate-phase hydrocarbons (SPH) were detected in the irrigation well at 2006 N Colt Court, south of NuStar's refined petroleum products pipeline. The irrigation well was deactivated and pipeline testing was implemented immediately after SPH were reported in the irrigation well. Based on this testing, the pipeline release location was identified approximately 80 feet northwest of the irrigation well at 2006 N Colt Court.

NuStar removed a portion of the pipeline at the release area and submitted it to a metallurgical facility for further testing to determine the precise release point in the pipeline since the location was so small that it could not be identified visually even after excavation or cleaning. The testing facility determined that the release point was pinhole size, not visible under normal conditions, and capable of transmitting fluids only under certain pressures. Due to these circumstances, the quantity of gasoline released and time period cannot be determined with accuracy. Although the quantity released is not known, source material was removed during excavation to the extent practicable.

The following response activities were implemented as part of NuStar's response to the pipeline release: (1) inspections and testing of the pipeline; (2) hydrotesting of the identified affected portion of the pipeline; (3) excavation and removal of soil containing petroleum constituents along a 45-foot section of pipeline; (4) replacement of a portion of the pipeline; (5) collection and analysis of water samples from the irrigation well at 2006 N Colt Court; (6) field screening of nearby irrigation wells; (7) vacuum and manual removal of SPH and water for the irrigation well at 2006 N Colt Court; and (8) deactivation of the irrigation well at 2006 N Colt Court and irrigation wells at other properties, and connection of the associated irrigation systems to the municipal water supply.

Ongoing remedial measures include weekly vacuum removal of SPH and water from the irrigation well at 2006 N Colt Court. Since removal measures were initiated in June 2012, SPH levels have decreased significantly; and since August 2013, SPH have been only intermittently present in the irrigation well. SPH have not been detected in other wells in the Neighborhood.

Following the initial response activities, NuStar also performed this CI, which included: (1) the advancement of 24 soil borings; (2) collection and analysis of soil samples from 16 soil borings; (3) installation of 16 groundwater monitoring wells, three soil vapor monitoring points, and four soil vacuum extraction (SVE) test wells; (4) collection and analysis of water samples from the 16 monitoring wells and 13 irrigation wells during one monitoring event and 16 irrigation wells during a second monitoring event; and (5) collection and analysis of vapor samples from the soil vapor monitoring points. During the CI, NuStar also performed a pilot test to evaluate if vacuum extraction may be an effective remediation technology for the Site.

The nature and extent of gasoline constituents in soil at the Site were characterized using field screening data and laboratory data. Twenty-three soil samples were collected from 16 borings during the CI and three soil samples were collected during the pipeline excavation activities. The results of the soil assessment indicate that gasoline constituents in soil are limited to the immediate pipeline release area.

Soil vapor samples were collected from the three soil vapor points at the property at 2006 N Colt Court as part of the vapor intrusion assessment. Data collected during the preliminary vapor intrusion assessment indicate that constituent concentrations in soil and groundwater do not pose a significant risk to indoor or outdoor air. Further evaluation of potential preferential vapor migration pathways, such as utility corridors, will be completed in 2014.

In groundwater, the nature and extent of gasoline constituents were characterized using groundwater data collected from monitoring wells and irrigation wells. In addition to the municipal water supply, some residents have irrigation wells that are used for landscaping purposes. During this investigation, approximately 13 irrigation wells were identified within the investigation area, and a total of 16 monitoring wells were installed. During the most recent comprehensive groundwater sampling event in October/November 2013, dissolved-phase hydrocarbons were detected in six monitoring wells and four irrigation wells above Kansas Department of Health and Environment (KDHE) Risk-Based Screening Values (RBSVs). These wells are generally located in the immediate vicinity of the release area in the vicinity of locations where gasoline constituents have been detected in soil. The highest concentrations of gasoline constituents in groundwater are present in the vicinity of the release location and decrease significantly with distance from the release.

Weekly groundwater level measurements have been collected at the Site since August 2013. Monitoring well installation data and water level measurements indicate groundwater gradients at the Site are influenced by local and regional systems. Locally, leakage from the nearby stormwater pond leads to groundwater recharge and elevated groundwater levels near the pond. This results in radial flow outward from the pond with relatively steep gradients near the pond. The effects of recharge from the stormwater pond appear to diminish in the vicinity of West Mountain, where the established easterly regional groundwater flow is apparent. The groundwater elevation data indicates that the groundwater does not flow toward the pond.

In an effort to expedite remediation at the Site, NuStar also performed a preliminary evaluation of cleanup technologies including an SVE pilot test. The pilot testing was conducted in December 2013, and the preliminary evaluation concluded that SVE may be an effective remedial alternative for the Site.

1.0 Introduction

This Comprehensive Investigation (CI) Report was prepared by Apex Companies, LLC (Apex) on behalf of NuStar Pipeline Operating Partnership L.P. (NuStar) in response to a gasoline release from a NuStar refined petroleum pipeline. The pipeline release was discovered after separate-phase hydrocarbons (SPH) were detected in an irrigation well at 2006 N Colt Court, in the Quail Crossing Neighborhood (the Neighborhood) of Andover, Kansas (the Site; Figure 1). The NuStar pipeline release location is approximately 80 feet north of the affected irrigation well.

The CI was performed in accordance with the Revised Groundwater Investigation Work Plan (Revised Work Plan; Apex, 2013a) and the Addendum to the Revised Groundwater Investigation Work Plan (the Addendum; Apex, 2013b), both of which were reviewed and approved by the Kansas Department of Health and Environment (KDHE). The purpose of the CI was to characterize the nature and extent of petroleum hydrocarbon constituents in soil, groundwater, and soil vapor, and to evaluate associated risks to human health and the environment. The information obtained during the CI will be used to evaluate the need for additional investigation and/or remedial action. The CI was performed in accordance with the Consent Agreement and Final Order (CAFO) dated May 10, 2013.

1.1 Scope of Comprehensive Investigation

The CI included research about land uses at the Site, regional geology, an interpretation of local geological and hydrogeological conditions; investigation of petroleum hydrocarbon constituents in soil, groundwater and soil vapor; and a preliminary evaluation of risks to human health and the environment. The Site is generally defined as the investigation area, which is located in the northern section of the Neighborhood, as shown on Figure 2. The completed scope of work included the advancement of soil borings; installation of monitoring wells, soil vapor monitoring points, and soil vapor extraction pilot test wells; and collection and analysis of soil, groundwater, and soil vapor samples. Sample locations are shown on Figure 2. Soil conditions were characterized based on field observations during drilling and laboratory analysis of 23 soil samples collected from the borings. Groundwater conditions were characterized through the collection and analysis of two rounds of groundwater samples from monitoring wells and irrigation wells. Soil vapor conditions and risks to indoor air were evaluated based on vapor samples collected from the three soil vapor monitoring points. Consistent with KDHE guidance, constituent concentrations in soil, groundwater, and soil vapor were compared to KDHE Tier 2 Risk-Based Screening Values (RBSVs).

1.2 Objectives

This report documents the scope and results of interim remedial measures (IRMs) and CI activities that were performed between June 2012 and December 2013. As defined by KDHE Policy BER-RS-018, *Scope of Work for a Comprehensive Investigation*, the objectives of the CI are: (1) identify the mechanisms of the release and characterize contaminant source areas; (2) define the nature and extent of petroleum

constituents at the Site; (3) characterize regional and site-specific geology and hydrogeology; (4) evaluate transport and fate of subsurface contamination; (5) identify exposure pathways for receptors; and (6) evaluate potential remedial action alternatives, including IRMs, as necessary to protect human health and the environment.

In addition to documenting completion of the CI objectives listed above, this report describes the scope and results of: (1) IRMs that have been implemented to date; and (2) pilot testing to evaluate the feasibility of additional IRMs.

1.3 Report Organization

This report is organized as follows:

- Introduction – This section provides an introduction to the Site, a brief discussion of the discovery of the pipeline release at the Site, and a discussion of the regulatory program under which the CI is being performed.
- Background and Site Description – This section describes the Site characteristics and presents background information for the CI.
- Interim Remedial Measures – This section describes the scope and results of IRMs that have been implemented at the Site.
- Comprehensive Investigation – This section documents investigation activities that were performed to assess local geological and hydrogeological conditions and evaluate the nature and extent of petroleum hydrocarbons in soil, groundwater, and soil vapor at the Site.
- Physical Setting – This section presents an interpretation of the physical setting of the Site, including soil and bedrock conditions and hydrogeological characteristics.
- Comprehensive Investigation Results – The results of the CI are presented in this section. Constituent analytical data are presented and the magnitude and extent of petroleum hydrocarbon concentrations in soil, soil vapor, and groundwater are delineated. As a preliminary evaluation of risks, data are compared to KDHE Tier 2 RBSVs.
- Conceptual Site Model – This section identifies contaminant sources, release mechanisms, affected media, and exposure pathways under current and reasonably likely future land uses.
- Summary and Conclusions – This section summarizes the work competed during the CI and presents conclusions based on that work.
- Proposed Activities – This section describes additional proposed activities to further refine the understanding of Site conditions.

2.0 Background and Site Description

The CI was performed in response to a gasoline release from a NuStar refined petroleum pipeline. The release was discovered after SPH were detected in an irrigation well at the property at 2006 N Colt Court. Upon notification of the discovery of SPH in the irrigation well, NuStar immediately mobilized to the Site and implemented several initial response and abatement activities, including: (1) inspecting and testing of the pipeline; (2) hydrotesting of the identified affected portion of the pipeline; (3) excavation and removal of soil containing petroleum constituents along a 45-foot section of pipeline; (4) replacement of a portion of the pipeline; (5) collection and analysis of water samples from the irrigation well at 2006 N Colt Court; (6) field screening of nearby irrigation wells; (7) vacuum and manual removal of SPH and water for the irrigation well at 2006 N Colt Court; and (8) deactivation of the irrigation well at 2006 N Colt Court and irrigation wells at other properties, and connection of the associated irrigation systems to the municipal water supply. Many of these activities were discussed in the Initial Response Summary Report (Apex, 2012).

In addition to the initial response activities listed above, NuStar removed a portion of the pipeline at the release area and submitted it to a metallurgical facility for further testing to determine the precise release point in the pipeline, since the location was so small that it could not be identified visually even after excavation and cleaning. The testing facility determined that the release point was pinhole size and only capable of transmitting fluids under certain pressures. Under these circumstances, the quantity released and associated time period cannot be determined with accuracy.

Following the initial response activities, NuStar planned and implemented the CI and performed a number of IRMs in coordination with KDHE and the Quail Crossing Neighborhood Association. These activities are described in detail below.

2.1 Regulatory Background and Response Activities

The CI is being performed in accordance with the CAFO dated May 10, 2013. KDHE guidance for performance of a comprehensive investigation is presented in the Bureau of Environmental Remediation Policy # BER-RS-018.

NuStar was contacted by the irrigation well owner at 2006 N Colt Court on the evening of June 8, 2012, and NuStar reported the release to KDHE on June 9, 2012. As discussed in Section 3.1, NuStar immediately performed a number of initial response activities to identify the location of the release. Concurrent with the initial response activities, NuStar developed a work plan for a comprehensive investigation at the Site and prepared to implement the investigation. Milestones for this initial investigation effort are listed below:

- June 9, 2012 – The release was discovered and reported to KDHE.
- June through July 2012 – Initial response activities were immediately implemented.

- August 15, 2012 – KDHE provided NuStar with a draft CAFO and requested comments by September 14, 2012.
- August 22, 2012 – NuStar submitted a Groundwater Investigation Work Plan (Apex, 2012) to KDHE and was scheduled to begin further response activities in late September 2012, pending property access and KDHE approval.
- September 2012 – NuStar requested a 10-day extension for comments on the draft CAFO. KDHE approved the extension and requested comments by September 25, 2012. On September 24, 2012, NuStar submitted a letter requesting enrollment in the Voluntary Cleanup and Property Redevelopment Program (VCPRP).
- August and September 2012 –The property owner at 2006 N Colt Court and the City of Andover provided access to their properties, and NuStar retained subcontractors for the planned investigation (i.e., drillers, traffic control, surveyors, waste disposal services, and private utility locators).

Before NuStar could begin field activities in September 2012, KDHE determined that the investigation should be performed under a CAFO (State Order), rather than within the VCPRP. Therefore, at KDHE's request, the investigation was delayed pending development and signing of the CAFO. Despite this delay, NuStar continued SPH removal activities throughout the CAFO process; the SPH removal activities are ongoing.

- May 2013 – The CAFO was finalized and KDHE provided comments on the August 22, 2012 Groundwater Investigation Work Plan.
- June 2013 – Apex and KDHE representatives conducted a joint project meeting to facilitate implementation of the investigation and to discuss the logistics and planned field schedule. NuStar and an Apex representative met on Site with the 2006 N Colt Court property owner and a representative of the Quail Crossing Homeowners Association (HOA) to generally discuss and coordinate the forthcoming field activities.
- July 2013 – In response to the KDHE comments, NuStar submitted the Revised Work Plan (Apex, 2013) and KDHE approved the Revised Work Plan. The first phase of field activities was implemented.
- August 2013 – NuStar and Apex representatives participated in a Neighborhood meeting, facilitated by KDHE to provide investigation information to the Neighborhood. The first comprehensive groundwater sampling event was initiated, which included monitoring wells and irrigation wells.
- September 2013 – NuStar and Apex representatives met with KDHE for a joint project meeting to facilitate and expedite the second phase of field investigation, which was implemented in late

September. Soil vapor samples were collected from soil vapor points VP-1 through VP-3 on September 24, 2013.

- October / November 2013 – A comprehensive groundwater sampling event was performed, which included monitoring wells and irrigation wells.
- November 2013 – The SVE Pilot Test Work Plan (Apex, 2013c) was submitted to KDHE and approved.
- December 2013 – The SVE Pilot Test was implemented. The scope and results of the vapor intrusion investigation were described in detail in the Soil Vapor Extraction and Proposed Soil Investigation Report; this report was submitted to KDHE on March 28, 2014.
- January 2014 – NuStar and Apex representatives met with KDHE for a joint project meeting to discuss results of the CI and facilitate continuing activities at the Site.

2.2 Site Location, Climate, and Demographics

The Site is located in the northern portion of the City of Andover, in southwest Butler County, Kansas (Figure 1). The Site is in Section 7, Township 27 South, Range 3 East. Land use at the Site and surrounding areas is residential. As shown on Figure 2, a stormwater retention pond is located near the Site, approximately 250 feet south of the NuStar pipeline.

The mean annual air temperature in the City of Andover is 56.4 degrees Fahrenheit (°F). Annually, temperatures range from a mean low of 30.2°F in January to 81.0°F in July. Average precipitation is approximately 30.4 inches per year, including annual mean snowfall of 16.7 inches (NOAA, 2010).

Residents at the Site use municipal water for domestic purposes. In addition to the municipal water supply, some residents have irrigation water wells that are used for outdoor irrigation purposes. Boring logs (included in Appendix A) indicate that Neighborhood irrigation wells range in depth from 80 to 116 feet below the ground surface (bgs). In most irrigation wells, the screened interval extends from total well depth to approximately 40 feet bgs; gravel filter packs typically extend from the total well depth to approximately 20 feet bgs.

2.3 Pipeline

The pipeline is constructed of 8-inch-diameter carbon steel and is used to transport liquefied petroleum products. The pipeline was installed to an approximate depth of 3 feet bgs in agricultural land in 1959. The pipeline remained in agricultural and/or undeveloped land until the late 1990s when development of the Quail Crossing Neighborhood began.

As part of the Neighborhood development, the pipeline depth was increased to approximately 6 feet bgs by re-excavating and backfilling with native material. An approximately 50-foot-wide pipeline right of

way (ROW) was created along the pipeline pathway for safety purposes during Neighborhood development. The ROW limits development activities near the pipeline. The pipeline location and associated ROW are shown on Figure 2.

The United States Department of Transportation Pipeline and Hazardous Materials Safety Administration (PHMSA) has regulatory jurisdiction of the pipeline; specific regulations are in *49 Code of Federal Regulations (CFR) Part 195: Transportation of Hazardous Liquids by Pipeline*. As discussed below, NuStar met and exceeded the PHMSA compliance requirements.

- This pipeline has its pipeline pressure monitored continuously through supervisory control and data acquisition by the NuStar Control Center.
- An aerial patrol surveys the pipeline at a frequency of every two weeks not to exceed 21 days.
- Sub-surface inspections are performed on a 5-year interval. The following are the most recent inspections and findings:
    - In 2009, a direct assessment was done based on the results of a conventional tool run. The results showed full-circumferential, shallow internal corrosion, which was expected due to the first use of the pipe, which was water for the City of El Dorado from Wichita. This finding is non-injurious to the pipe.
    - In 2007, an Axial Flaw Detection tool was deployed through the line to identify any possible long seam anomalies and none were found.
- Potential internal corrosion is monitored by examining two corrosion coupons on the line segment between Wichita and Augusta.
- At associated pump stations, any pressure-related devices, such as pressure relief valves, are tested.

In June of 2014, an in-line inspection using Ultrasonic Crack Detection (Compression Wave) technology is scheduled to be performed.

2.4 Site History

As previously discussed, the Site is defined as the investigation area that is located in the northernmost portion of the Quail Crossing Neighborhood, as shown on Figure 2. The Neighborhood is located on 21st Street between 159th Street and Andover Road in the City of Andover, and encompasses approximately a one-quarter- by one-half-mile area. This suburban residential neighborhood was developed on agricultural land in the late 1990s. Approximately 165 homes were constructed, and the predominant home construction style is multi-level wood-framed buildings with finished basements. The dwelling at 2006 N Colt Court, as well as many other dwellings located within the investigation area, has a finished "walk-out"

basement with exterior doors. Property ownership information, home construction details, and available construction plans for the Neighborhood are included in Appendix B.

During Neighborhood development, three engineered stormwater retention ponds were constructed. As shown on the grading plans for stormwater ponds (Appendix B), the ponds were constructed via general excavation into the shallow native soil, and are approximately 10 feet below the surrounding grade. Several stormwater discharge points convey water from Neighborhood streets into the retention ponds. A grass-lined stormwater swale that conveys stormwater to the pond is located on the northwest corner of the pond as shown on Figure 2.

2.5 Current Land Use and Zoning

The area is currently zoned for residential use (R-2) by Butler County, and current land use is residential. Some open, undeveloped areas are present at the Site, south of the NuStar pipeline. A Butler County zoning map and associated regulations are included in Appendix C.

2.6 Threatened and Endangered Species

The Site consists of a densely developed suburban residential neighborhood. Land at the Site is occupied by single-family dwellings, landscaped areas, and asphalt-concrete-paved roadways and sidewalks. A stormwater retention pond is located approximately 250 feet south of the pipeline. Fish are reportedly present in the stormwater pond, and waterfowl (Canada Geese [*Branta canadensis]* and Mallard Ducks [*Anas platyrhynchos*]) have also been observed in the vicinity of the pond; however, data collected during the CI indicate that the pipeline release has not affected the pond and will not affect it in the future.

On January 26, 2014, NuStar submitted a request to the Kansas Department of Wildlife, Parks, and Tourism (KDWPT) for a listing of threatened and endangered species that may be present at the Site. On February 21, 2014, the KDWPT responded that "*no state-listed threatened or endangered species or crucial wildlife habitats should be significantly affected. No Department of Wildlife and Parks permits or special authorizations are needed*" (Appendix D). Overall, the physical conditions in the Neighborhood do not constitute ecologically valuable habitat, and no threatened or endangered species are present.

3.0 Interim Remedial Measures

Several initial abatement activities and IRMs and have been conducted as part of the response to the pipeline release in the Neighborhood. Completed IRMs include: (1) excavation and off-site disposal of soil containing petroleum constituents at the pipeline release area; (2) removal of SPH and water from the irrigation well at 2006 N Colt Court using vacuum and manual methods; (3) deactivation of the irrigation wells at 2006 N Colt Court and several other properties, and connection of the associated irrigation systems to the

municipal water supply; and (4) performance of a SVE pilot test. Ongoing IRMs include weekly vacuum removal of SPH (if present) and water from the irrigation well at 2006 N Colt Court. These IRMs are described in the following sections.

3.1 Pipeline Inspections and Testing After Discovery of SPH

Pipeline inspections and testing were implemented immediately after discovery of SPH in the irrigation well at 2006 N Colt Court. Based on this testing, the pipeline release location was identified approximately 80 feet northwest of the irrigation well at 2006 N Colt Court. As described in Section 2.0, NuStar removed a portion of the pipeline at the release area and submitted it to a metallurgical facility for further testing to determine the precise release point in the pipeline. The testing facility determined that the release point was pinhole size, not visible under normal conditions, and capable of transmitting fluids only under certain pressures. Due to these conditions, the quantity of gasoline released cannot be determined with accuracy.

3.2 Removal of Soil Containing Petroleum Constituents

On July 5 and 6, 2012, NuStar excavated approximately 16 cubic yards of soil containing petroleum constituent concentrations from the pipeline release area and replaced the affected portion of the pipeline. KDHE personnel observed these activities. The lateral extent of the excavation was limited by buried utility infrastructure and private property boundaries, while the excavation depth was limited by bedrock at a depth of approximately 13 feet bgs. The excavated soil was transported off-site to the NuStar El Dorado landfarm facility for treatment and disposal. KDHE authorization for soil management at the landfarm is included in Appendix E. The excavation location and boundaries are shown on Figure 2.

Three soil samples were collected from the base and sidewall of the pipeline excavation and submitted to ALS Laboratory in Houston, Texas for analysis of gasoline-, diesel-, and oil-range organics and volatile organic compounds (VOCs). As shown in Table 1 and on Figures 3 and 4, the samples were collected from the south and north sidewalls and the floor of the excavation, at depths of 6 and 13 feet bgs, respectively. The soil samples collected from the north sidewall and the base of the excavation contained concentrations of gasoline-range organics (GRO), benzene, and/or toluene above the corresponding KDHE Tier 2 RBSVs for the soil to groundwater pathway. The laboratory data are included in Appendix F.

KDHE personnel observed the pipeline excavation activities and collected three soil samples from the base and sidewalls. The KDHE samples were submitted to Pace Analytical Services in Lenexa, Kansas for analysis of VOCs. Details regarding the precise locations and depths of these samples have not been provided to NuStar; however, the laboratory data report has been provided by KDHE. Concentrations of the following VOCs were detected in the KDHE samples: benzene, toluene, ethylbenzene, and xylenes (BTEX; 2-butanone; n-butylbenzene; naphthalene; n-propylbenzene; 1,2,4-trimethylbenzene; 1,3,5-trimethylbenzene; cyclohexane; isopropylbenzene; and methylcyclohexane. The KDHE analytical laboratory report is included in Appendix F.

3.3 SPH Removal and Testing at the Irrigation Well at 2006 N Colt Court

NuStar implemented SPH removal efforts and recovery from the irrigation well at 2006 N Colt Court as soon as SPH were observed in June 2012. In addition, samples of water and SPH from the well were submitted for laboratory analysis. These activities are described in the following sections.

3.3.1 SPH Removal Program

On June 14, June 15, and July 3, 2012, a vacuum truck was used to extract SPH from the irrigation well at 2006 N Colt Court. In addition, SPH were removed from the irrigation well at 2006 N Colt Court on a bi-weekly schedule between June 2012 and May 2013 (excluding September and October) using hand bailers. Between June 2013 and present, SPH have been removed on a weekly schedule using a vacuum truck. During each vacuum event:

- The irrigation well is gauged and the thickness of SPH, if present, is measured using an electronic water interface probe. Gauging occurs at the start and completion of each SPH removal event.
- A vacuum truck, capable of generating vacuum equivalent to 100 inches of water, is used to extract groundwater and SPH from the well and to induce a vacuum in the formation surrounding the well. Vacuum is induced for approximately two hours, through flexible hosing that is secured to the well head. Extracted SPH and water are contained in a tank located on the truck. Extracted vapor is discharged through a temporary stack (comprised of a vertically installed 15-foot length of 4-inch-diameter PVC pipe). Specifications for the vacuum truck are included in Appendix G.
- Purged water and SPH, if any, are treated and disposed of at the Custom Wastewater Facility in Wichita, Kansas.

As shown in Table 2, approximately 236 gallons of SPH have been removed from the irrigation well at 2006 N Colt Court. Since removal measures were initiated in June 2012, SPH levels have decreased significantly; since August 2013, SPH have been only intermittently present in the irrigation well. SPH have not been detected in other wells in the Neighborhood.

3.3.2 Laboratory Characterization of SPH

On June 12, 2012, samples of SPH and water were obtained from the irrigation well at 2006 N Colt Court and the NuStar pipeline and submitted to ALS laboratory, in Houston, Texas for analysis. NuStar additionally retained the services of an environmental forensic chemist with the Friedman and Bruya Inc. laboratory, in Seattle, Washington, for interpretation of the analytical results. Freidman and Bruya evaluated the constituent concentrations in the SPH and water samples and concluded that the SPH in the irrigation well sample consisted of gasoline and gasoline constituents.

Analytical data from the irrigation well samples are consistent with soil data collected at the pipeline release location. That is, constituents detected in samples from both locations are limited to gasoline-range hydrocarbons and associated VOCs (i.e., GRO, BTEX, 2-butanone, n-butylbenzene, naphthalene, n-propylbenzene, 1,2,4-trimethylbenzene, 1,3,5-trimethylbenzene cyclohexane, isopropylbenzene, and methylcyclohexane). The consistency of the samples from both locations is further supported by the absence of gasoline additives in both samples.

3.4 Deactivation of Irrigation Wells

Since the release was discovered, NuStar coordinated with several property owners within the investigation area and deactivated several irrigation wells in the Neighborhood (six as of the date of this report), reconfigured the associated irrigation systems to receive municipal water, and reimbursed affected property owners for municipal water fees. Irrigation wells were selected for deactivation based on their location within the investigation area, groundwater quality, and well owner concerns. The purpose of deactivating the wells is to: (1) prevent direct contact, ingestion, or inhalation of potentially affected groundwater; and (2) eliminate well pumping that could influence groundwater conditions in the Neighborhood. Irrigation wells that have been deactivated are shown on Figure 2. Deactivation does not include permanently decommissioning a well; therefore, in the future, some wells may be reactivated or permanently decommissioned.

NuStar has also selected the irrigation wells at 2001 N Colt Court, 2019 N Ruger Circle, 2020 N Ruger Circle, 2021 N Ruger Court, 2025 N Ruger Court, 2007 N Mountain Court, and 2009 N Mountain Court for deactivation. The owners of the properties at 2007 N Mountain Court, 2019 N Ruger Circle, 2020 N Ruger Circle, 2021 N Ruger Court, and 2025 N Ruger Court recently agreed to allow deactivation of their irrigation wells; the owners of the property at 2001 N Colt Court have not responded to the offer for well deactivation; and the owner of the property at 2009 N Mountain Court declined to deactivate the well at this time. Coordination and negotiation with each of the property owners is ongoing, and NuStar anticipates that well deactivation will occur prior to the 2014 irrigation season.

3.5 Soil Vapor Extraction Pilot Test

To evaluate the feasibility of SVE technology for remediating petroleum hydrocarbons in the subsurface, NuStar performed an SVE pilot test during the week of December 9, 2013. This pilot test was performed in accordance with the KDHE-approved SVE pilot test work plan (Apex, 2013c). In general, the pilot test results indicate that: (1) the permeability of soil in the interval between approximately 20 and 30 feet bgs is sufficient for mass removal using normal SVE equipment; and (2) petroleum hydrocarbon mass is available for removal using an SVE system. Overall, a preliminary evaluation of the SVE pilot test results indicates that SVE may be an effective remedial technology for the Site. A detailed summary of the SVE pilot test and results will be included in the SVE Pilot Test Report, which is scheduled for submittal to KDHE in February 2014.

4.0 Comprehensive Investigation

Concurrent with the interim abatement and recovery measures discussed in the previous sections, a comprehensive investigation work plan was developed and submitted in August 2012. Based upon KDHE comments received on May 15, 2013, NuStar: (1) submitted the *Revised Groundwater Investigation Work Plan* (Apex, 2013a) on July 2, 2013; (2) implemented the first phase of field activities beginning on July 8, 2013; (3) submitted the *Addendum to the Revised Groundwater Investigation Work Plan* (Apex, 2013b) on September 20, 2013; and (4) implemented the second phase of field activities beginning on September 23, 2013.

The CI was performed in two phases between July and December 2013. The first phase of the CI was performed in July and August. Data collected during that phase indicated that additional investigation was necessary to characterize groundwater conditions at the Site. The second phase of the CI was performed between October and December. NuStar regularly coordinated with KDHE during the investigation and KDHE staff supervised selected field investigation activities. Field notes were maintained by Apex staff throughout the investigation. Copies of field notes are provided in Appendix H.

Briefly, the CI activities completed between July and December 2013 include:

- Coordinating with KDHE and Neighborhood representatives through telephone and e-mail correspondence and on-site meetings.
- Executing access agreements with owners of affected properties.
- Retaining subcontractors, including drillers, utility locators, waste management professionals, land surveyors, and analytical laboratories.
- Identifying buried utilities in work areas, using public and private locating services.
- Completing 24 soil borings at depths ranging from 10 to 65 feet bgs. Field screening soil samples from borings for gasoline impacts.
- Collecting and analyzing soil samples from one soil boring, 16 monitoring well borings, and four SVE test well borings.
- Installing 16 groundwater monitoring wells.
- Collecting and analyzing water samples from 16 monitoring wells and 16 irrigation wells.
- Installing three soil vapor monitoring points and collecting soil vapor samples.
- Installing four SVE pilot test wells and performing an SVE pilot test.

These activities are described in detail below.

4.1 Drilling Methods

Borings for monitoring wells, soil vapor points, and soil vapor extraction test wells were advanced using air rotary, solid stem auger, and direct-push drilling equipment that was owned and operated by GeoCore, Inc., a Kansas-licensed well driller. Drilling equipment was selected based on site conditions and investigation objectives. Borings depths and drilling methods are listed below:

- Temporary soil boring B-1: This 21-foot boring was advanced using direct-push equipment.
- Monitoring well borings MW-1 through MW-6: The upper 11 to 21.5 feet of these borings were advanced using direct-push equipment. Due to refusal of the direct-push equipment in dense soil/weathered shale, the lower portions of these borings were advanced using air rotary drilling equipment (total depths 30 to 60 feet bgs).
- Monitoring well borings MW-7 through MW-16: These borings were completed using solid stem auger and/or air rotary equipment (total depths 30 to 50 feet bgs).
- Soil vapor test points VP-1 through VP-3: These 10-foot borings were advanced using direct-push equipment.
- SVE pilot test borings SVE-1 through SVE-4: These 30-foot borings were advanced using solid stem auger equipment.

Boring logs are included in Appendix I.

4.2 Lithologic Logging, Field Screening, and Soil Sample Collection

Subsurface conditions in soil borings were evaluated through lithologic logging, field screening, and soil sampling. Continuous soil cores were obtained from the direct-push borings for observations, screening, and sampling. Subsurface conditions in borings advanced using air rotary and solid stem auger drilling equipment were evaluated based on drill cuttings and driller observations.

Lithologic Logging

Soil/rock conditions in borings were observed and documented in general accordance with ASTM 2487/2488. Subsurface conditions in borings advanced using solid stem auger and air rotary equipment were interpreted based on driller observations and soil cuttings, rather than undisturbed samples. Therefore, lithological details are limited in borings completed using solid stem auger and air rotary equipment.

Field Screening

Soil samples were extracted at approximately 5-foot intervals from the direct-push borings for field screening. Field screening methods included headspace vapor measurements using a photoionization detector (PID), visual observations, and sheen tests. Cuttings from solid stem auger and air rotary borings

were screened using visual methods. Field screening data are presented on boring logs, included in Appendix I. Field screening procedures are described in detail in Standard Operating Procedure (SOP) 2.1, which is included in Appendix J.

Collection of Soil Samples

A total of 23 soil samples were collected and submitted for laboratory analysis. At least one soil sample was collected from each boring that was advanced using direct-push or solid stem auger equipment (i.e., temporary boring B-1; monitoring well borings MW-1 through MW-6, MW-11 through MW-16; and SVE pilot test well borings SVE-1 through SVE-3). Soil samples from air rotary borings were not submitted for laboratory analysis because the samples were significantly disturbed during the drilling process; however, the soil cuttings were field screened consistent with procedures outlined in SOP 2.1, which is included in Appendix J.

In borings that exhibited field indications of the presence of petroleum constituents (i.e., sheen headspace vapor concentrations, or visible staining), samples were collected from the interval that exhibited the maximum field indications and from the overlying, apparently non-impacted, soil. In borings that did not exhibit indications of petroleum constituents, a sample was collected immediately above the soil-water interface. Sample intervals for each boring are listed in Table 3 and shown on boring logs in Appendix I. The soil samples were submitted to ALS Laboratory in Houston, Texas for analysis of GRO by Iowa Method OA-1 and VOCs by EPA Method 8260B. The soil analytical data are listed in Table 3 and further discussed in Section 6.1.

4.3 Groundwater Monitoring Well Installation

A total of 16 groundwater monitoring wells (MW-1 through MW-16) were installed at the Site at the locations shown on Figure 2. Monitoring wells MW-1 though MW-10 were installed during the first phase of investigation in July and August 2013, and wells MW-11 through MW-16 were installed during the second phase of investigation in September and October 2013. The monitoring wells were installed in accordance with *KDHE SOP BER-06 – Installation of Monitoring Wells*. Monitoring well construction details are listed in Table 4 and shown on boring logs included in Appendix I.

Information about hydrogeological conditions at the Site was limited prior to the CI. To improve the understanding of hydrogeological conditions and select appropriate monitoring well screen intervals, temporary screened well points were installed in all monitoring well borings to measure groundwater levels and select well screen intervals. Groundwater levels in the well points were monitored for at least 24 hours before wells were constructed.

Monitoring wells installed during the CI were constructed using 2-inch-diameter polyvinyl chloride (PVC) casing and screen, with the exception of well MW-1, which was constructed using 4-inch-diameter PVC casing and screen (to allow future use as a recovery well, if necessary). The well point observations

showed that groundwater levels at the Site exhibit significant variability, both temporally and spatially. To minimize the potential for flooded (that is, a well where the screen interval is submerged) or dry wells, with KDHE concurrence, the monitoring wells were constructed with 20-foot-long screen intervals.

At each well, filter-pack silica sand (#12/20) was placed in the well annulus from the bottom of the screen to approximately 2 feet above the top of the screen interval. Bentonite grout was emplaced in the annulus from the top of the sand pack to approximately 1 foot bgs. The monitoring wells were completed at the ground surface in flush-mounted traffic-rated monuments.

4.4 Groundwater Monitoring Well Development

The completed monitoring wells were allowed to set for at least 24 hours prior to initiating well development. Wells were developed by over-pumping to remove excess turbidity and improve hydraulic communication with the adjacent water-bearing zone. The developed wells were allowed to stabilize for at least 24 hours before groundwater samples were collected.

4.5 Groundwater Monitoring Well Sample Collection

Groundwater samples were collected from wells MW-1 through MW-10 in August 2013 and from wells MW-1 through MW-16 in October 2013. During each event, samples were collected using a bladder pump and flow cell, following low-flow methods (KDHE, 2011). During sampling, groundwater was extracted from the wells at a rate of less than 500 mL per minute while water quality parameters and depth-to-groundwater were monitored. When water quality parameters stabilized, samples were collected in new laboratory-provided containers. Field notes documenting groundwater sampling procedures are included in Appendix H. The low-flow methods are described in more detail in SOP 2.5, which is included in Appendix J.

4.6 Irrigation Well Sampling Program

Groundwater samples were collected from a total of 16 irrigation wells during two sampling events, between July and November 2013. Samples were collected from 13 irrigation wells in July/August and from 16 wells in October/November. Sampled irrigation wells are shown on Figures 7 through 9. The samples were collected using no-purge methods due to limitations imposed by irrigation wellheads, downhole pumps, and other infrastructure. Field notes documenting groundwater sampling procedures are included in Appendix H.

4.7 Groundwater Chemical Analytical Program

Groundwater samples collected from monitoring wells and irrigation wells were submitted to ALS Laboratory in Houston, Texas, under chain of custody, and analyzed for GRO by Method IA OA-1 and VOCs (BTEX,

1,2-dicholoethane, naphthalene, 1,2,4-trimethylbenzene, 1,3,5-trimethylbenzene, n-butylbenzene, and n-propylbenzene) by EPA Method 8260B. The groundwater analytical data are listed in Tables 5 and 6 and further discussed in Section 6.2.

4.8 Monitoring Well and Pond Survey

Following development, the horizontal locations and elevations of the new monitoring wells were surveyed by Garber Surveying Service, P.A., a Kansas-licensed land surveyor. Top of well casing and cap elevations were measured to the nearest hundredth of a foot, using the NAVD88 datum. To evaluate possible surface water-groundwater interactions, Garber Surveying Service also surveyed the bathymetry of the stormwater retention pond and installed a surface water gauge in the pond. At the time of the survey, the approximate depth of the pond was 9 feet. Survey data are provided in Appendix K.

4.9 Soil Vapor Assessment

Three soil vapor monitoring points (VP-1 through VP-3) were installed near the dwelling at 2006 N Colt Court on July 23, 2013. The vapor points were installed in accordance with *Kansas Vapor Intrusion Guidance. Chemical Vapor Intrusion and Residential Indoor Air* (KDHE, 2007).

The property at 2006 N Colt Court was selected for the soil vapor investigation because it is considered a worst-case area under KDHE guidance for evaluation of potential vapor intrusion. This consideration was determined based on the concentrations in soil and groundwater in nearby borings and wells (boring B-1 and monitoring wells MW-1 and MW-3) and the historical presence of SPH in the irrigation well at that property.

As shown on Figure 2, soil vapor points VP-1, VP-2, and VP-3 were installed on the north, northeast, and east sides of the dwelling at 2006 N Colt Court, respectively. The dwelling has a daylight basement on the east side; therefore, the ground elevation, and the surface completion of soil vapor point VP-3, are approximately 5 feet lower in elevation compared to the other soil vapor points. The elevation of well monument VP-3 is approximately equivalent to the concrete slab foundation of the daylight basement of the dwelling at 2006 N Colt Court. All three vapor points are located between the dwelling and the pipeline. Soil vapor point construction details are included in Appendix I.

Soil vapor samples were collected from soil vapor points VP-1 through VP-3 on September 24, 2013. The samples were submitted for analysis of VOCs by EPA Method TO-15. The scope and results of the vapor intrusion investigation are summarized in Section 6.3. A second round of soil vapor samples was collected in late January 2014, and vapor intrusion data collection will continue during the first half of 2014.

4.10 Investigation-Derived Waste

Investigation-derived waste (IDW) generated during the CI consisted of soil cuttings, excavated soil from well monument construction, decontamination water, purge water, and personal protection equipment (PPE). Water IDW was temporarily placed in totes and subsequently disposed at the Custom Wastewater Facility in Wichita, Kansas. Consistent with KDHE approval, soil was collected in an on-site trailer, profiled, and transported to the NuStar El Dorado landfarm for treatment. PPE was disposed of as unregulated solid waste.

5.0 Physical Setting

This section discusses the physical characteristics of the Site, including geology and hydrogeology. The following discussion is based on data obtained during the CI as well as information presented in reports prepared by the Kansas Geological Survey.

5.1 Geology

The regional geology in Butler County consists of unconsolidated sediments, including Tertiary and Quaternary alluvium and Quaternary loess at the ground surface, overlying lower Permian limestone and shale of the Council Grove and Chase Groups (Aber, 1991). O'Connor et al. (1982) report that the uppermost bedrock unit at the Site is the Permian Wellington Formation, which reportedly consists of up to 100 feet of light gray and green silty shale, with some thin limestone and gypsum beds. The Wellington Formation is underlain by the Nolans Limestone formation, which is approximately 20 to 30 feet thick, and consists of a light-buff limestone and dolomite in upper part.

Geological conditions at the Site are generally consistent with regional conditions, based on information presented in irrigation well construction logs (surface to 116 feet bgs) and observations in borings (surface to 65 feet bgs) advanced during the CI. At the Site, yellowish brown clay (loess) is generally encountered from the surface to depths of approximately 10 to 15 feet bgs. The clay is underlain by gray, yellow, and olive brown shale of the Wellington Formation; the Wellington Formation is weathered at the interface between consolidated and unconsolidated sediments. Thin layers of gypsum are occasionally encountered in the shale. An interpretation of geological conditions at the Site is presented in the geological cross-sections on Figures 5 through 7. Boring logs and well completion forms for the CI are included in Appendix I.

5.2 Groundwater / Aquifer Characteristics

This Section describes the regional groundwater conditions and those observed at the Site.

5.2.1 Regional Conditions

The Site and surrounding area are generally flat, although regional topography slopes gently to the east, toward the Whitewater River, which is approximately 4 miles east of the Site. O'Connor et al. (1982) report that the upper most water-bearing unit at the Site is the Wellington Formation. O'Connor et al. indicate that the productivity and quality of water from the Wellington Formation are limited. A regional groundwater elevation map prepared by O'Connor et al. (1982) indicates that the groundwater level near the Site is approximately 1,320 feet above mean sea level (msl), with a 0.005 foot per foot (ft/ft) easterly gradient.

O'Connor et al. also report that the shale units in southwest Butler County are relatively impermeable or of very low permeability with respect to vertical groundwater flow below approximately 50 feet. These conclusions indicate that the potential for vertical migration of contaminants in groundwater below approximately 50 feet is low.

5.2.2 Site Conditions

Weekly groundwater level measurements collected between August 8 and November 26, 2013 (and tabulated in Table 4) indicate that the groundwater level at the Site ranges between approximately 13 and 45 feet bgs (equivalent to approximately 1305 to 1336 feet msl). During the same period, the water stage in the nearby stormwater retention pond ranged between 1344 and 1345 feet msl. Figures 8 through 10 show groundwater and elevations on August 13, October 23, and November 26, 2013, respectively.

Monitoring well installation data and water level measurements indicate that groundwater gradients at the Site are controlled by local and regional systems. Locally, leakage from the stormwater retention pond leads to groundwater recharge and elevated groundwater levels near the pond. As shown on Figure 7, this recharge effect results in radial outward flow of groundwater from the pond and relatively steep groundwater gradients near the retention pond. During the November 26, 2013 monitoring event, for example, groundwater near the northeast corner of the pond exhibited a steep northerly gradient of approximately 0.1 ft/ft (represented by wells MW-6 and MW-9). In contrast, during the same monitoring event, wells farther from the pond (e.g., wells MW-16 and MW-15) exhibited a gradient on the order of 0.01 ft/ft.

The local effects of recharge from the stormwater retention pond appear to be the primary factor affecting groundwater gradients at the Site; however, an easterly groundwater flow component is apparent with distance from the pond. The effects of recharge from the stormwater retention pond appear to diminish in the vicinity of West Mountain Street (Figures 6 through 10). For example, the monitoring wells north of West Mountain Street and furthest from the pond (MW-15 and MW-16) indicate an easterly gradient during both the October and November 2013 monitoring events (these wells were not installed prior to the August 2013 monitoring event). The easterly flow direction exhibited by wells MW-15 and MW-16 is consistent with the regional groundwater flow system reported by O'Connor et al. (1982).

As previously discussed, irrigation wells are installed at many of the properties in the Neighborhood. It is likely that historical pumping from these wells influenced localized gradients at the Site, although the influence of these wells has not been quantified. During the initial phase of the CI (August 2013), most of the Neighborhood wells were active and irrigation was ongoing. During subsequent phases of work, fewer irrigation wells were active (due to NuStar's well deactivation program and seasonal irrigation usage patterns). The effects of the irrigation well pumping have been observed on at least two irrigation wells. During the peak pumping period in August, samples collected from four irrigation wells (2005 N Colt Court, 2007 N Colt Court, 2019 N Ruger Court, and 2028 N Ruger Court) contained GRO, benzene, or naphthalene at concentrations above the corresponding KDHE Tier 2 RBSVs. During the October/November 2013 monitoring event, the magnitude of gasoline constituents in irrigation well groundwater was reduced, with only two irrigation wells (2005 N Colt Court and 2019 N Ruger Court) exhibiting gasoline constituent concentrations above Tier 2 residential RBSVs.

6.0 Comprehensive Investigation Results

This section presents the analytical results for soil, groundwater, and soil vapor samples collected during the CI and as part of IRMs (e.g., the pipeline excavation and SPH removal). Consistent with KDHE guidance, and since a quantitative risk assessment was not performed, the data are compared to KDHE Tier 2 RBSVs. Laboratory data are listed in Tables 1, 3, 5, 6, and 7. Laboratory reports and a laboratory data quality assurance/quality control (QA/QC) review are included in Appendix F.

6.1 Soil

The nature and extent of petroleum hydrocarbons in soil at the Site were characterized using field screening data and laboratory data. Twenty-three soil samples were collected during the CI and three soil samples were collected during the pipeline excavation activities. Soil analytical data are listed in Tables 1 and 3.

Petroleum hydrocarbon concentrations above Tier 2 RBSVs for soil are limited to the immediate pipeline release area. The highest concentrations of gasoline constituents were detected in residual soil at the pipeline excavation area and nearby temporary boring B-1. Samples collected from the north sidewall and base of the pipeline excavation (6 and 13 feet bgs, respectively) exhibited GRO concentrations of 180 and 560 milligrams per kilogram (mg/kg), respectively (the corresponding Tier 2 RBSV for the soil to groundwater pathway is 79 mg/kg). Benzene concentrations in those samples were 1.0 and 2.0 mg/kg, respectively. A soil sample collected at 21 feet bgs in boring B-1 exhibited a benzene concentration of 2.3 mg/kg (the corresponding Tier 2 RBSV is 0.168 mg/kg). Toluene was detected in the excavation base sample at a concentration of 73 mg/kg (the corresponding Tier 2 RBSV is 51.2 mg/kg). As previously discussed, pipeline excavation samples were collected at the boundaries of the excavation, which was limited by dense soil/rock and subsurface utilities. Soil data for the pipeline release area are shown on Figures 3 and 4.

Outside of the immediate pipeline release area, at locations such as MW-1 and MW-3, the concentrations of gasoline constituents in soil are significantly reduced. Gasoline constituents were not detected in soil at 10 of the 16 monitoring well borings and, where detected, constituent concentrations were less than Tier 2 RBSVs and are limited to the interval below approximately 19.5 feet bgs.

Overall, field screening data and laboratory analytical results indicate that petroleum hydrocarbon concentrations in soil are limited to the interval below approximately 6 feet bgs at the release area and the interval below approximately 20 feet outside of the pipeline release area. As shown on Figure 4, the lateral extent of constituent concentrations in soil above Tier 2 RBSVs appears limited to the area bounded by the release location on the west, well MW-4 on the north, well MW-3 on the east, and well MW-1 on the south. This area is occupied by W Mountain Road and a portion of the property at 2006 N Colt Court.

6.2 Groundwater

The nature and extent of groundwater constituents at the Site were characterized using groundwater data collected from monitoring wells and irrigation wells. Tables 5 and 6 list groundwater analytical data for samples collected from monitoring wells and irrigation wells, respectively. Laboratory analytical reports are included in Appendix F.

6.2.1 Monitoring Wells

Sixteen groundwater monitoring were installed at the Site, at the locations shown on Figure 2. Since installation, the monitoring wells have been gauged for the presence of SPH and to measure depth to water on a weekly basis. Groundwater samples were collected from each of the monitoring wells and submitted for laboratory analysis during two monitoring events conducted between August and November 2013. Groundwater analytical data are listed in Tables 5 and 6. Figures 11 and 12 depict the groundwater chemical analytical data for the July/August and October/November 2013 monitoring events, respectively.

To date, SPH have not been observed in any of the monitoring wells at the Site, indicating that mobile SPH is limited to the immediate vicinity of the pipeline release, at the irrigation well at 2006 N Colt Court.

During the July/August 2013 monitoring event, gasoline constituents were absent or below KDHE Tier 2 RBSVs in 8 of the 16 monitoring wells installed at the Site. One or more of the following constituents were detected at concentrations above the corresponding Tier 2 RBSVs in eight monitoring wells (MW-1, MW-2, MW-3, MW-4, MW-5, MW-6, MW-9, and MW-10): GRO, benzene, toluene, ethylbenzene, naphthalene, 1,2,4-trimethylbenzene, and 1,3,5-trimethylbenzene. The highest concentrations of gasoline constituents were detected in monitoring well MW-1, which is approximately 50 feet from the release location.

During the most recent (October/November 2013) monitoring event, the horizontal extent of gasoline constituents in groundwater was reduced. The extent of gasoline constituents in groundwater in

August/September and October/November 2013 is shown on Figures 13 and 14, respectively. Gasoline constituents were not detected or were less than Tier 2 RBSVs in 10 of the 16 monitoring wells at the Site (MW-2, MW-6, MW-7, MW-8, and MW-11 through MW-16). Therefore, as shown on Figures 14 through 16, these wells, along with irrigation wells (see Section 6.2.2), define the lateral boundary of gasoline constituents in groundwater at the Site.

The groundwater data represent a distribution of dissolved-phase gasoline constituents that is similar to the distribution of gasoline constituents in soil. That is, the highest concentrations of gasoline constituents in groundwater are present in the vicinity of the pipeline release location and nearby to the east (e.g., wells MW-1, MW-3, and MW-9). Dissolved-phase constituent concentrations significantly decrease with distance from the release location. Overall, the distribution of dissolved-phase constituents in groundwater is generally consistent with groundwater gradients at the Site. Although, lower concentrations of dissolved-phase gasoline constituents have also been detected in two wells north (MW-5) and south (MW-2) of the release location, which may be as a consequence of historical pumping from Neighborhood irrigation wells and associated perturbations of localized groundwater gradients at the Site.

6.2.2 Irrigation Wells

During two monitoring events performed in July/August and October/November 2013, 13 and 16 irrigation wells, respectively, were gauged for the presence of SPH and groundwater samples were collected for laboratory analysis. Irrigation well data are listed in Table 6 and shown on Figures 11 and 12. As discussed in Section 2.2, Neighborhood irrigation wells range in depth from 80 to 116 feet bgs. In most irrigation wells, the screened interval extends from total well depth to approximately 40 feet bgs; gravel filter packs typically extend from the total well depth to approximately 20 feet bgs.

SPH have been observed only in the irrigation well at 2006 N Colt Court. Although regular SPH recovery activities have been conducted on this irrigation well since 2012, regular measurement of SPH thicknesses has been conducted only since June 2013. Since regular measurement began, SPH thicknesses have ranged from a sheen to 0.81 foot, and the maximum SPH thickness was measured on June 13, 2013. Weekly vacuum extraction of SPH from the irrigation well began in June 2013, and since August 2013, SPH have been only intermittently present in the irrigation well.

One or more of the following gasoline constituents (GRO, BTEX, 2-butanone, n-butylbenzene, naphthalene, n-propylbenzene, 1,2,4-trimethylbenzene, 1,3,5-trimethylbenzene cyclohexane, isopropylbenzene, and methylcyclohexane) have been detected in four irrigation wells in the Neighborhood. During the July/August 2013 monitoring event, samples collected from four irrigation wells (2005 N Colt Court, 2007 N Colt Court, 2019 N Ruger Court, and 2028 N Ruger Court) contained GRO, benzene, or naphthalene at concentrations exceeding the corresponding KDHE Tier 2 RBSVs. During the October/November 2013 monitoring event, the magnitude of gasoline constituents in irrigation well groundwater was reduced, with only two irrigation

wells (2005 N Colt Court and 2019 N Ruger Court) exhibiting gasoline constituent concentrations that exceed Tier 2 residential RBSVs.

6.3 Soil Vapor

On September 24, 2013, soil vapor samples were collected from three soil vapor probes and submitted for analysis of VOCs. The soil vapor probe locations are near the dwelling at 2006 N Colt Court as shown on Figures 2 and 17. Chemical concentrations in soil vapor probe VP-2 were non-detect with the exception of one constituent (toluene), which was detected at a concentration of 0.60 $\mu g/m^3$ (micrograms per cubic meter), which only slightly exceeds the laboratory reporting limit (0.57 $\mu g/m^3$). Detected benzene concentrations in soil vapor probes VP-1 and VP-3 were 3.8 and 5.5 $\mu g/m^3$, respectively. Naphthalene was not detected in any samples. Chemical concentrations in soil vapor are listed in Table 7 and shown on Figure 17.

The soil vapor data were modified using the KDHE attenuation factor (0.01; KDHE, 2007) and compared to Tier 2 RBSVs for indoor air in accordance with KDHE guidance. The modified soil vapor concentrations are generally two to three orders of magnitude lower than the corresponding screening values, indicating that vapor concentrations in soil do not pose a significant vapor intrusion risk at the Site. A second round of soil vapor samples was collected in late January 2014, and vapor intrusion data collection will continue during the first half of 2014.

Further evaluation of preferential vapor migration pathways (e.g., utility corridors) will be conducted following completion of the ongoing additional soil investigation within the immediate release area. The additional soil data will be useful for the evaluation of potential preferential vapor migration pathways.

6.4 Identification of Gasoline Constituents

To identify constituents of concern at the Site, Apex compared the maximum detected concentrations of constituents of interest in soil, groundwater, and soil vapor to the applicable Tier 2 RBSVs. Soil data were compared to Tier 2 RBSVs for the residential soil-to-groundwater pathway exposure scenario. Groundwater data were compared to the Tier 2 RBSVs for the groundwater ingestion exposure scenario. Soil vapor data were modified by the KDHE attenuation factor and compared to the Tier 2 RBSVs for residential indoor air. Constituents that were detected in one or more samples and are above the corresponding RBSV are presented in Tables 1, 3, 5, 6, and 7 and listed below.

<u>Soil</u>
GRO, benzene, and toluene.

<u>Groundwater</u>
GRO, benzene, ethylbenzene, naphthalene, toluene, 1,2,4-trimethylbenzene, and 1,3,5-trimethylbenzene.

Soil Vapor

None.

7.0 Conceptual Site Model

The following conceptual site model (CSM) was developed based on Site conditions, the observed extent of SPH on groundwater, field screening data from the pipeline excavation and borings, and dissolved-phase petroleum hydrocarbon concentration data. The CSM identifies contaminant sources, release mechanisms, affected media, and exposure pathways under current and reasonably likely future land uses. Figure 18 presents a graphical summary of the CSM.

In general, Site conditions are summarized as follows:

- The Site and surrounding area are used for residential purposes. Future uses at the Site are likely to remain residential.
- The source of petroleum hydrocarbons in the subsurface is the gasoline release from the NuStar pipeline that was discovered on June 9, 2012. The release location is approximately 65 feet northwest of monitoring well MW-1.
- Surface soil beneath the pipeline and elsewhere at the Site consists of clay with some silt, sand, and gravel. The clay soil is underlain by shale of the Wellington formation at approximately 10 to 15 feet bgs. Shale extends to the total depths explored (approximately 65 feet bgs).
- Soil analytical data indicate that gasoline released from the pipeline primarily migrated vertically through soil until the SPH reached the water table.
- The groundwater level at the site ranges from approximately 13 and 45 feet bgs (equivalent to approximately 1305 to 1336 feet msl). Based on the depth to water and lithology observed in borings, the Wellington Formation is the water-bearing unit at the Site. O'Connor et al. (1982) report that the shale units in southwest Butler County are considered relatively impermeable or of very low permeability with respect to vertical groundwater flow below approximately 50 feet; therefore the risk of vertical migration of gasoline below approximately 50 feet appears very low.
- Water leakage from the stormwater retention pond leads to localized groundwater recharge and elevated groundwater levels near the pond. This recharge effect results in radial outward flow of groundwater from the pond and relatively steep groundwater gradients away from the retention pond. At the Site, the overall result of the stormwater pond recharge to groundwater is the flow of groundwater to the north, away from the pond. However, with some distance from the pond, groundwater exhibits a more easterly flow component and shallower gradient, consistent with regional patterns.

- The following gasoline constituents were detected at concentrations above Tier 2 RBSVs: GRO, benzene, ethylbenzene, toluene, naphthalene, 1,2,4-trimethylbenzene, and 1,3,5-trimethylbenzene, in various samples, as shown in Tables 1, 3, 5, and 6.
- The extent of petroleum concentrations in soil and groundwater has been delineated during this investigation. Gasoline constituents in soil are limited to a small area in the vicinity of the pipeline release area. At the pipeline release location, soil with petroleum concentrations is present below approximately 6 feet bgs. Away from the release location, soil with petroleum concentrations is limited to the interval below approximately 20 feet bgs. Gasoline constituents were not detected or were less than Tier 2 RBSVs in 10 of the 16 monitoring wells at the Site (MW-2, MW-6, MW-7, MW-8, and MW-11 through MW-16). Therefore, as shown on Figures 14 through 16, these wells, along with irrigation wells (see Section 6.2.2), define the lateral boundary of gasoline constituents in groundwater at the Site.
- Soil vapor testing has shown that very low concentrations of petroleum constituents are present in soil vapor within approximately 10 feet of the ground surface at areas affected by relatively high concentrations of gasoline in the subsurface (e.g., 2006 N Colt Court). Even lower soil vapor concentrations are expected at areas with lower petroleum constituent concentrations in the subsurface.
- The gasoline release was discovered approximately 18 months ago. Source materials have been removed from soil at the release location and from the irrigation well at 2006 N Colt Court; therefore, constituent concentrations in the subsurface are attenuating and will continue to attenuate.

7.1 Potential Migration Routes

Potential migration routes for gasoline constituents at the Site are discussed in this Section.

Primary Release to Soil. Soil containing petroleum constituents is present at the release area. Approximately 16 cubic yards of soil containing gasoline constituents were removed from the source area and the affected portion of the pipeline was replaced during initial response actions. Therefore, there are no ongoing releases to soil at the Site. In a limited area near the pipeline release location, soil and shale bedrock in the interval below approximately 6 feet contain gasoline constituents at concentrations that exceed applicable Tier 2 RBSVs. Not all of the source material was removed due to physical constraints. Outside of the pipeline release area, gasoline constituents have not been detected in soil at depths less than approximately 19.5 feet bgs; where detected, gasoline constituents are near the soil-groundwater interface and may be attributable to concentrations in groundwater.

Leaching to Groundwater. Dissolved-phase constituents have been detected in groundwater, indicating that this migration pathway is complete. However, as described in Section 6.1, petroleum concentrations in soil above the Tier 2 RBSV for the residential soil-to-groundwater pathway are limited to soil in the release area, at

depths between approximately 6 and 21 feet bgs. Outside of the release area, gasoline constituents have not been detected in soil at depths less than approximately 19.5 feet bgs.

Volatilization to Air. The petroleum constituents at the Site have a volatile component. While volatile constituents could migrate to air under some circumstances, data collected during the vapor intrusion investigation indicate that constituent concentrations in soil and groundwater do not pose a significant risk to human health as a result of vapor intrusion to indoor or outdoor air.

Groundwater. Dissolved- and separate-phase hydrocarbons are present in Site groundwater as described in Section 6.2. Groundwater gauging data and reports by others indicate that groundwater at the Site generally flows to the east, although groundwater gradients are locally variable due the presence of the stormwater retention pond. The extent of gasoline constituents in groundwater has been defined, as shown on Figures 14 through 16.

7.2 Exposure Assessment

Potential contaminant exposure scenarios for people and ecological receptors include:

Soil

- *Incidental ingestion and/or dermal contact with surface soil.*
- *Incidental ingestion and/or dermal contact with subsurface soil.*
- *Soil volatilization to indoor/outdoor air and subsequent inhalation.*
- *Terrestrial ecological ingestion/dermal contact and root uptake of contaminants.*

Groundwater

- *Incidental dermal contact, ingestion, and inhalation of groundwater.*
- *Groundwater volatilization to indoor/outdoor air and subsequent inhalation.*
- *Groundwater discharge to surface water.*

Each of the exposure scenarios listed above are evaluated and discussed below.

7.2.1 Soil Exposure Assessment

- Incidental ingestion and/or dermal contact with surface soil: Soil in the interval between the surface and approximately 6 feet bgs does not contain gasoline constituents; therefore, incidental ingestion and/or dermal contact with any gasoline constituents in surface soil (defined by KDHE as 0 to 2 feet bgs) is an incomplete exposure pathway.

- Incidental ingestion and/or dermal contact with subsurface soil: Soil below 6 feet (at the release location and deeper at other parts of the Site) contains gasoline constituents. Due to the depth of the gasoline constituents and the asphalt-concrete pavement that covers the release area, residential exposure to gasoline constituents in subsurface soil is unlikely. Excavation workers, however, could contact soil containing gasoline constituents at the release location. Consequently, excavation worker exposure to petroleum hydrocarbons in subsurface soil is a potentially complete exposure pathway, if soil is excavated.
- Soil volatilization to indoor/outdoor air and subsequent inhalation: Soil in some areas of the Site contains volatile constituents. Volatile constituents in soil could migrate to outdoor or indoor air; therefore, this is a potentially complete exposure pathway. Data collected during the preliminary vapor intrusion assessment indicate that soil vapor concentrations do not pose a significant risk to human health as a result of vapor intrusion; however, NuStar will perform additional investigation to further refine the understanding of vapor intrusion risks at the Site.
- Terrestrial ecological ingestion/dermal contact and root uptake of contaminants: Gasoline constituents in soil are limited to the interval below 6 feet. The biologically active soil zone is normally limited to the interval between the surface and approximately 3 feet bgs. Because the soil containing gasoline constituents is minimal and below the biologically active zone, this is an incomplete exposure pathway.

7.2.2 Groundwater Exposure Assessment

- Incidental dermal contact, ingestion, and inhalation of groundwater: Groundwater at the Site contains gasoline constituents; however, the potential for exposure to gasoline constituents in groundwater is limited because: (1) six irrigation wells located within the investigation area have been deactivated, and seven additional wells within the investigation area are not currently in use (due to the winter season) and are targeted for deactivation prior to the 2014 irrigation season; (2) the City of Andover provides municipal water to the Neighborhood; and (3) due to the depth to groundwater (approximately 20 feet), incidental contact is not reasonably likely. Risk is minimal under current conditions; however, additional wells could be installed in the investigation area in the future. Incidental dermal contact, ingestion, and inhalation of petroleum hydrocarbons in groundwater is a potentially complete exposure pathway. However, if the existing wells are permanently deactivated and no additional wells can be installed, this will become an incomplete exposure pathway.
- Groundwater volatilization to indoor/outdoor air and subsequent inhalation: Groundwater at the Site contains volatile constituents. Volatile constituents in groundwater could migrate to outdoor or indoor air; therefore, this is a potentially complete exposure pathway. Data collected during the preliminary vapor intrusion assessment indicate that soil vapor concentrations do not pose a significant risk to human health as a result of vapor intrusion; however, NuStar will perform additional investigation to further refine the understanding of vapor intrusion risks at the Site.

- Groundwater discharge to surface water: A stormwater retention pond is located approximately 250 feet south of the pipeline release location. The pond may be used for recreation and ecological habitat. Groundwater/pond stage elevations, along with adjacent groundwater elevations, indicate that the bottom of the pond lies several feet above the regional water table and the pond leaks via infiltration into the shallow subsurface soil. This leakage recharges the lower shallow aquifer. Therefore, groundwater discharge to surface water in the pond does not occur. Additionally, groundwater monitoring data for wells between the release location and the pond (i.e., the irrigation well at 2002 N Colt Court and monitoring well MW-7) do not contain constituent concentrations above KDHE Tier 2 RBSVs, indicating that groundwater containing petroleum constituents is not migrating to the pond. For the reasons cited above, groundwater discharge to surface water is an incomplete exposure pathway.

7.3 Summary of Exposure Assessment

In summary, potentially complete exposure pathways and receptors at the Site include:

- Incidental ingestion and/or dermal contact with subsurface soil (excavation workers).
- Soil volatilization to indoor/outdoor air and subsequent inhalation (residents).
- Incidental dermal contact, ingestion, and inhalation of groundwater (residents).

However, the data collected indicate that there is no significant risk.

7.4 Remedial Action Objectives

In this section, the remedial action objectives (RAOs) are identified and the Correction Action Alternatives (CAAs) evaluated to date are presented. The CAAs will be evaluated in detail during the Corrective Action Study.

7.4.1 Remedial Action Objectives

Consistent with KDHE guidance for sites where a quantitative risk assessment was not performed, Tier 2 RBSVs in soil and groundwater are the remedial action objectives for the Site.

7.4.2 Preliminary Screening of Remedial Actions

As presented in Section 3, concurrent with the CI, a preliminary screening of remedial actions for soil and groundwater was conducted. This screening primarily evaluated soil which appears to be limited to the immediate source area. As presented in Section 6.2, two comprehensive groundwater sampling events have been conducted, and results indicate that the extent of dissolved phase constituents has reduced since groundwater sampling began. More groundwater data is necessary in order to evaluate appropriate

groundwater remediation technologies. A list of potential remedial actions is presented below; a more detailed evaluation of the remedial actions will be presented in the Corrective Action Study.

Potential Remedial Actions for Groundwater

- No action. This alternative will not be selected; however, it is included as required in KDHE Guidance.
- Institutional controls, including environmental use control / groundwater use restrictions.
- *In situ* Physical / Chemical / Thermal treatment, including: (1) ozone sparging; (2) soil vapor extraction; (3) multi-phase extraction; (4) steam flushing/stripping; (5) chemical oxidation; and (6) passive / reactive treatment walls.
- *Ex situ* Physical / Chemical / Thermal treatment of groundwater, including: adsorption; air stripping; separation / reverse osmosis; ultraviolet oxidation; ion exchange; and precipitation / coagulation / flocculation.
- *Ex situ* biological treatment of groundwater including bioreactors / trickling filter.
- *In situ* biological treatment, including: (1) bioremediation; (2) monitored natural attenuation; and (3) phytoremediation.
- Engineering controls, including: (1) development of a new irrigation wells; (2) wellhead treatment at irrigation wells; and (3) various building controls, if applicable.
- Containment technologies, including: (1) installation of vertical barriers; and (2) installation of extraction well(s).
- Removal and discharge technologies, including: (1) installation of extraction well(s); (2) installation of a trench or horizontal boring filled with porous media; (3) discharge of water (which may require treatment) into storm sewer or sanitary sewer; and (4) discharge of water (which may require treatment) into aquifer by reinjection wells.

Potential Remedial Actions for Soil

- No action. This alternative will not be selected; however, it is included as required in KDHE Guidance.
- Institutional controls, including: (1) deed restrictions / soil management plan; and (2) monitoring.
- *In situ* physical /chemical/thermal treatment options, including: (1) soil vapor extraction; (2) electrokinetic separation; (3) fracturing; (4) chemical oxidation; (5) soil flushing; (6) solidification /stabilization / vitrification; and (7) thermally enhanced removal.
- *In situ* biological treatment options, including: (1) bioventing; (2) bioremediation; (3) land treatment; (4) monitored natural attenuation; and (5) phytoremediation.

- *Ex situ* physical /chemical/thermal treatment options, including: (1) chemical extraction; (2) incineration; (3) soil washing; (4) solar detoxification; and (5) thermal desorption.
- *Ex situ* biological treatment, including: (1) biopiles; (2) composting; (3) landfarming; and (4) slurry phase biological treatment.
- Engineering controls, including: (1) development of new irrigation wells; (2) wellhead treatment at irrigation wells; and (3) use of building controls including use of HVAC systems, installation of low permeable barriers and sub-slab venting systems.
- Removal / off-site disposal options, including: (1) excavation; and (2) off-site disposal.

When evaluating the aforementioned remedial options as part of this preliminary screening, the following criteria were considered: overall protection of human health and the environment, implementability, site/subsurface conditions, volume of affected material, short-term and long-term effectiveness, community acceptance, and cost.

Based on an initial desktop evaluation, SVE was identified as a potentially effective technology to remove petroleum hydrocarbons from the subsurface. To further evaluate the potential for application of SVE technology at the Site, an SVE pilot test was performed. Data collected during the pilot test confirm Site conditions may be conducive to the application of SVE technology. A detailed summary of the SVE pilot test results along with recommendations and/or proposal will be submitted to KDHE in March 2014.

7.5 Qualitative Risk Assessment

Under current conditions, potential risks to human health are very low because groundwater and soil exposure pathways are incomplete. Groundwater exposure pathways are incomplete because irrigation wells that contain gasoline constituents have been deactivated or are not currently in use. Soil exposure pathways are incomplete because soil with petroleum constituents is more than 6 feet bgs and asphalt-concrete pavement covers soil with the highest concentrations of petroleum constituents. Data collected during the preliminary vapor intrusion investigation indicate that the concentrations of volatile constituents in soil gas do not pose a significant risk to human health as a result of vapor intrusion; however, NuStar will perform additional investigation to further refine the understanding of vapor intrusion risks at the Site.

Despite the minimal risks, remediation may be necessary until petroleum constituents decrease to concentrations below KDHE Tier 2 RBSVs in soil and groundwater. The scope for remediation will be determined in the future when additional data are available, as discussed in Section 9.

8.0 Summary and Conclusions

NuStar has implemented IRMs and a CI at the Site in response to the discovery of a gasoline release from a NuStar pipeline in the Quail Crossing neighborhood, which included excavation of soil containing petroleum constituents from the release area, removal of SPH from the irrigation well at 2006 N Colt Court, and deactivation of selected irrigation wells. Data collected during the investigation indicate that the release occurred from the pipeline at a location approximately 50 feet northwest of monitoring well MW-1. The release was the result of a pinhole-sized leak, capable of transmitting fluids only under certain pressures, which did not occur very often. Although the quantity released is not known, source material was removed to the extent practicable. Gasoline constituents migrated vertically through soil before encountering groundwater and migrating laterally through low permeability shale of the Wellington Formation.

Groundwater gradients at the Site are controlled by local and regional systems. Locally, leakage from the stormwater retention pond leads to groundwater recharge and elevated groundwater levels near the pond. This recharge effect results in radial outward flow of groundwater from the pond and relatively steep groundwater gradients near the retention pond. The overall result of the stormwater pond recharge to groundwater is the flow of groundwater to the north, away from the pond. However, with distance from the pond, groundwater exhibits a more easterly flow component and shallower gradient, consistent with established regional patterns.

Gasoline constituents at concentrations above Tier 2 RBSVs are present in soil below approximately 6 feet bgs in a limited area near the pipeline release location. The extent of gasoline constituents in groundwater above Tier 2 RBSVs appears limited to the area bounded by the MW-8 on the west, well MW-11 on the north, well MW-12 on the east, and well MW-6 on the south. The magnitude and extent of petroleum constituents in soil and groundwater is expected to decrease, as source materials (soil and SPH) have been removed and irrigation wells have been deactivated or are not currently in use.

Under current conditions, potential risks to human health are very low because groundwater and soil exposure pathways are incomplete. Data collected during the preliminary vapor intrusion assessment indicate that soil vapor concentrations do not pose a significant risk to human health as a result of vapor intrusion; however, NuStar will perform additional investigation to further refine the understanding of vapor intrusion risks at the Site. Remediation may be necessary until petroleum constituents decrease to concentrations below KDHE Tier 2 RBSVs in soil and groundwater.

Additional data would be useful for refining the understanding of Site conditions, confirming the conclusions drawn herein, and evaluating remedial alternatives. These additional data include: (1) soil data to refine the understanding of the extent of gasoline constituents in soil in the immediate vicinity of the release; (2) groundwater gauging data to improve the understanding of groundwater gradients at the Site; (3) groundwater quality data to evaluate constituent trends; and (4) soil vapor data to confirm soil vapor concentrations.

9.0 Proposed Activities

A summary of the activities that have been proposed to further refine the understanding of Site conditions is presented in this Section. These proposed activities are described in more detail in the Soil Vapor Extraction Evaluation and Proposed Soil Investigation Report (Apex, 2014).

9.1 Soil Sampling

Soil data collected to date have defined the extent of gasoline constituents in the soil. However, additional soil data would be useful to: (1) refine the understanding of the extent of gasoline in soil in the immediate vicinity of the release adjacent to the pipeline; and (2) design appropriate IRMs and CAAs.

To obtain the data described above, NuStar has proposed to advance soil borings in the immediate vicinity of the pipeline leak location. The number and location of soil borings will be determined in the field in coordination with KDHE, based upon utility conflicts and field screening data. In general, the soil borings will be completed to approximately 20 feet bgs using hollow stem auger (HSA) drilling technology. Subsurface conditions in soil borings will be evaluated through lithologic logging, field screening, and soil sampling. Continuous soil cores will be obtained from the split-spoon sampler for observations, screening, and sampling. Soil/rock conditions in borings will be observed and documented in general accordance with ASTM 2487/2488. Field screening methods will include headspace vapor measurements using a PID, visual observations, and sheen tests. Field screening procedures are described in detail in SOP 2.1, which is included in Appendix J.

In borings with field indications of petroleum constituents (i.e., sheen headspace vapor concentrations, or visible staining), soil samples will be collected from the interval that exhibits the maximum field indications of petroleum constituents, and from the overlying, apparently non-impacted, soil. In borings that do not exhibit indications of petroleum constituents, a sample will collected at the base of the boring. The soil samples will be submitted to ALS Laboratory in Houston, Texas for analysis of GRO by Method IA OA-1 and VOCs (BTEX; 1,2-dicholoethane; naphthalene; 1,2,4-trimethylbenzene; 1,3,5-trimethylbenzene; n-butylbenzene; and n-propylbenzene) by EPA Method 8260B.

Pending KDHE approval of the Soil Vapor Extraction Evaluation and Soil Investigation Work Plan (Apex, 2014), the soil investigation will be performed in April 2014 and results of the investigation will presented within 60 days after receipt of analytical data.

9.2 Groundwater Monitoring and Reporting

Groundwater data collected to date have defined the extent of gasoline constituents in the groundwater. However, additional groundwater monitoring data would be useful to: (1) evaluate groundwater concentration trends; (2) assess seasonal variations in groundwater levels and constituent concentrations; and (3) identify the effects, if any, of irrigation well deactivations on groundwater quality and gradients at the Site.

To obtain the data described above, NuStar proposes to implement a groundwater monitoring program in monitoring wells and irrigation wells at the Site. In general, the proposed groundwater monitoring program consists of: (1) monthly gauging of water levels in monitoring wells MW-1 through MW-16 and soil vapor extraction wells SVE-1 through SVE-4; (2) quarterly collection and analysis of groundwater samples from monitoring wells MW-1 through MW-16; and (3) quarterly collection and analysis of groundwater monitoring samples from selected irrigation wells. The proposed groundwater monitoring program for monitoring wells and irrigation wells is presented in Tables 8 and 9, respectively.

As previously approved by KDHE, groundwater samples will be collected from monitoring wells using low-flow sampling techniques and irrigation wells using a no-purge technique. Groundwater samples will be submitted to ALS Laboratories in Houston, Texas for analysis of GRO by Method IA OA-1 and VOCs (BTEX; 1,2-dicholoethane; naphthalene; 1,2,4-trimethylbenzene; 1,3,5-trimethylbenzene; n-butylbenzene; and n-propylbenzene) by EPA Method 8260B.

Groundwater monitoring reports will be prepared on a quarterly schedule in 2014. Each report will document the results of the activities proposed in Section 9.2, and will be submitted within 60 days following receipt of the analytical data. NuStar will evaluate, and in coordination with KDHE, potentially modify the sampling and reporting schedule in 2015.

9.3 Vapor Intrusion Assessment

Data collected during the preliminary vapor intrusion assessment indicate that soil vapor concentrations do not pose a significant risk to human health as a result of vapor intrusion. Outdoor air risks are even lower. While these results indicate the absence of a risk of vapor intrusion exceedances, NuStar conducted an additional round of soil vapor sampling from vapor probes VP-1 through VP-3 in January 2014 in accordance with KDHE Guidance. These data will be compared to KDHE Tier 2 screening values using the KDHE attenuation factor (0.01) to confirm that soil vapor does not pose a significant risk to human health. Further evaluation of preferential vapor migration pathways (e.g. utility corridors) will be conducted following completion of the ongoing additional soil investigation within the immediate release area. The additional soil data will be useful for the evaluation of potential preferential vapor migration pathways.

9.4 Interim Remedial Measures

NuStar proposes to continue or implement the following IRMs:

- Continuation of SPH removal, if any, from the irrigation well at 2006 N Colt Court using vacuum and manual methods. This work will be performed on a weekly schedule until conditions change and a schedule modification is warranted.
- Deactivation of the irrigation wells at the properties at 2007 N Mountain Court, 2009 N Mountain Court, 2001 N Colt Court, 2019 N Ruger Circle, 2020 N Ruger Circle, 2021 N Ruger Court and 2025 N Ruger Court for deactivation, pending owner authorization. NuStar anticipates that well deactivation will occur prior to the 2014 irrigation season. Deactivation of additional irrigation wells if necessary to reduce pumping influences on groundwater containing petroleum constituents and/or to protect human health.
- On March 28, 2014, the SVE Evaluation and Soil Investigation Report was submitted to KDHE (Apex, 2014). The pilot test data indicated that SVE would be an effective remedial technology for removing petroleum constituents from the Site. NuStar will continue to coordinate with KDHE and Neighborhood representatives during the evaluation of remedial technologies, and implement IRMs that will be effective and accepted by the Neighborhood.

The scope and schedule for IRMs will be developed in coordination with KDHE and in accordance with the CAFO. A corrective action study will be prepared and submitted to KDHE for review following approval of the CI and completion of IRMs.

10.0 References

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Table 1
Soil Analytical Data - Pipeline Excavation
Andover Colt Court Release Site
Andover, Kansas

Sample Location	Sample Depth (feet bgs)	Sample Date	DRO	ORO	GRO	Benzene	Toluene	Ethylbenzene	m,p-Xylene	o-Xylene	Total Xylenes	1,2 Dichloroethane	2-Butanone	Cyclohexane	Isopropylbenzene	Methylcyclohexane
			Concentrations in mg/kg (ppm)													
Andover / South Wall	6	7/6/2012	<1.7	<3.4	0.13	0.021	0.0082	<0.005	0.010	0.0059	0.016	<0.005	<0.01	<0.005	<0.005	0.005
Andover / Floor	13	7/6/2012	52	7.4	**560**	**2.0**	**73.0**	34.0	110.0	45.0	160.0	<0.050	<0.10	5.9	3.1	7.3
Andover / North Wall	6	7/6/2012	700	<68	**180**	**1.0**	14	7.1	27	14	41	<0.05	<0.1	1.7	1.1	1.7
KDHE Tier 2 Screening Value (soil to groundwater pathway)			**5440**	--	**79.3**	**0.168**	**51.2**	**65.6**	--	--	**809**	**0.060**	**24.15**	--	**65.14**	--

Notes:

1. DRO = Diesel-range organics quantified by IOWA OA-2.
2. ORO = Oil-range organics quantified by IOWA OA-2.
3. GRO = Gasoline-range organics quantified by IOWA OA-1.
4. Volatile organic compounds by U.S. Environmental Protection Agency (EPA) Method 8260B.
5. mg/kg (ppm) = Milligrams per kilogram (parts per million).
6. **Bold** indicates detected concentration above the KDHE screening value.
7. < = Not detected above the method reporting limit (MRL).
8. -- = A KDHE Tier 2 Risk Based Screening Values has not been established.
9. KDHE Tier 2 Screening Values from the *Risk-Based Standards for Kansas, 5th Editior.*, October 2010.

Table 2
SPH Recovery Data - 2006 N. Colt Court
Andover Colt Court Release Site
Andover, Kansas

Date	Depth to Groundwater (feet bgs)	Depth to Product (feet)	Product Thickness (feet)	SPH Recovered (gallons)	Water Recovered (gallons)	Total Gallons Recovered	Fluid Removal Technology
6/14/2012		--		20	--	--	Mobile vacuum truck
6/15/2012	--	--	--	20	--	--	Mobile vacuum truck
6/28/2012	--	--	--	10	0	10	Hand bailer
7/2/2012	--	--	--	10	0	10	Hand bailer
7/3/2012	--	--	--	5	0	5	Hand bailer
7/5/2012	--	--	--	8	0	8	Hand bailer
7/5/2012	--	--	--	5	--	--	Mobile vacuum truck
8/15/2012	--	--	--	15	0	15	Hand bailer
8/20/2012	--	--	--	5	0	5	Hand bailer
11/8/2012	--	--	--	15			Hand bailer
11/15/2012	--	--	--	15	0	15	Hand bailer
11/21/2012	--	--	--	15	0	15	Hand bailer
11/30/2012	--	--	--	7	0	15	Hand bailer
12/7/2012	--	--	--	4	4	11	Hand bailer
12/14/2012	--	--	--	2	2	6	Hand bailer
12/21/2012	--	--	--	2	2	4	Hand bailer
12/28/2012	--	--	--	1.5	2	4	Hand bailer
1/4/2013	--	--	--	1	1	2.5	Hand bailer
1/17/2013	--	--	--	1.5	2	3	Hand bailer
2/1/2013	--	--	--	2	1.5	3	Hand bailer
2/13/2013	--	--	--	3	1.5	3.5	Hand bailer
3/15/2013	--	--	--	10	1	4	Hand bailer
3/20/2013	--	--	--	5	0	10	Hand bailer
4/5/2013	--	--	--	8	1	6	Hand bailer
4/12/2013	--	--	--	1	4	4	Hand bailer
4/25/2013	--	--	--	4	2	3	Hand bailer
5/10/2013	--	--	--	9	2	6	Hand bailer
5/17/2013	--	--	--	4	1	8	Hand bailer
5/21/2013	--	--	--	1	2	6	Hand bailer

Please refer to notes at end of table.

Table 2
SPH Recovery Data - 2006 N. Colt Court
Andover Colt Court Release Site
Andover, Kansas

Date	Depth to Groundwater (feet bgs)	Depth to Product (feet)	Product Thickness (feet)	SPH Recovered (gallons)	Water Recovered (gallons)	Total Gallons Recovered	Fluid Removal Technology
6/5/2013	--	--	--	1	2	3	Hand bailer
6/12/2013	42.19	41.38	0.81	8	1	2	Mobile vacuum truck and hand bailing
6/21/2013	43.73	43.40	0.33	4	--	--	Mobile vacuum truck
6/26/2013	43.59	43.16	0.43	2.5	--	--	Mobile vacuum truck
7/2/2013	49.31	49.01	0.30	1.5	--	--	Mobile vacuum truck
7/12/2013	55.11	54.82	0.29	2	--	--	Mobile vacuum truck
7/17/2013	55.10	54.88	0.22	4	--	--	Mobile vacuum truck
8/1/2013	46.35	46.15	0.20	2	--	--	Mobile vacuum truck
8/8/2013	41.49	--	0.00	0	--	--	Mobile vacuum truck
8/13/2013	39.10	--	0.00	0	--	--	Mobile vacuum truck
8/20/2013	37.40	--	0.00	0	--	--	Mobile vacuum truck
8/28/2013	43.81	--	0.00	0	--	--	Mobile vacuum truck
9/5/2013	47.86	--	0.00	0	--	--	Mobile vacuum truck
9/11/2013	50.61	--	0.00	0	--	--	Mobile vacuum truck
9/17/2013	49.06	--	0.00	0	--	--	Mobile vacuum truck
9/23/2013	48.97	--	0.00	0	--	--	Mobile vacuum truck
9/30/2013	48.63	--	0.00	0	--	--	Mobile vacuum truck
10/10/2013	49.16	49.01	0.15	1	--	--	Mobile vacuum truck
10/17/2013	48.40	--	0.00	0	--	--	Mobile vacuum truck
10/24/2013	48.71	--	0.00	0	--	--	Mobile vacuum truck
10/31/2013	44.86	--	0.00	0	--	--	Mobile vacuum truck
11/6/2013	43.66	--	0.00	0	--	--	Mobile vacuum truck
11/13/2013	41.82	--	0.00	0	--	--	Mobile vacuum truck
11/20/2013	40.60	--	0.00	0	--	--	Mobile vacuum truck
11/26/2013	40.30	40.19	0.11	1	--	--	Mobile vacuum truck
12/3/2013	39.44	sheen	0.00	0	--	--	Mobile vacuum truck
12/11/2013	39.63	sheen	0.00	0	--	--	Mobile vacuum truck
12/19/2013	39.23	--	0.00	0	--	--	Mobile vacuum truck
12/27/2013	39.38	39.34	0.04	1	--	--	Mobile vacuum truck

Notes

1. The SPH volume removed using vacuum technology was calculated by measuring the SPH thicknesses in the well before and after each event. The volume of SPH removed is approximate.
2. SPH = Separate-phase hydrocarbons.

Table 3
Soil Analytical Data - Borings
Andover Colt Court Release Site
Andover, Kansas

Sample Location	Sample Depth (feet bgs)	Sample Date	GRO	1,2,4 Trimethylbenzene	1,2 Dichloroethane	1,3,5-Trimethylbenzene	2-Butanone	Benzene	Cyclohexane	Ethylbenzene	Isopropylbenzene	m,p-Xylene	Methylcyclohexane	Naphthalene	n-Butylbenzene	n-Propylbenzene	o-Xylene	Toluene	Total Xylenes
			Concentrations in mg/kg (ppm)																
B-1	21.0	7/22/2013	0.82	0.14	<0.0074	0.037	0.11	**2.3**	0.046	0.30	<0.0074	1.1	<0.0074	0.043	<0.0074	0.021	<0.26	0.58	1.3
	9.0	7/22/2013	<0.050	<0.0085	<0.0085	<0.0085	<0.017	<0.0085	<0.0085	<0.0085	<0.0085	<0.017	<0.0085	<0.0085	<0.0085	<0.0085	<0.0085	<0.0085	<0.017
MW-1	13.5	7/22/2013	<0.050	<0.0072	<0.0072	<0.0072	<0.014	<0.0072	<0.0072	<0.0072	<0.0072	<0.014	<0.0072	<0.0072	<0.0072	<0.0072	<0.0072	<0.0072	<0.014
MW-2	12.5	7/22/2013	<0.050	<0.0058	<0.0058	<0.0058	<0.012	<0.0058	<0.0058	<0.0058	<0.0058	<0.012	<0.0058	<0.0058	<0.0058	<0.0058	<0.0058	<0.0058	<0.012
MW-3	19.75	7/22/2013	0.40	0.12	<0.0064	0.034	<0.013	0.12	.045	0.037	0.0091	0.062	0.0099	0.016	<0.0064	<0.0064	<0.0064	<0.0064	0.064
	16.5	7/22/2013	<0.050	<0.0068	<0.0068	<0.0068	<0.014	<0.0068	<0.0068	<0.0068	<0.0068	<0.014	<0.0068	<0.0068	<0.0068	<0.0068	<0.0068	<0.0068	<0.014
MW-4	10.5	7/22/2013	<0.050	<0.0064	<0.0064	<0.0064	<0.013	<0.0064	<0.0064	<0.0064	<0.0064	<0.013	<0.0064	<0.0064	<0.0064	<0.0064	<0.0064	<0.0064	<0.013
MW-5	17.5	7/22/2013	<0.050	<0.0074	<0.0074	<0.0074	<0.015	<0.0074	<0.0074	<0.0074	<0.0074	<0.015	<0.0074	<0.0074	<0.0074	<0.0074	<0.0074	<0.0074	<0.015
MW-6	14.5	7/23/2013	<0.050	<0.0070	<0.0070	<0.0070	<0.014	<0.0070	<0.0070	<0.0070	<0.0070	<0.014	<0.0070	<0.0070	<0.0070	<0.0070	<0.0070	<0.0070	<0.014
MW-11	30	9/23/2013	<0.050	<0.005	<0.005	<0.005	<0.01	<0.005	<0.005	<0.005	<0.005	<0.01	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.01
	40	9/23/2013	0.073	<0.005	<0.005	<0.005	<0.01	<0.005	0.0096	<0.005	<0.005	<0.01	0.0063	<0.005	<0.005	<0.005	<0.005	<0.005	<0.01
MW-12	25	9/24/2013	<0.050	<0.005	<0.005	<0.005	<0.01	<0.005	<0.005	<0.005	<0.005	<0.01	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.01
	30	9/24/2013	<0.050	<0.005	<0.005	<0.005	<0.01	<0.005	<0.005	<0.005	<0.005	<0.01	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.01
MW-13	35	9/24/2013	<0.050	<0.005	<0.005	<0.005	<0.01	<0.005	<0.005	<0.005	<0.005	<0.01	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.01
MW-14	40	9/24/2013	<0.050	<0.005	<0.005	<0.005	<0.01	<0.005	<0.005	<0.005	<0.005	<0.01	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.01
MW-15	40	9/26/2013	<0.050	<0.005	<0.005	<0.005	<0.01	<0.005	<0.005	<0.005	<0.005	<0.01	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.01
MW-16	40	9/26/2013	<0.050	<0.005	<0.005	<0.005	<0.01	<0.005	<0.005	<0.005	<0.005	<0.01	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.01
SVE-1	25	9/24/2013	<0.050	<0.005	<0.005	<0.005	<0.01	<0.005	<0.005	<0.005	<0.005	<0.01	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.01
	30	9/24/2013	<0.050	<0.005	<0.005	<0.005	<0.01	<0.005	<0.005	<0.005	<0.005	<0.01	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.01
SVE-2	25	9/25/2013	<0.050	<0.005	<0.005	<0.005	<0.01	<0.005	<0.005	<0.005	<0.005	<0.01	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.01
	30	9/25/2013	<0.050	<0.005	<0.005	<0.005	<0.01	<0.005	<0.005	<0.005	<0.005	<0.01	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.01
SVE-3	20	9/25/2013	<0.050	<0.005	<0.005	<0.005	<0.01	<0.005	<0.005	<0.005	<0.005	<0.01	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.01
	30	9/25/2013	2.4	0.023	<0.005	<0.005	<0.01	<0.005	<0.005	<0.005	<0.005	<0.01	<0.005	0.020	<0.005	<0.005	<0.005	<0.005	<0.01
KDHE Tier 2 Screening Value (soil to groundwater pathway)			**79.3**	**1.07**	**0.060**	**5.51**	**24.15**	**0.168**	--	**65.6**	**65.14**	--	--	**0.349**	**10.2**	**110**	--	**51.2**	**809**

Notes:

1. GRO = Gasoline-range organics quantified by IOWA OA-1.
2. Volatile organic compounds by U.S. Environmental Protection Agency (EPA) Method 8260B.
3. mg/kg (ppm) = Milligrams per kilogram (parts per million).
4. **Bold** indicates detected concentration above the KDHE screening value.
5. < = Not detected above the method reporting limit (MRL).
6. -- = A KDHE Tier 2 Risk Based Screening Values has not been established.
7. KDHE Tier 2 Screening Values from the *Risk-Based Standards for Kansas, 5th Edition* , October 2010.

Table 4
Groundwater Gauging Data
Andover Colt Court Release Site
Andover, Kansas

Well ID	Measurement Date	Casing Diameter (inches)	Top of Casing Elevation (feet)[1]	Total Depth (feet bgs)	Screen Interval (feet bgs)	Depth to Groundwater (feet bgs)	Depth to SPH (feet)	SPH Thickness (feet)	Groundwater Elevation (feet MSL)
MW-1	8/8/2013	4.0	1352.13	35	20-35	24.64	--	--	1327.49
	8/13/2013					24.36	--	--	1327.77
	8/21/2013					23.79	--	--	1328.34
	8/28/2013					25.21	--	--	1326.92
	9/5/2013					27.19	--	--	1324.94
	9/11/2013					25.93	--	--	1326.20
	9/17/2013					25.92	--	--	1326.21
	9/23/2013					28.49	--	--	1323.64
	9/30/2013					23.00	--	--	1329.13
	10/10/2013					25.28	--	--	1326.85
	10/17/2013					26.21	--	--	1325.92
	10/23/2013					23.55	--	--	1328.58
	10/31/2013					24.28	--	--	1327.85
	11/6/2013					NM	--	--	NM
	11/13/2013					23.04	--	--	1329.09
	11/20/2013					22.84	--	--	1329.29
	11/26/2013					24.88	--	--	1327.25
	12/3/2013					30.19	--	--	1321.94
	12/11/2013					31.12	--	--	1321.01
	12/19/2013					31.38	--	--	1320.75
	12/27/2013					31.50	--	--	1320.63
MW-2	8/8/2013	2.0	1353.17	44	29-44	31.93	--	--	1321.24
	8/13/2013					31.27	--	--	1321.90
	8/21/2013					30.85	--	--	1322.32
	8/28/2013					31.45	--	--	1321.72
	9/5/2013					31.45	--	--	1321.72
	9/11/2013					32.18	--	--	1320.99
	9/17/2013					32.10	--	--	1321.07
	9/23/2013					31.66	--	--	1321.51
	9/30/2013					32.55	--	--	1320.62
	10/10/2013					29.11	--	--	1324.06
	10/17/2013					31.91	--	--	1321.26
	10/23/2013					32.47	--	--	1320.70
	10/31/2013					32.19	--	--	1320.98
	11/6/2013					31.46	--	--	1321.71
	11/13/2013					31.96	--	--	1321.21
	11/20/2013					31.19	--	--	1321.98
	11/26/2013					31.38	--	--	1321.79
	12/3/2013					30.94	--	--	1322.23
	12/11/2013					NM	--	--	--
	12/19/2013					31.45	--	--	1321.72
	12/27/2013					NM	--	--	--
MW-3	8/8/2013	2.0	1350.47	60	40-60	36.94	--	--	1313.53
	8/13/2013					34.71	--	--	1315.76
	8/21/2013					33.30	--	--	1317.17
	8/28/2013					39.26	--	--	1311.21
	9/5/2013					42.54	--	--	1307.93
	9/11/2013					45.19	--	--	1305.28
	9/17/2013					43.52	--	--	1306.95
	9/23/2013					43.34	--	--	1307.13
	9/30/2013					43.40	--	--	1307.07

Please refer to notes at end of table.

Table 4
Groundwater Gauging Data
Andover Colt Court Release Site
Andover, Kansas

Well ID	Measurement Date	Casing Diameter (inches)	Top of Casing Elevation (feet)[1]	Total Depth (feet bgs)	Screen Interval (feet bgs)	Depth to Groundwater (feet bgs)	Depth to SPH (feet)	SPH Thickness (feet)	Groundwater Elevation (feet MSL)
MW-3 (continued)	10/10/2013	2.0	1350.47	60	40-60	43.18	--	--	1307.29
	10/17/2013					41.23	--	--	1309.24
	10/23/2013					41.43	--	--	1309.04
	10/31/2013					41.58	--	--	1308.89
	11/6/2013					41.19	--	--	1309.28
	11/13/2013					35.98	--	--	1314.49
	11/20/2013					35.27	--	--	1315.20
	11/26/2013					34.56	--	--	1315.91
	12/3/2013					33.77	--	--	1316.70
	12/11/2013					34.04	--	--	1316.43
	12/19/2013					33.72	--	--	1316.75
	12/27/2013					33.89	--	--	1316.58
MW-4	8/8/2013	2.0	1350.73	41	26-41	28.89	--	--	1321.84
	8/13/2013					28.85	--	--	1321.88
	8/21/2013					28.18	--	--	1322.55
	8/28/2013					28.56	--	--	1322.17
	9/5/2013					29.16	--	--	1321.57
	9/11/2013					29.55	--	--	1321.18
	9/17/2013					30.06	--	--	1320.67
	9/23/2013					30.32	--	--	1320.41
	9/30/2013					30.11	--	--	1320.62
	10/10/2013					30.45	--	--	1320.28
	10/17/2013					30.43	--	--	1320.30
	10/23/2013					30.36	--	--	1320.37
	10/31/2013					30.14	--	--	1320.59
	11/6/2013					29.78	--	--	1320.95
	11/13/2013					30.21	--	--	1320.52
	11/20/2013					29.81	--	--	1320.92
	11/26/2013					30.34	--	--	1320.39
	12/3/2013					30.64	--	--	1320.09
	12/11/2013					30.19	--	--	1320.54
	12/19/2013					30.47	--	--	1320.26
	12/27/2013					30.43	--	--	1320.30
MW-5	8/8/2013	2.0	1352.77	30	15-30	19.61	--	--	1333.16
	8/13/2013					19.39	--	--	1333.38
	8/21/2013					19.66	--	--	1333.11
	8/28/2013					20.02	--	--	1332.75
	9/5/2013					20.54	--	--	1332.23
	9/11/2013					20.81	--	--	1331.96
	9/17/2013					21.03	--	--	1331.74
	9/23/2013					21.00	--	--	1331.77
	9/30/2013					21.17	--	--	1331.60
	10/10/2013					21.45	--	--	1331.32
	10/17/2013					21.18	--	--	1331.59
	10/23/2013					21.20	--	--	1331.57
	10/31/2013					21.19	--	--	1331.58
	11/6/2013					20.91	--	--	1331.86
	11/13/2013					20.79	--	--	1331.98
	11/20/2013					20.18	--	--	1332.59
	11/26/2013					21.29	--	--	1331.48
	12/3/2013					20.84	--	--	1331.93
	12/11/2013					20.96	--	--	1331.81
	12/19/2013					20.54	--	--	1332.23
	12/27/2013					20.82	--	--	1331.95

Please refer to notes at end of table.

Table 4
Groundwater Gauging Data
Andover Colt Court Release Site
Andover, Kansas

Well ID	Measurement Date	Casing Diameter (inches)	Top of Casing Elevation (feet)[1]	Total Depth (feet bgs)	Screen Interval (feet bgs)	Depth to Groundwater (feet bgs)	Depth to SPH (feet)	SPH Thickness (feet)	Groundwater Elevation (feet MSL)
MW-6	8/8/2013	2.0	1349.76	41	26-41	15.67	--	--	1334.09
	8/13/2013					18.34	--	--	1331.42
	8/21/2013					17.40	--	--	1332.36
	8/28/2013					17.95	--	--	1331.81
	9/5/2013					18.32	--	--	1331.44
	9/11/2013					18.21	--	--	1331.55
	9/17/2013					18.44	--	--	1331.32
	9/23/2013					18.30	--	--	1331.46
	9/30/2013					18.69	--	--	1331.07
	10/10/2013					18.84	--	--	1330.92
	10/17/2013					18.76	--	--	1331.00
	10/23/2013					18.69	--	--	1331.07
	10/31/2013					18.57	--	--	1331.19
	11/6/2013					18.01	--	--	1331.75
	11/13/2013					19.42	--	--	1330.34
	11/20/2013					19.02	--	--	1330.74
	11/26/2013					19.84	--	--	1329.92
	12/3/2013					19.63	--	--	1330.13
	12/11/2013					20.45	--	--	1329.31
	12/19/2013					21.21	--	--	1328.55
	12/27/2013					21.67	--	--	1328.09
MW-7	8/8/2013	2.0	1348.98	24	9-24	13.32	--	--	1335.66
	8/13/2013					13.68	--	--	1335.30
	8/21/2013					14.03	--	--	1334.95
	8/28/2013					14.76	--	--	1334.22
	9/5/2013					15.44	--	--	1333.54
	9/11/2013					15.66	--	--	1333.32
	9/17/2013					15.78	--	--	1333.20
	9/23/2013					15.54	--	--	1333.44
	9/30/2013					15.39	--	--	1333.59
	10/10/2013					15.65	--	--	1333.33
	10/17/2013					15.68	--	--	1333.30
	10/23/2013					15.64	--	--	1333.34
	10/31/2013					15.66	--	--	1333.32
	11/6/2013					15.11	--	--	1333.87
	11/13/2013					15.21	--	--	1333.77
	11/20/2013					15.62	--	--	1333.36
	11/26/2013					15.89	--	--	1333.09
	12/3/2013					16.03	--	--	1332.95
	12/11/2013					16.45	--	--	1332.53
	12/19/2013					16.41	--	--	1332.57
	12/27/2013					16.59	--	--	1332.39
MW-8	8/8/2013	2.0	1353.38	30	15-30	18.62	--	--	1334.76
	8/13/2013					18.13	--	--	1335.25
	8/21/2013					18.32	--	--	1335.06
	8/28/2013					19.21	--	--	1334.17
	9/5/2013					20.00	--	--	1333.38
	9/11/2013					20.35	--	--	1333.03
	9/17/2013					20.54	--	--	1332.84
	9/23/2013					20.59	--	--	1332.79

Please refer to notes at end of table.

Table 4
Groundwater Gauging Data
Andover Colt Court Release Site
Andover, Kansas

Well ID	Measurement Date	Casing Diameter (inches)	Top of Casing Elevation (feet)[1]	Total Depth (feet bgs)	Screen Interval (feet bgs)	Depth to Groundwater (feet bgs)	Depth to SPH (feet)	SPH Thickness (feet)	Groundwater Elevation (feet MSL)
MW-8 (continued)	9/30/2013	2.0	1353.38	30	15-30	20.70	--	--	1332.68
	10/10/2013					20.82	--	--	1332.56
	10/17/2013					20.92	--	--	1332.46
	10/23/2013					20.85	--	--	1332.53
	10/31/2013					20.89	--	--	1332.49
	11/6/2013					19.21	--	--	1334.17
	11/13/2013					19.38	--	--	1334.00
	11/20/2013					18.86	--	--	1334.52
	11/26/2013					20.30	--	--	1333.08
	12/3/2013					20.54	--	--	1332.84
	12/11/2013					21.09	--	--	1332.29
	12/19/2013					21.11	--	--	1332.27
	12/27/2013					21.54	--	--	1331.84
MW-9	8/8/2013	2.0	1349.48	34	19-34	28.61	--	--	1320.87
	8/13/2013					27.58	--	--	1321.90
	8/21/2013					27.52	--	--	1321.96
	8/28/2013					27.60	--	--	1321.88
	9/5/2013					28.28	--	--	1321.20
	9/11/2013					30.57	--	--	1318.91
	9/17/2013					30.05	--	--	1319.43
	9/23/2013					30.25	--	--	1319.23
	9/30/2013					30.45	--	--	1319.03
	10/10/2013					30.76	--	--	1318.72
	10/17/2013					30.69	--	--	1318.79
	10/23/2013					30.73	--	--	1318.75
	10/31/2013					30.11	--	--	1319.37
	11/6/2013					30.03	--	--	1319.45
	11/13/2013					29.54	--	--	1319.94
	11/20/2013					28.66	--	--	1320.82
	11/26/2013					28.67	--	--	1320.81
	12/3/2013					28.40	--	--	1321.08
	12/11/2013					28.55	--	--	1320.93
	12/19/2013					28.55	--	--	1320.93
	12/27/2013					NM	--	--	--
MW-10	8/8/2013	2.0	1348.79	34	19-34	26.72	--	--	1322.07
	8/13/2013					25.39	--	--	1323.40
	8/21/2013					24.94	--	--	1323.85
	8/28/2013					25.94	--	--	1322.85
	9/5/2013					28.21	--	--	1320.58
	9/11/2013					28.42	--	--	1320.37
	9/17/2013					28.49	--	--	1320.30
	9/23/2013					28.46	--	--	1320.33
	9/30/2013					28.32	--	--	1320.47
	10/10/2013					28.30	--	--	1320.49
	10/17/2013					28.45	--	--	1320.34
	10/23/2013					28.33	--	--	1320.46
	10/31/2013					28.40	--	--	1320.39
	11/6/2013					27.87	--	--	1320.92
	11/13/2013					28.25	--	--	1320.54
	11/20/2013					27.53	--	--	1321.26
	11/26/2013					27.30	--	--	1321.49
	12/3/2013					26.81	--	--	1321.98
	12/11/2013					27.14	--	--	1321.65
	12/19/2013					27.10	--	--	1321.69
	12/27/2013					27.42	--	--	1321.37

Please refer to notes at end of table.

Table 4
Groundwater Gauging Data
Andover Colt Court Release Site
Andover, Kansas

Well ID	Measurement Date	Casing Diameter (inches)	Top of Casing Elevation (feet)[1]	Total Depth (feet bgs)	Screen Interval (feet bgs)	Depth to Groundwater (feet bgs)	Depth to SPH (feet)	SPH Thickness (feet)	Groundwater Elevation (feet MSL)
MW-11	9/30/2013	2.0	1351.34	42	22-42	29.03	--	--	1322.31
	10/10/2013					28.08	--	--	1323.26
	10/17/2013					28.26	--	--	1323.08
	10/23/2013					29.36	--	--	1321.98
	10/31/2013					28.92	--	--	1322.42
	11/6/2013					28.14	--	--	1323.20
	11/13/2013					28.16	--	--	1323.18
	11/20/2013					27.70	--	--	1323.64
	11/26/2013					28.03	--	--	1323.31
	12/3/2013					28.03	--	--	1323.31
	12/11/2013					28.54	--	--	1322.80
	12/19/2013					28.53	--	--	1322.81
	12/27/2013					28.80	--	--	1322.54
MW-12	9/30/2013	2.0	1349.74	43	23-43	30.15	--	--	1319.59
	10/10/2013					30.55	--	--	1319.19
	10/17/2013					30.49	--	--	1319.25
	10/23/2013					30.40	--	--	1319.34
	10/31/2013					30.45	--	--	1319.29
	11/6/2013					29.91	--	--	1319.83
	11/13/2013					29.32	--	--	1320.42
	11/20/2013					28.16	--	--	1321.58
	11/26/2013					27.91	--	--	1321.83
	12/3/2013					27.41	--	--	1322.33
	12/11/2013					27.83	--	--	1321.91
	12/19/2013					27.74	--	--	1322.00
	12/27/2013					NM	--	--	--
MW-13	9/30/2013	2.0	1354.58	45	25-45	31.25	--	--	1323.33
	10/10/2013					31.59	--	--	1322.99
	10/17/2013					31.74	--	--	1322.84
	10/23/2013					31.70	--	--	1322.88
	10/31/2013					31.72	--	--	1322.86
	11/6/2013					31.61	--	--	1322.97
	11/13/2013					31.70	--	--	1322.88
	11/20/2013					30.84	--	--	1323.74
	11/26/2013					31.30	--	--	1323.28
	12/3/2013					31.02	--	--	1323.56
	12/11/2013					31.26	--	--	1323.32
	12/19/2013					31.16	--	--	1323.42
	12/27/2013					31.48	--	--	1323.10
MW-14	9/30/2013	2.0	1354.99	45	25-45	31.59	--	--	1323.40
	10/10/2013					31.53	--	--	1323.46
	10/17/2013					31.71	--	--	1323.28
	10/23/2013					31.74	--	--	1323.25
	10/31/2013					31.76	--	--	1323.23
	11/6/2013					NM	--	--	NM
	11/13/2013					31.48	--	--	1323.51
	11/20/2013					30.51	--	--	1324.48
	11/26/2013					31.47	--	--	1323.52
	12/3/2013					31.42	--	--	1323.57
	12/11/2013					31.73	--	--	1323.26
	12/19/2013					31.74	--	--	1323.25
	12/27/2013					31.95	--	--	1323.04
MW-15	9/30/2013	2.0	1351.79	45	25-45	32.64	--	--	1319.15
	10/10/2013					32.75	--	--	1319.04
	10/17/2013					32.93	--	--	1318.86
	10/23/2013					32.84	--	--	1318.95
	10/31/2013					32.77	--	--	1319.02

Please refer to notes at end of table.

Table 4
Groundwater Gauging Data
Andover Colt Court Release Site
Andover, Kansas

Well ID	Measurement Date	Casing Diameter (inches)	Top of Casing Elevation (feet)[1]	Total Depth (feet bgs)	Screen Interval (feet bgs)	Depth to Groundwater (feet bgs)	Depth to SPH (feet)	SPH Thickness (feet)	Groundwater Elevation (feet MSL)
MW-15 (continued)	11/6/2013	2.0	1351.79	45	25-45	32.23	--	--	1319.56
	11/13/2013					31.72	--	--	1320.07
	11/20/2013					30.80	--	--	1320.99
	11/26/2013					30.96	--	--	1320.83
	12/3/2013					30.63	--	--	1321.16
	12/11/2013					30.93	--	--	1320.86
	12/19/2013					31.75	--	--	1320.04
	12/27/2013					31.05	--	--	1320.74
MW-16	9/30/2013	2.0	1352.13	45	25-45	31.60	--	--	1320.53
	10/10/2013					30.76	--	--	1321.37
	10/17/2013					30.79	--	--	1321.34
	10/23/2013					30.78	--	--	1321.35
	10/31/2013					30.80	--	--	1321.33
	11/6/2013					30.33	--	--	1321.80
	11/13/2013					30.01	--	--	1322.12
	11/20/2013					29.63	--	--	1322.50
	11/26/2013					29.71	--	--	1322.42
	12/3/2013					29.52	--	--	1322.61
	12/11/2013					29.71	--	--	1322.42
	12/19/2013					28.51	--	--	1323.62
	12/27/2013					29.97	--	--	1322.16
Stormwater Pond		NA	NA	NA	NA	NA	NA	NA	Pond Stage (feet MSL)
	8/8/2013								1344.75
	8/13/2013								1344.75
	8/21/2013								1344.50
	8/28/2013								1344.25
	9/5/2013								1344.25
	9/11/2013								1344.00
	9/17/2013								1344.00
	9/23/2013								1344.50
	10/3/2013								1344.50
	10/10/2013								1344.50
	10/17/2013								1344.00
	10/23/2013								1344.50
	10/31/2013								1345.00
	11/6/2013								1344.75
	11/13/2013								1344.50
	11/20/2013								1344.40
	11/26/2013								1344.25
	12/3/2013								1344.25
	12/11/2013								1344.75
	12/19/2013								1344.25
	12/27/2013								1344.25

Notes:
1. feet MSL = Feet above mean sea level (NAVD88).
2. -- = No SPH
3. DRY = Well was dry.
4. Pond elevation is measured directly from a staff gaige om the pond (in 0.25-foot increments). The top of the staff gauge is 1347.59 feet above mean sea level.
5. NA = Not applicable.

Table 5
Groundwater Analytical Results – Monitoring Wells
Andover Colt Court Release Site
Andover, Kansas

Sample Location	Sample Date	GRO	1,2,4 Trimethylbenzene	1,2 Dichloroethane	1,3,5- Trimethylbenzene	2-Butanone	Benzene	Cyclohexane	Ethylbenzene	Isopropylbenzene	m,p-Xylene	Methylcyclohexane	Naphthalene	n-Butylbenzene	n-Propylbenzene	o-Xylene	Toluene	Total Xylenes
		Concentrations in mg/L (ppm)																
MW-1	8/9/2013	**120**	**0.86**	<0.05	**0.22**	<0.1	**9.1**	0.37	**1.9**	<0.05	6.3	0.1	**0.23**	<0.05	0.068	2.8	**26**	9.1
	10/24/2013	**39**	**0.69**	<0.010	**0.19**	0.050	**7.8**	0.26	**2.0**	0.031	4.9	0.043	**0.14**	0.011	0.084	2.2	**18**	7.1
MW-2	8/8/2013	**2.3**	<0.005	<0.005	<0.005	0.13	**0.12**	0.099	<0.005	<0.005	0.017	0.02	<0.005	<0.005	<0.005	<0.005	0.027	0.021
DUP	8/8/2013	**2.2**	<0.005	<0.005	<0.005	0.13	**0.15**	0.11	<0.005	<0.005	0.021	0.021	<0.005	<0.005	<0.005	<0.005	0.031	0.026
	10/23/2013	<0.05	<0.001	<0.001	<0.001	<0.002	<0.001	<0.001	<0.001	<0.001	<0.002	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.003
MW-3	8/9/2013	**6**	**0.054**	<0.005	0.01	0.016	**1.2**	0.07	0.12	<0.005	0.086	0.014	**0.011**	<0.005	0.0074	0.12	0.4	0.21
	10/24/2013	**1.7**	**0.075**	<0.001	0.012	0.0057	**1.1**	0.082	0.12	0.0061	0.065	0.011	**0.017**	0.010	0.010	0.011	0.051	0.077
DUP	10/24/2013	**2.0**	**0.073**	<0.001	0.012	0.0059	**1.1**	0.077	0.11	0.0058	0.063	0.011	**0.018**	0.001	0.010	0.011	0.051	0.075
MW-4	8/8/2013	0.48	0.0013	<0.001	0.0013	<0.002	**0.035**	0.012	0.0075	0.0013	0.027	0.0027	**0.0027**	<0.001	0.0022	0.011	0.056	0.038
	10/23/2013	**1.0**	**0.0096**	<0.001	0.016	0.0046	**0.083**	0.050	0.017	<0.0010	0.0071	0.0085	**0.0036**	<0.001	0.0013	0.034	0.034	0.041
MW-5	8/8/2013	**0.94**	**0.015**	<0.001	**0.15**	<0.002	**0.038**	0.24	0.002	0.0018	0.11	0.0046	**0.0084**	<0.001	0.0023	0.0068	0.05	0.17
	10/24/2013	**2.1**	**0.098**	<0.001	0.028	<0.002	**0.081**	0.039	0.063	0.0051	0.20	0.0075	**0.023**	0.0026	0.011	0.12	0.10	0.32
MW-6	8/9/2013	<0.05	<0.001	<0.001	<0.001	0.0029	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	**0.0026**	<0.001	<0.001	<0.001	<0.001	<0.003
	10/24/2013	<0.05	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.003
DUP	10/24/2013	<0.05	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.003
MW-7	8/9/2013	<0.05	<0.001	<0.001	<0.001	<0.002	0.0012	<0.001	<0.001	<0.001	<0.002	<0.001	<0.001	<0.001	<0.001	<0.001	0.0014	<0.003
	10/24/2013	<0.05	<0.001	<0.001	<0.001	<0.002	<0.001	<0.001	<0.001	<0.001	<0.002	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.003
MW-8	8/8/2013	<0.05	<0.001	<0.001	<0.001	<0.002	<0.001	<0.001	<0.001	<0.001	<0.002	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.003
	10/24/2013	<0.05	<0.001	<0.001	<0.001	<0.002	<0.001	<0.001	<0.001	<0.001	<0.002	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.003
MW-9	8/9/2013	**36**	**0.82**	<0.001	**0.23**	0.23	**0.99**	0.21	0.65	0.025	2.8	0.048	**0.17**	0.014	0.068	1.3	**4.4**	4.1
	10/23/2013	0.054	<0.001	<0.001	<0.001	<0.002	0.0026	0.0011	<0.001	<0.001	<0.002	0.0025	**0.001**	<0.001	<0.001	<0.001	<0.001	<0.003
	11/25/2013	**0.57**	**0.022**	<0.010	0.013	0.004	**0.058**	0.017	0.0019	<0.001	0.019	0.0028	**0.0084**	<0.001	<0.001	0.018	0.005	0.037
MW-10	8/9/2013	<0.05	<0.001	<0.001	<0.001	<0.002	<0.001	<0.001	<0.001	<0.001	<0.002	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.003
	10/23/2013	**2.6**	**0.033**	<0.001	0.029	0.014	**0.051**	0.069	0.0034	<0.001	0.27	0.021	**0.0013**	0.0014	<0.001	0.15	0.14	0.42
	11/25/2013	**3.7**	**0.22**	<0.001	**0.072**	0.019	**0.016**	0.081	0.027	0.0065	0.26	0.016	**0.023**	<0.001	0.025	0.12	0.048	0.38
MW-11	10/23/2013	<0.05	<0.001	<0.001	<0.001	<0.002	<0.001	<0.001	<0.001	<0.001	<0.002	0.0024	<0.001	<0.001	<0.001	<0.001	<0.001	<0.003
MW-12	10/23/2013	<0.05	<0.001	<0.001	<0.001	<0.002	<0.001	<0.001	<0.001	<0.001	<0.002	0.0026	<0.001	<0.001	<0.001	<0.001	<0.001	<0.003
MW-13	10/23/2013	<0.05	<0.001	<0.001	<0.001	<0.002	<0.001	<0.001	<0.001	<0.001	<0.002	0.0032	<0.001	<0.001	<0.001	<0.001	<0.001	<0.003
MW-14	10/23/2013	<0.05	<0.001	<0.001	<0.001	<0.002	<0.001	<0.001	<0.001	<0.001	<0.002	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.003
MW-15	10/24/2013	<0.05	<0.001	<0.001	<0.001	<0.002	<0.001	<0.001	<0.001	<0.001	<0.002	0.0026	<0.001	<0.001	<0.001	<0.001	<0.001	<0.003
MW-16	10/23/2013	<0.05	<0.001	<0.001	<0.001	<0.002	<0.001	<0.001	<0.001	<0.001	<0.002	0.0027	<0.001	<0.001	<0.001	<0.001	<0.001	<0.003
KDHE Tier 2 Values		**0.5**	**0.00844**	**0.005**	**0.044**	**4.92**	**0.005**	--	**0.7**	**0.451**	--	--	**0.00111**	**0.0338**	**0.66**	--	**1**	**10**

Notes:

1. GRO = Gasoline-range organics quantified by IOWA OA-1.
2. Volatile organic compounds by U.S. Environmental Protection Agency (EPA) Method 8260B.
3. mg/L (ppm) = Milligrams per liter (parts per million).
4. **Bold** indicates detected concentration above the KDHE screening value.
5. < = Not detected above the method reporting limit (MRL).
6. -- = A KDHE Tier 2 Risk Based Screening Values has not been established.
7. KDHE Tier 2 Screening Values from the *Risk-Based Standards for Kansas, 5th Edition* , October 2010.

Table 6
Groundwater Analytical Results – Irrigation Wells
Andover Colt Court Release Site
Andover, Kansas

Well Location	Sample Date	GRO	1,2,4 Trimethylbenzene	1,2 Dichloroethane	1,3,5- Trimethylbenzene	2-Butanone	Benzene	Cyclohexane	Ethylbenzene	Isopropylbenzene	m,p-Xylene	Methylcyclohexane	Naphthalene	n-Butylbenzene	n-Propylbenzene	o-Xylene	Toluene	Total Xylenes
		Concentrations in mg/L (ppm)																
2005 N Colt Ct	7/26/2013	**6.6**	0.16	<0.005	0.045	0.019	**0.47**	0.09	0.13	<0.005	0.27	0.014	**0.027**	<0.005	0.013	0.17	0.34	0.44
	10/24/2013	**4.2**	0.14	<0.001	0.022	<0.002	**0.31**	0.073	0.19	0.0055	0.27	0.012	**0.023**	0.0039	0.017	0.15	0.35	0.42
2002 N Colt Ct	7/26/2013	<0.05	<0.001	<0.001	<0.001	<0.002	0.0047	<0.001	<0.001	<0.001	<0.002	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.003
	10/24/2013	<0.05	<0.001	<0.001	<0.001	<0.002	<0.0010	<0.001	<0.001	<0.001	<0.002	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.003
DUP	10/24/2013	<0.05	<0.001	<0.001	<0.001	<0.002	<0.0010	<0.001	<0.001	<0.001	<0.002	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.003
HOA-1	8/20/2013	<0.05	<0.001	<0.001	<0.001	<0.002	<0.001	<0.001	<0.001	<0.001	<0.002	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.003
	10/25/2013	<0.05	<0.001	<0.001	<0.001	<0.002	<0.001	<0.001	<0.001	<0.001	<0.002	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.003
HOA-2	10/31/2013	<0.05	<0.001	<0.001	<0.001	<0.002	<0.001	<0.001	<0.001	<0.001	<0.002	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.003
2007 N Colt Ct	7/26/2013	**0.71**	0.018	<0.001	0.0061	<0.002	**0.14**	0.018	0.01	0.0014	0.025	0.002	**0.0052**	<0.001	0.002	0.024	0.045	0.048
	10/25/2013	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
2019 N Ruger Cir	8/9/2013	0.42	<0.001	<0.001	<0.001	<0.002	**0.085**	0.026	0.0034	0.0013	0.0046	0.0035	**0.0021**	<0.001	0.0016	0.0034	0.017	0.0081
	10/25/2013	0.28	0.0.15	<0.001	<0.001	<0.002	**0.13**	0.0084	0.0062	<0.0010	<0.0020	0.0030	0.0010	<0.001	<0.001	<0.001	0.0011	<0.003
2020 N Ruger Cir	7/26/2013	<0.05	<0.001	<0.001	<0.001	<0.002	0.0015	<0.001	<0.001	<0.001	<0.002	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.003
	10/25/2013	<0.05	<0.001	<0.001	<0.001	<0.002	<0.001	<0.001	<0.001	<0.001	<0.002	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.003
2028 N Ruger Cir	8/20/2013	0.47	<0.001	<0.001	<0.001	<0.002	**0.011**	0.042	<0.001	<0.001	<0.002	0.0051	<0.001	<0.001	<0.001	<0.001	<0.001	<0.003
	10/25/2013	<0.05	<0.001	<0.001	<0.001	0.015	<0.001	<0.001	<0.001	<0.001	<0.002	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.003
2032 N Ruger Cir	8/20/2013	<0.05	<0.001	<0.001	<0.001	<0.002	<0.001	<0.001	<0.001	<0.001	<0.002	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.003
	10/25/2013	<0.05	<0.001	<0.001	<0.001	<0.002	<0.001	<0.001	<0.001	<0.001	<0.002	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.003
2021 N Ruger Ct	8/28/2013	<0.050	<0.0010	<0.0010	<0.0010	<0.0020	<0.0010	<0.0010	<0.0010	<0.0010	<0.0020	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0030
	10/25/2013	<0.050	<0.0010	<0.0010	<0.0010	<0.0020	<0.0010	<0.0010	<0.0010	<0.0010	<0.0020	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0030
2025 N Ruger Ct	8/28/2013	<0.050	0.0028	<0.0010	0.0012	<0.0020	<0.0010	<0.0010	<0.0010	<0.0010	<0.0020	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0030
	10/25/2013	<0.050	<0.0010	<0.0010	<0.0010	<0.0020	<0.0010	<0.0010	<0.0010	<0.0010	<0.0020	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0030
1009 W Mountain	8/20/2013	<0.05	<0.001	<0.001	<0.001	<0.002	<0.001	<0.001	<0.001	<0.001	<0.002	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.003
	10/24/2013	<0.05	<0.001	<0.001	<0.001	<0.002	<0.001	<0.001	<0.001	<0.001	<0.002	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.003
2007 N Mountain Ct	10/24/2013	<0.05	<0.001	<0.001	<0.001	<0.002	<0.001	<0.001	<0.001	<0.001	<0.002	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.003
2009 N Mountain Ct	8/20/2013	<0.05	<0.001	<0.001	<0.001	<0.002	<0.001	<0.001	<0.001	<0.001	<0.002	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.003
	10/24/2013	<0.05	<0.001	<0.001	<0.001	<0.002	<0.001	<0.001	<0.001	<0.001	<0.002	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.003
1211 W Quail Crossing Ct	8/20/2013	<0.05	<0.001	<0.001	<0.001	<0.002	<0.001	<0.001	<0.001	<0.001	<0.002	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.003
	10/25/2013	<0.05	<0.001	<0.001	<0.001	<0.002	<0.001	<0.001	<0.001	<0.001	<0.002	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.003
1910 N Quail Crossing	10/24/2013	<0.05	<0.001	<0.001	<0.001	<0.002	<0.001	<0.001	<0.001	<0.001	<0.002	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.003
KDHE Tier 2 Values		**0.5**	**0.00844**	**0.005**	**0.044**	**4.92**	**0.005**	**NE**	**0.7**	**0.451**	**NE**	**NE**	**0.00111**	**0.0338**	**0.66**	**NE**	**1**	**10**

Notes:

1. GRO = Gasoline-range organics quantified by IOWA OA-1.
2. Volatile organic compounds by U.S. Environmental Protection Agency (EPA) Method 8260B.
3. mg/L (ppm) = Milligrams per liter (parts per million).
4. **Bold** indicates detected concentration above the KDHE screening value.
5. < = Not detected above the method reporting limit (MRL).
6. NE = A KDHE Tier 2 Risk Based Screening Values has not been established.
7. KDHE Tier 2 Screening Values from the *Risk-Based Standards for Kansas, 5th Edition* , October 2010.
8. Well locations are shown on Figure 2.
9. NS = No sample collected.

Table 7
Soil Vapor Analytical Data
Andover Colt Court Release Site
Andover, Kansas

Sample Location	Sample Date	1,2 Dichloroethane	Benzene	Toluene	Ethylbenzene	Total Xylenes	1,3,5 Trimethylbenzene	1,2,4 Trimethylbenzene	Naphthalene
		Concentrations in ug/m^3 (micrograms per cubic meter)							
VP-1	9/24/2013	<0.61	3.8	<0.57	5.6	22.4	2.4	5.5	<10.48
VP-2	9/24/2013	<0.61	<0.48	0.60	<0.65	<1.30	<0.74	<0.74	<10.48
VP-3	9/24/2013	12	5.5	67	4.8	28	3.2	9.6	<10.48
KDHE Tier 2 Screening Value		**93.6**	**312**	**521,000**	**973**	**10,400**	**3,650**	**730**	**71.6**

Notes:

1. 1,2-Dichloroethane, benzene, toluene, ethylbenzene, total xylenes, 1,3,5 trimethylbenzene, 1,2,4 trimethylbenzene, and naphthalene by Environmental Protection Agency (EPA) Method TO-15.
2. ug/m^3 (ppm) = Micrograms per cubic meter.
3. < = Not detected above the method reporting limit (MRL).
4. KDHE Tier 2 Screening Values from the *Risk-Based Standards for Kansas, 5th Edition*, October 2010 (adjusted with KDHE attenuation factor - 0.01).

Table 8
Proposed Groundwater Monitoring Program - Monitoring Wells
Andover Colt Court Release Site
Andover, Kansas

Well ID	Gauging	GRO	VOCs
MW-1	M	Q	Q
MW-2	M	Q	Q
MW-3	M	Q	Q
MW-4	M	Q	Q
MW-5	M	Q	Q
MW-6	M	Q	Q
MW-7	M	Q	Q
MW-8	M	Q	Q
MW-9	M	Q	Q
MW-10	M	Q	Q
MW-11	M	Q	Q
MW-12	M	Q	Q
MW-13	M	Q	Q
MW-14	M	Q	Q
MW-15	M	Q	Q
MW-16	M	Q	Q

Notes:

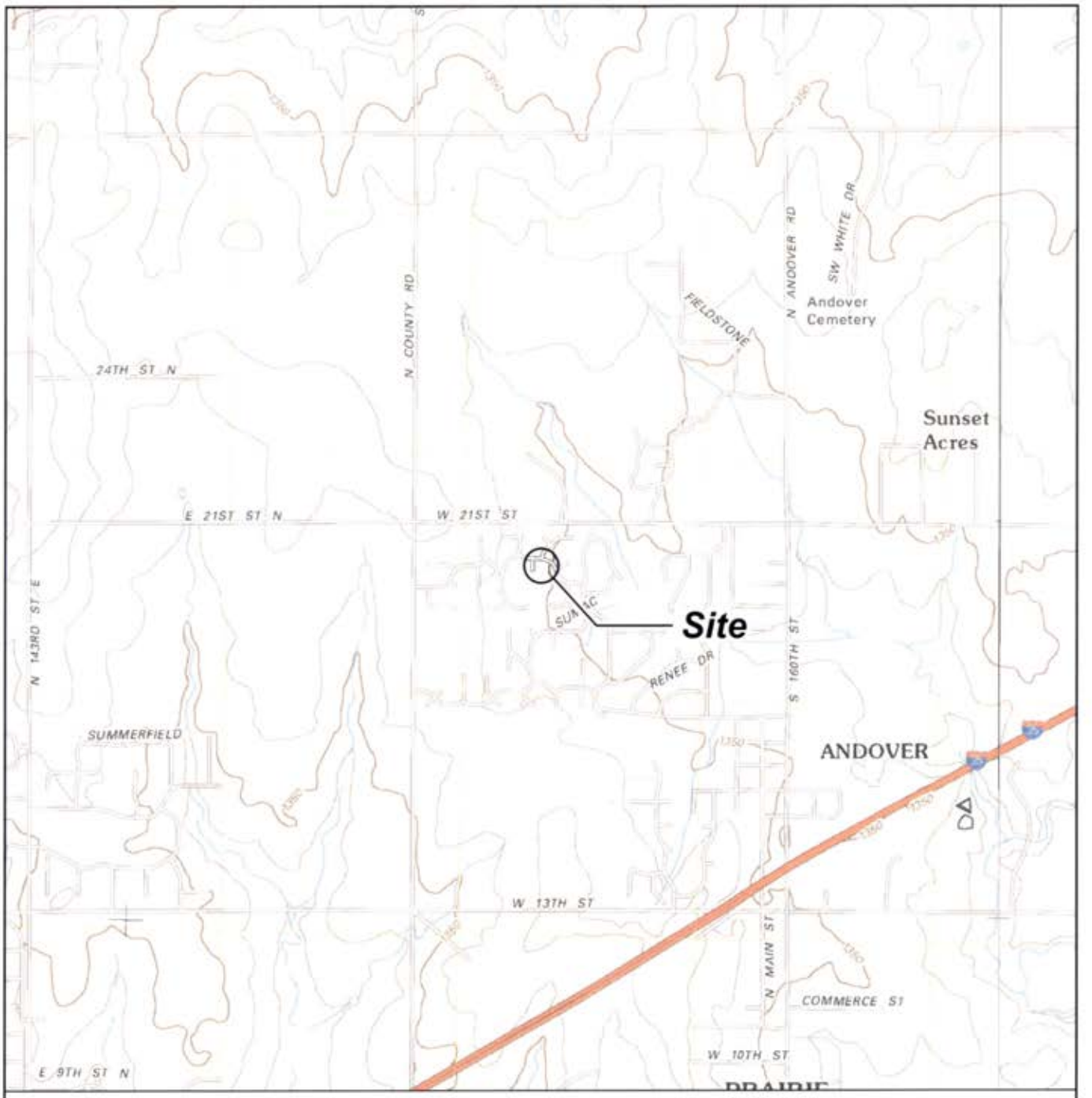
1. GRO = Gasoline-range organics quantified by IOWA OA-1.
2. VOCs = Volatile organic compounds; benzene, toluene, ethylbenzene, xylenes [BTEX], 1,2-dicholoethane, naphthalene, 1,2,4-trimethylbenzene, 1,3,5-trimethylbenzene, n-butylbenzene, and n-propylbenzene by U.S. Environmental Protection Agency Method 8260B.
3. Q = Performed quarterly.
4. M = Performed monthly.
5. Monitoring wells will not be sampled if SPH are present.

Table 9
Proposed Groundwater Monitoring Program - Irrigation Wells
Andover Colt Court Release Site
Andover, Kansas

Well Location	Well Status (Deactivated or Not Currently in Use)	GRO	VOCs
2001 N Colt Ct	Not Currently in Use	Q	Q
2002 N Colt Ct	Deactivated	Q	Q
2005 N Colt Ct	Deactivated	Q	Q
2006 N Colt Ct	Deactivated	Q	Q
HOA-1	Not Currently in Use	Q	Q
HOA-2	Not Currently in Use	Q	Q
2007 N Colt Ct	Deactivated	Q	Q
2019 N Ruger Cir	Not Currently in Use	Q	Q
2020 N Ruger Cir	Not Currently in Use	Q	Q
2028 N Ruger Cir	Deactivated	Q	Q
2032 N Ruger Cir	Deactivated	Q	Q
2021 N Ruger Ct	Not Currently in Use	Q	Q
2025 N Ruger Ct	Not Currently in Use	Q	Q
1009 W Mountain	Not Currently in Use	Q	Q
2007 N Mountain Ct	Not Currently in Use	Q	Q
2009 N Mountain Ct	Not Currently in Use	Q	Q
1211 W Quail Crossing Ct	Not Currently in Use	Q	Q
1910 N Quail Crossing	Not Currently in Use	Q	Q

Notes:

1. GRO = Gasoline-Range Organics quantified by IOWA OA-1.
2. VOCs = Volatile Organic Compounds (VOCs); benzene, toluene, ethylbenzene, xylenes [BTEX], 1,2-dichloroethane, naphthalene, 1,2,4-trimethylbenzene, 1,3,5-trimethylbenzene, n-butylbenzene, and n-propylbenzene by U.S. Environmental Protection Agency Method 8260B.
3. Q = Performed quarterly.
4. Well locations are shown on Figure 2.



Note: Base map prepared from USGS 7.5-minute quadrangles of Andover and Santa Fe Lake, KS, dated 2009 as provided by USGS.gov.

0 2,000 4,000

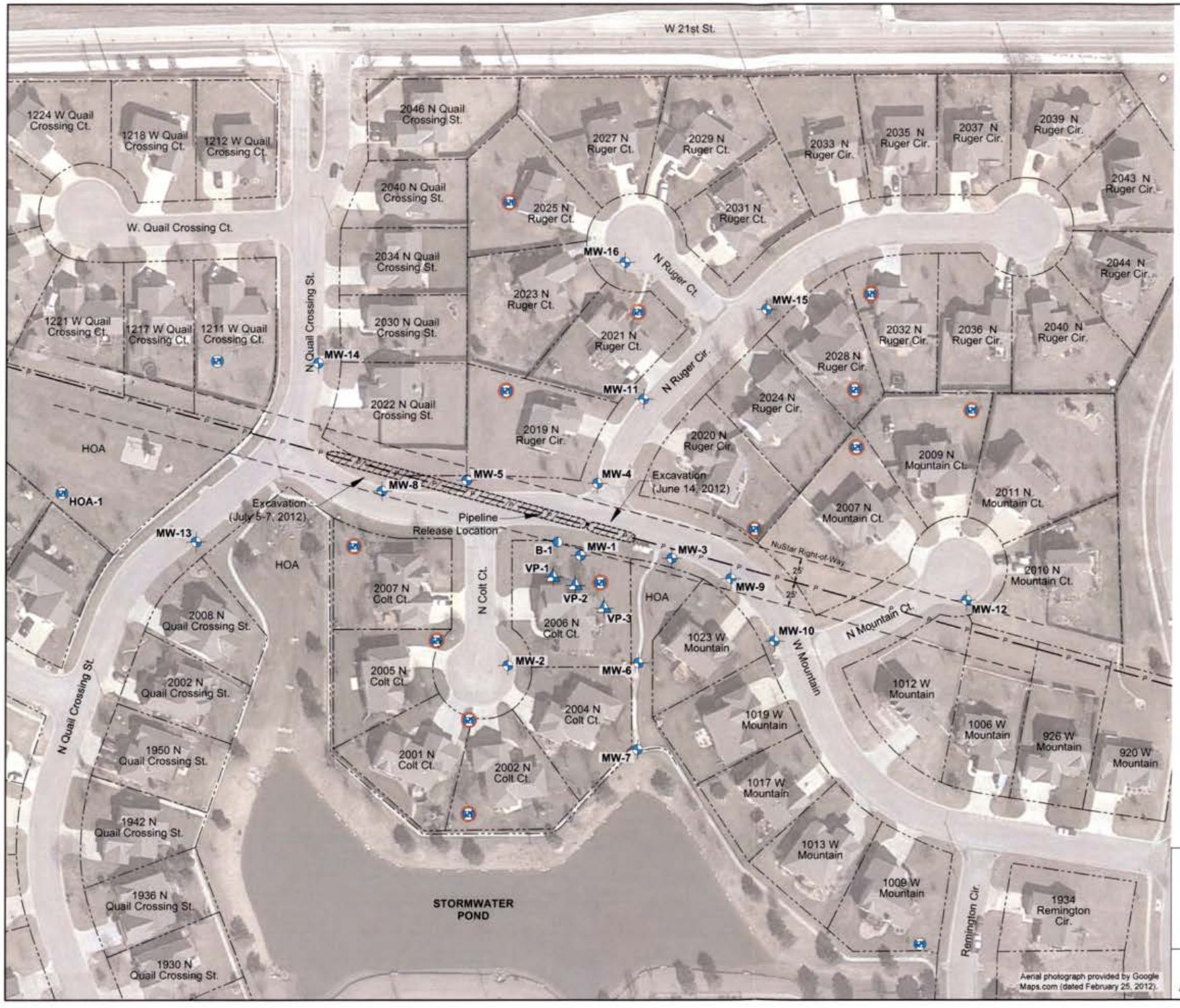
Approximate Scale in Feet

N

Site Location Map

Comprehensive Investigation Report
NuStar Pipeline Operating Partnership L.P.
Andover, Kansas

Apex Companies, LLC 3015 SW First Avenue Portland, Oregon 97201	Project Number	1641-04	Figure 1
	April 2014		



Site Plan and Sampling Location Map

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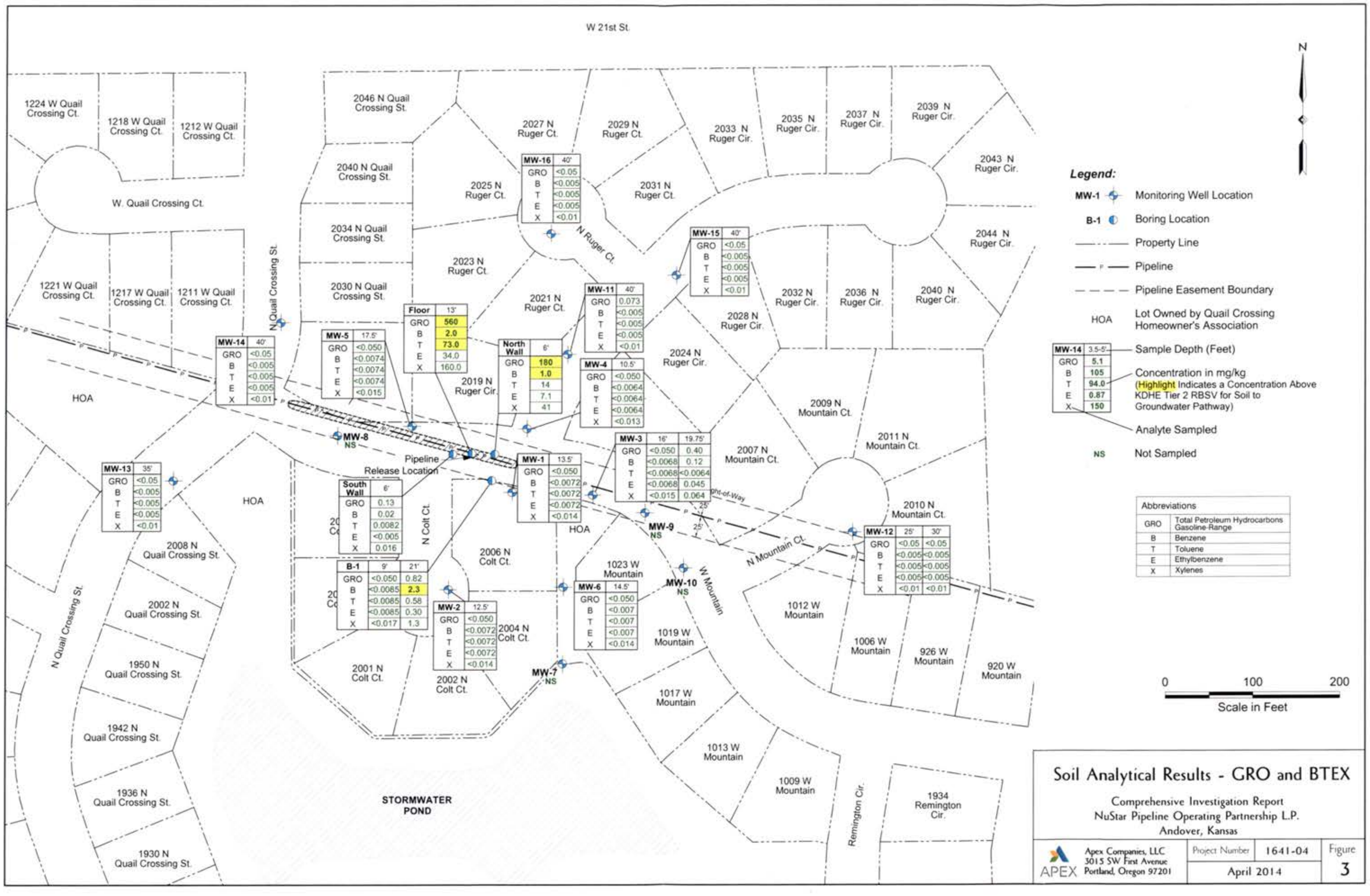
Andover, Kansas

Apex Companies, LLC 3015 SW First Avenue Portland, Oregon 97201	Project Number	1641-04	Figure 2
	April 2014		



Soil Analytical Results - GRO and BTEX

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NuStar Pipeline Operating Partnership L.P.
Andover, Kansas

Apex Companies, LLC
3015 SW First Avenue
Portland, Oregon 97201

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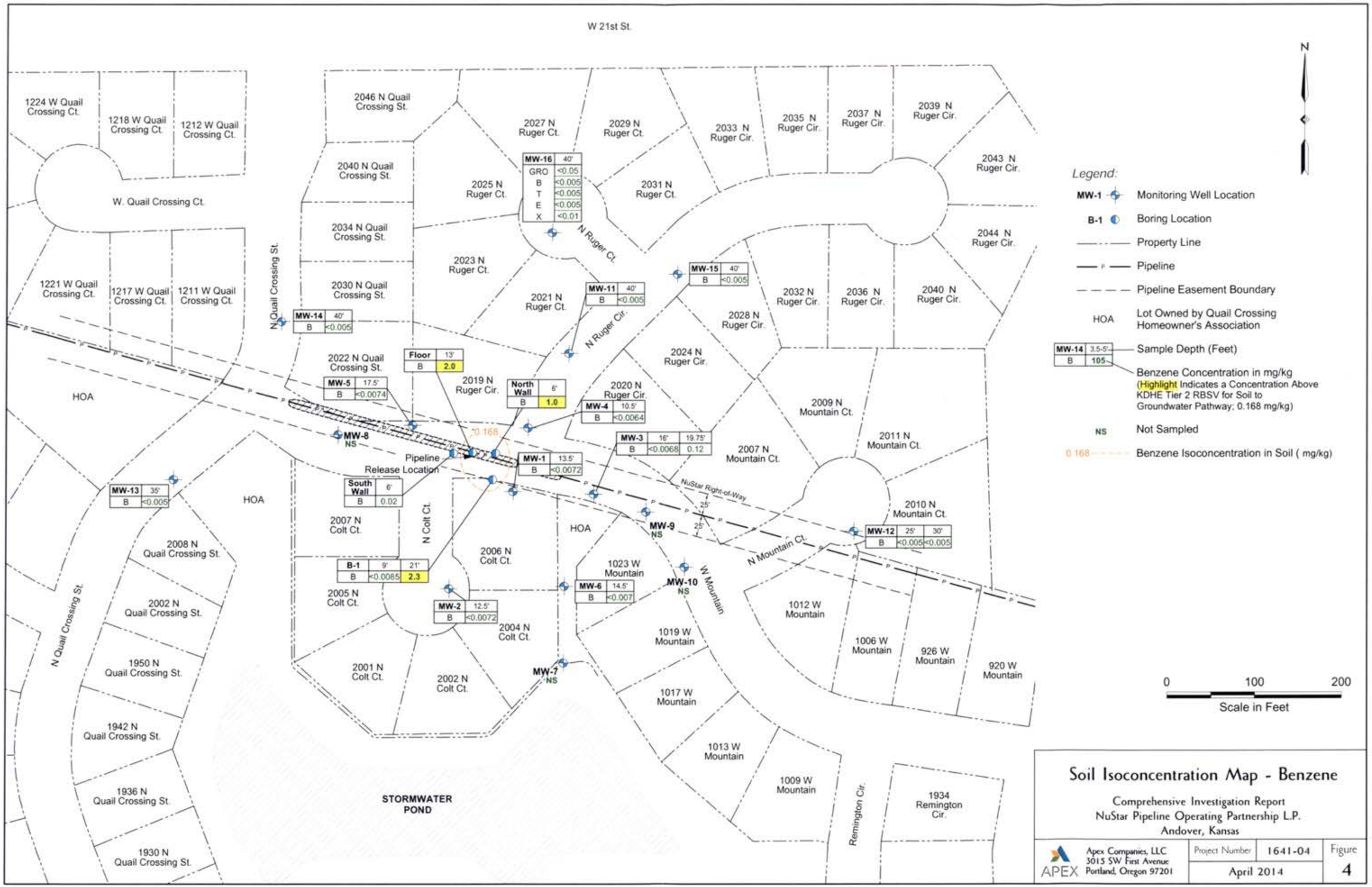
Figure 3



Soil Isoconcentration Map - Benzene

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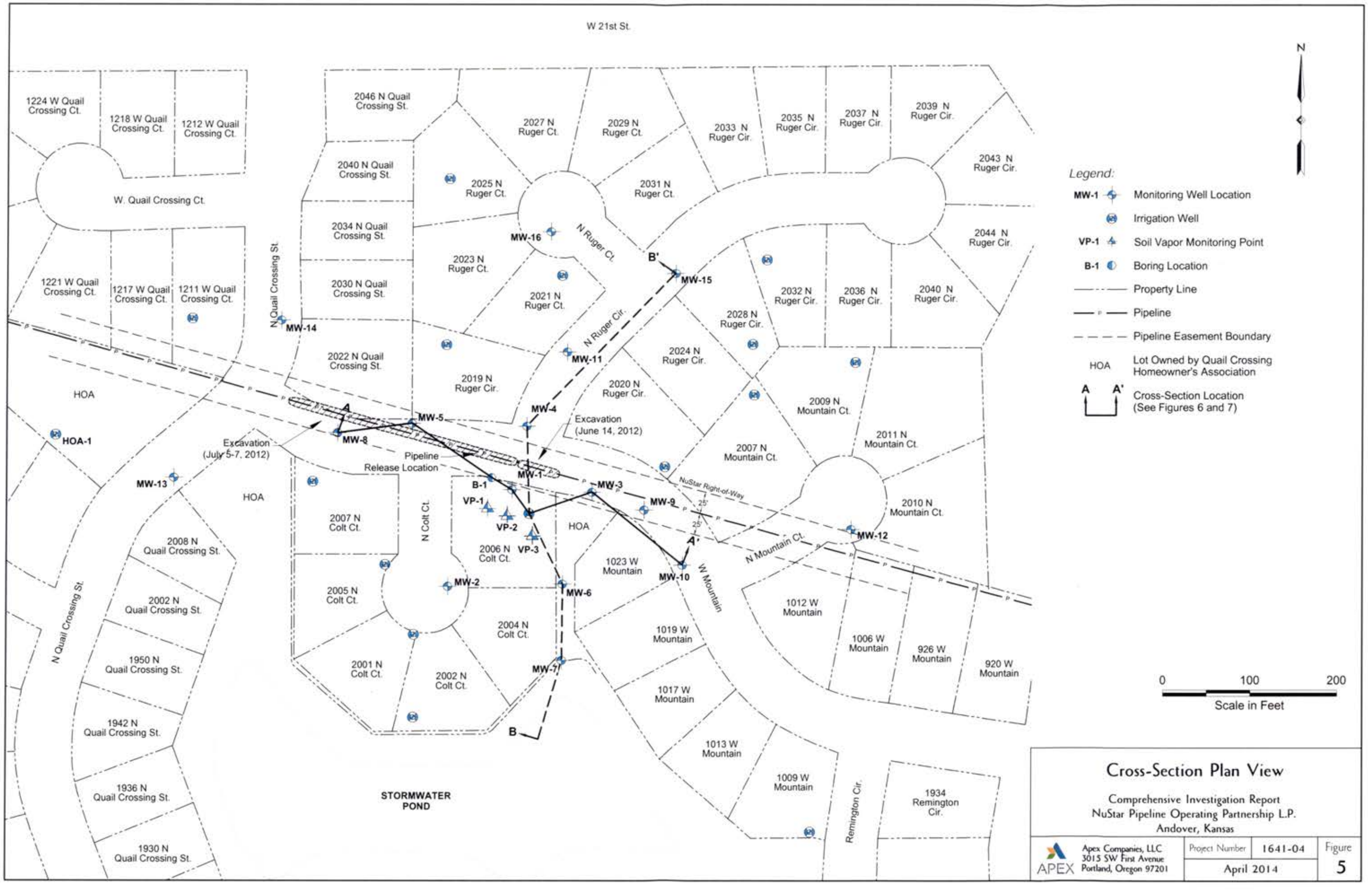
NuStar Pipeline Operating Partnership L.P.
Andover, Kansas

Apex Companies, LLC 3015 SW First Avenue Portland, Oregon 97201	Project Number	1641-04	Figure 4
	April 2014		



Cross-Section Plan View

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NuStar Pipeline Operating Partnership L.P.
Andover, Kansas

Apex Companies, LLC 3015 SW First Avenue Portland, Oregon 97201	Project Number	1641-04	Figure 5
	April 2014		

A (West)

A' (East)

Elevation Above Mean Sea Level (MSL) (Feet)

1,350
1,345
1,340
1,335
1,330
1,325

1,350
1,345
1,340
1,335
1,330
1,325
1,320
1,315

Well Construction Details:

- Cement Surface Seal
- Bentonite Seal
- Sand Filter Pack
- Gravel Filter Pack

MW-8 (TOC 1353.38)
MW-5 (TOC 1352.77)
B-1
MW-1 (TOC 1352.13)
Irrigation Water Well 2006 N Colt Court
MW-3 (TOC 1350.47)
MW-10 (TOC 1348.79)

Pipeline Release Location*

Excavation July 5-7, 2012*

NuStar Pipeline*

CLAY and Silty CLAY

Screen 15' to 30'
Screen 15' to 30'
Screen 20' to 35'
Screen 19' to 34'
Screen 40' to 116'
Screen 40' to 60'

Water Level (10/23/13)
Water Level (10/23/13)
Water Level (10/23/13)
Water Level (10/23/13)
Water Level = 48.71' (10/24/13)

Depth to Water At Time of Drilling (April 6, 2011; 40 ft bgs)

Light gray and green silty SHALE with Limestone and Gypsum beds (Wellington Formation)

Total depth 32'
Total depth 32'
Total depth 37'
Total depth 35'
Total depth 116'
Total depth 60'

0 40 80
Horizontal Scale in Feet
8X Vertical Exaggeration

0 5 10
Vertical Scale in Feet

Legend:

- MW-1 — Monitoring Well Identification
- Monitoring Well Location
- Refusal with Push-Probe/ Hard Drilling
- Screened Interval
- B-1 — Boring Identification
- Boring Location
- Soil Sample Collected (Constituent Concentrations > KDHE Tier 2 Risk-Based Screening Values [RBSVs])
- Soil Sample Collected (Constituent Concentrations < KDHE Tier 2 RBSVs)
- Water Sample Collected (Constituent Concentrations > KDHE Tier 2 RBSVs [October/November 2013]
- Water Sample Collected (Constituent Concentrations < KDHE Tier 2 RBSVs) [October/November 2013]

* A spatial offset was included for these features, which are presented for illustration purposes.

Note: Monitoring well logs are based on soil cuttings from air rotary or solid stem auger drill rig.

Cross-Section A-A'

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Apex Companies, LLC
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Project Number	1641-04	Figure
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B (South)

B' (North)

MW-7 (TOC 1348.98)

MW-6 (TOC 1349.76)

Irrigation Water Well 2006 N Colt Court

MW-4 (TOC 1349.48)

MW-15 (TOC 1351.79)

Actual Distance from MW-4 to MW-15 (248')

Elevation Above Mean Sea Level (MSL) (Feet)

1,350

1,345

1,340

1,335

1,330

1,325

1,320

1,315

Pond Surface Elevation (11/26/13)

Stormwater Pond

Recharge Zone

Water Level (11/26/13)

Screen 9' to 24'

Sampled on 10/24/13

Total depth 25'

CLAY and Silty CLAY

Sampled on 7/23/13

Water Level (11/26/13)

Screen 26' to 41'

Sampled on 10/24/13

Total depth 44'

Depth to Water At Time of Drilling (April 6, 2011; 40 ft bgs)

Screen 40' to 116'

Water Level = 40.30' (11/26/13)

Total depth 116'

Irrigation Water Well 2006 N Colt Court

NuStar Pipeline (Alignment is Perpendicular to Cross-Section)

Excavation Extent (Perpendicular to Cross-Section)

Light gray and green silty SHALE with Limestone and Gypsum beds (Wellington Formation)

Regional Water Table (O'Connor et al., 1982)

Sampled on 10/23/13

Sampled on 7/22/13

Screen 26' to 41'

Water Level (11/26/13)

Total depth 43'

CLAY and Silty CLAY

Well Construction Details:

- Cement Surface Seal
- Bentonite Seal
- Sand Filter Pack
- Gravel Filter Pack

Screen 25' to 45'

Water Level (11/26/13)

Sampled on 09/26/13 (40')

Sampled on 10/24/13

Total depth 45'

Legend:

- MW-1 — Monitoring Well Identification
- Monitoring Well Location
- Refusal with Push-Probe/ Hard Drilling
- Screened Interval
- Soil Sample Collected (Constituent Concentrations > KDHE Tier 2 Risk-Based Screening Values [RBSVs])
- Soil Sample Collected (Constituent Concentrations < KDHE Tier 2 RBSVs)
- Water Sample Collected (Constituent Concentrations > KDHE Tier 2 RBSVs)
- Water Sample Collected (Constituent Concentrations < KDHE Tier 2 RBSVs)

Note: Monitoring well logs are based on soil cuttings from air rotary or solid stem auger drill rig.

0 40 80

Horizontal Scale in Feet

8X Vertical Exaggeration

0 5 10

Vertical Scale in Feet

Cross-Section B-B'

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NuStar Pipeline Operating Partnership L.P.
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Apex Companies, LLC
3015 SW First Avenue
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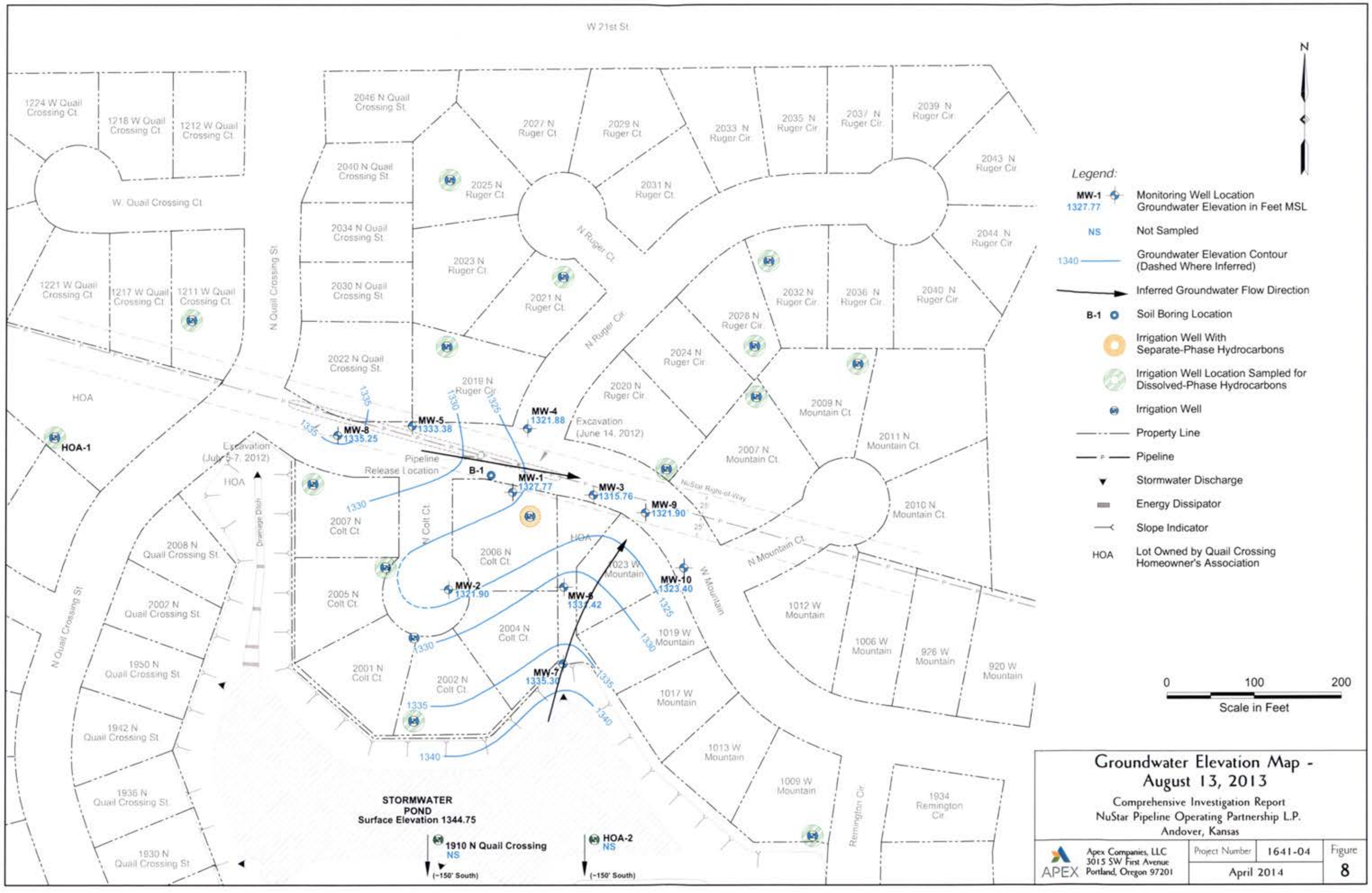
Figure 7



Groundwater Elevation Map - August 13, 2013

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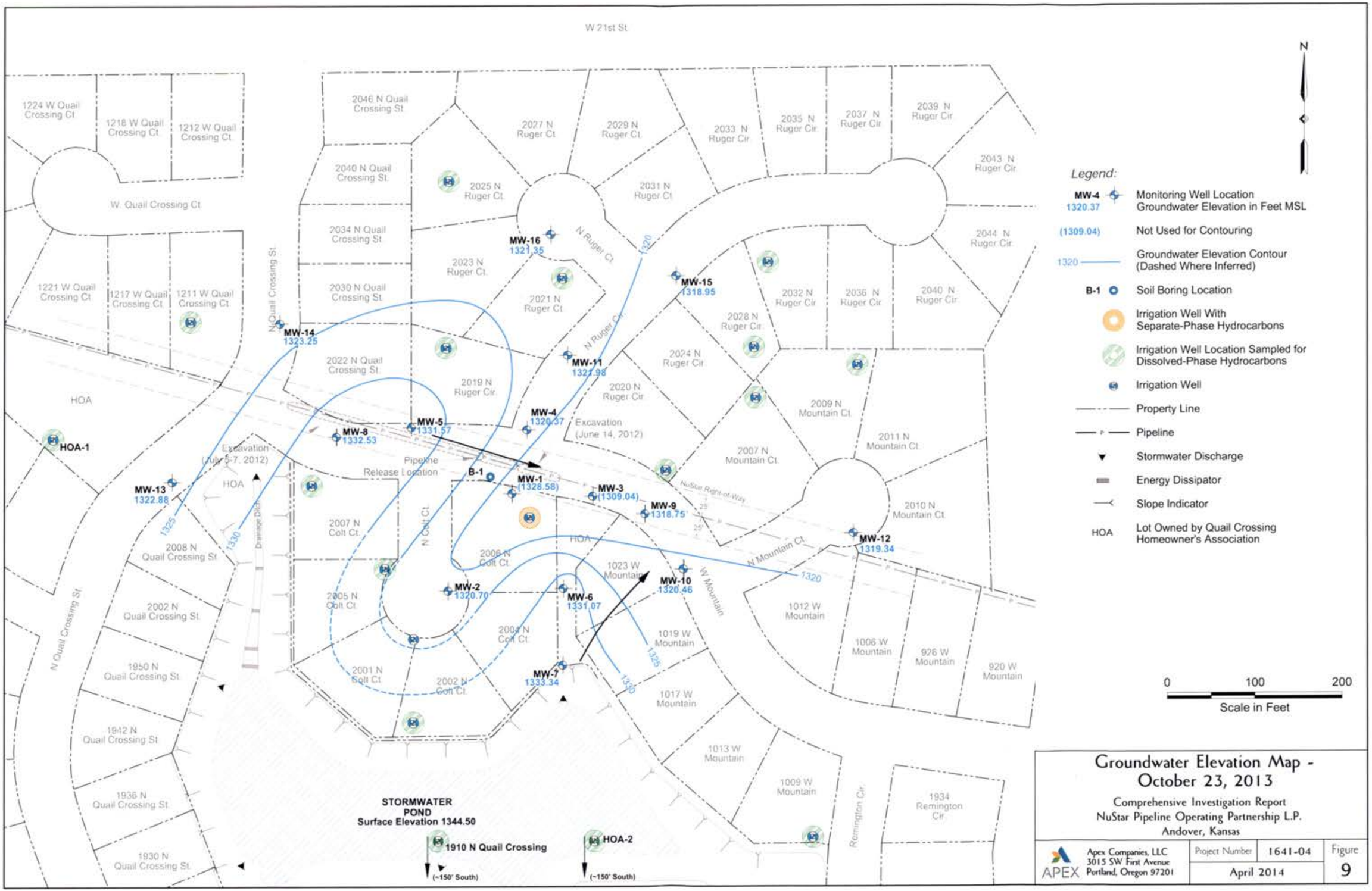
NuStar Pipeline Operating Partnership L.P.
Andover, Kansas

Apex Companies, LLC 3015 SW First Avenue Portland, Oregon 97201	Project Number	1641-04	Figure 8
APEX	April 2014		



Groundwater Elevation Map - October 23, 2013

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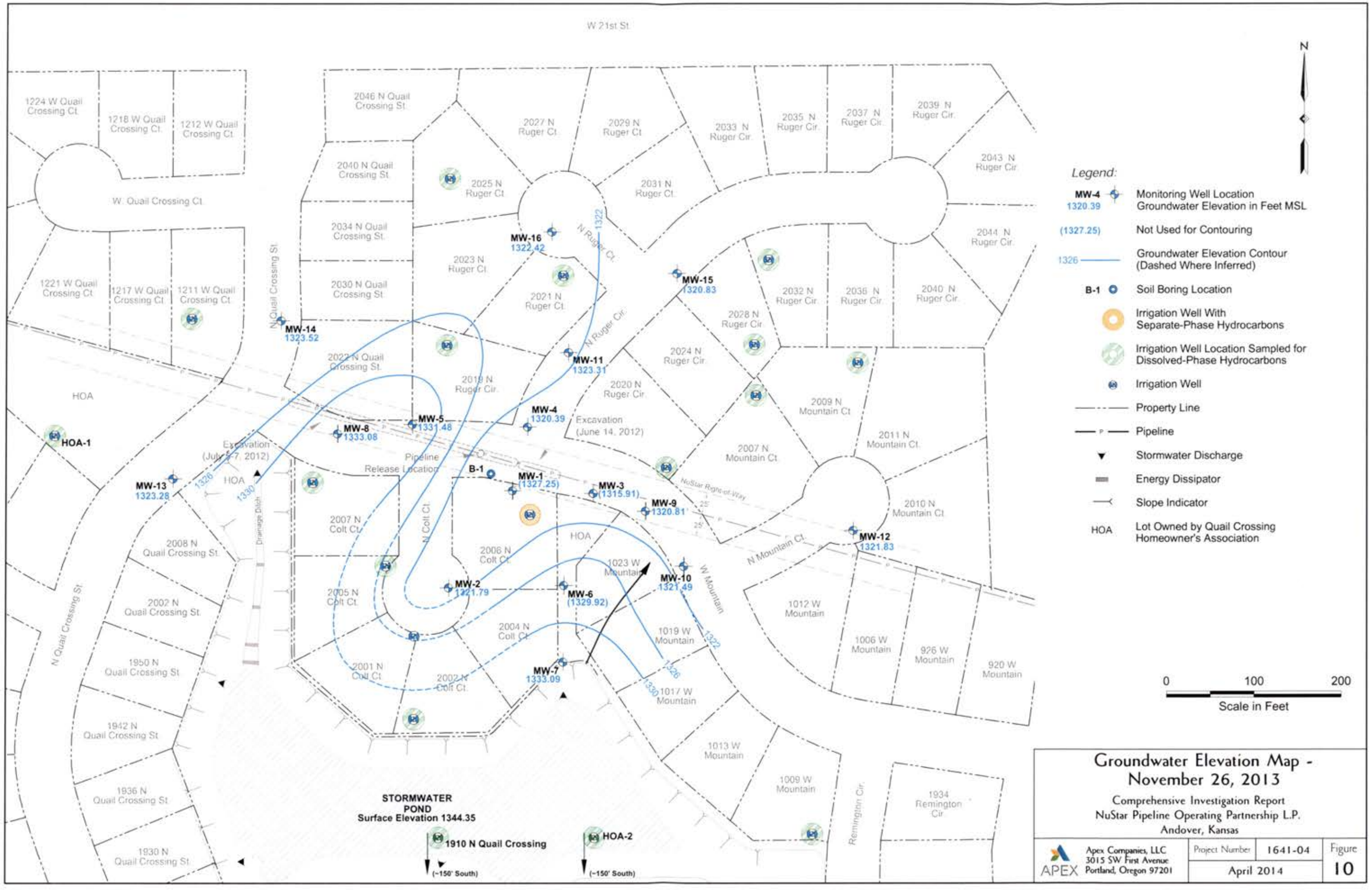
Andover, Kansas

Apex Companies, LLC 3015 SW First Avenue Portland, Oregon 97201	Project Number	1641-04	Figure 9
	April 2014		



Groundwater Elevation Map - November 26, 2013

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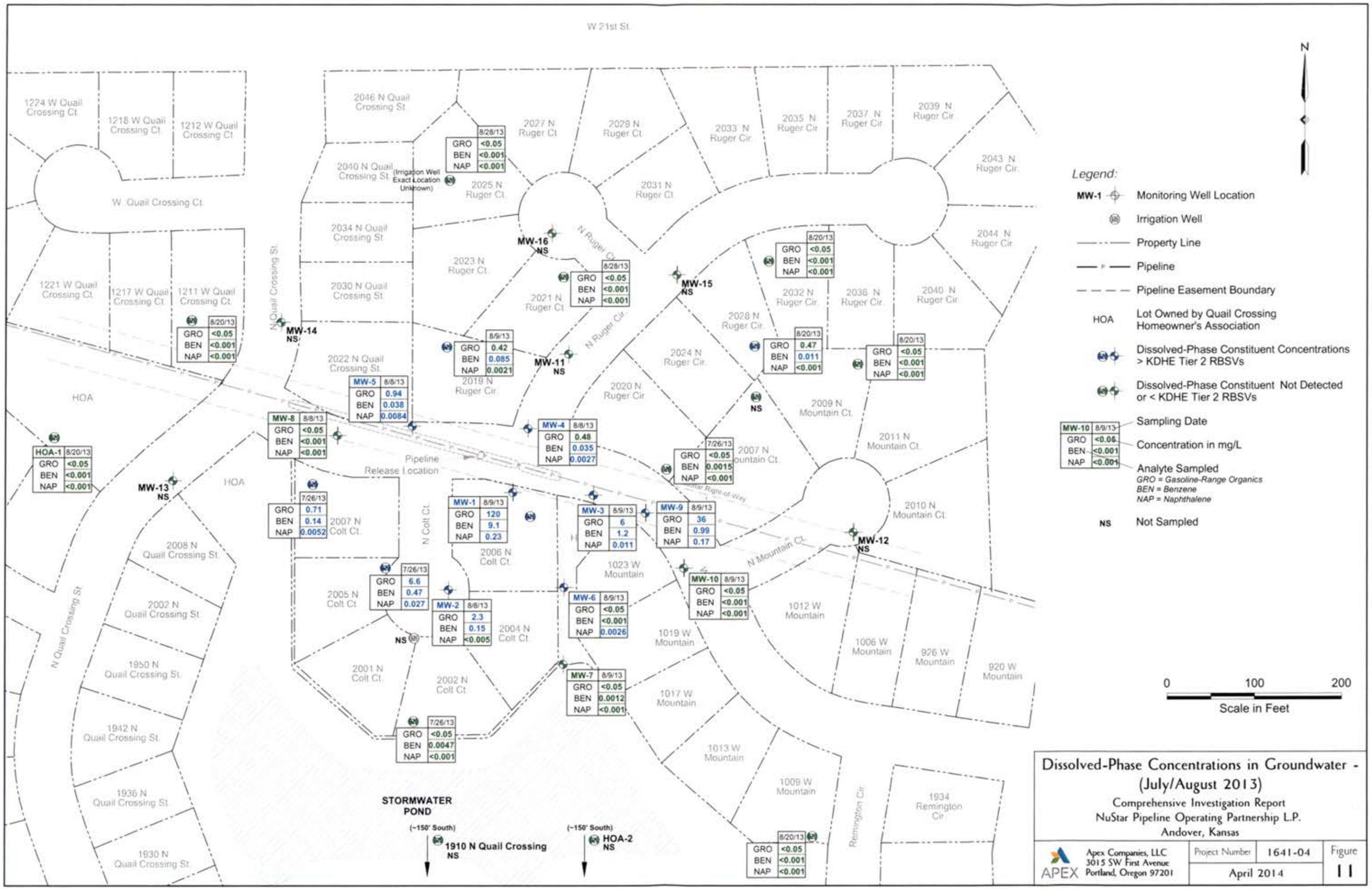
Andover, Kansas

APEX Apex Companies, LLC 3015 SW First Avenue Portland, Oregon 97201	Project Number	1641-04	Figure 10
	April 2014		



Dissolved-Phase Concentrations in Groundwater - (July/August 2013)

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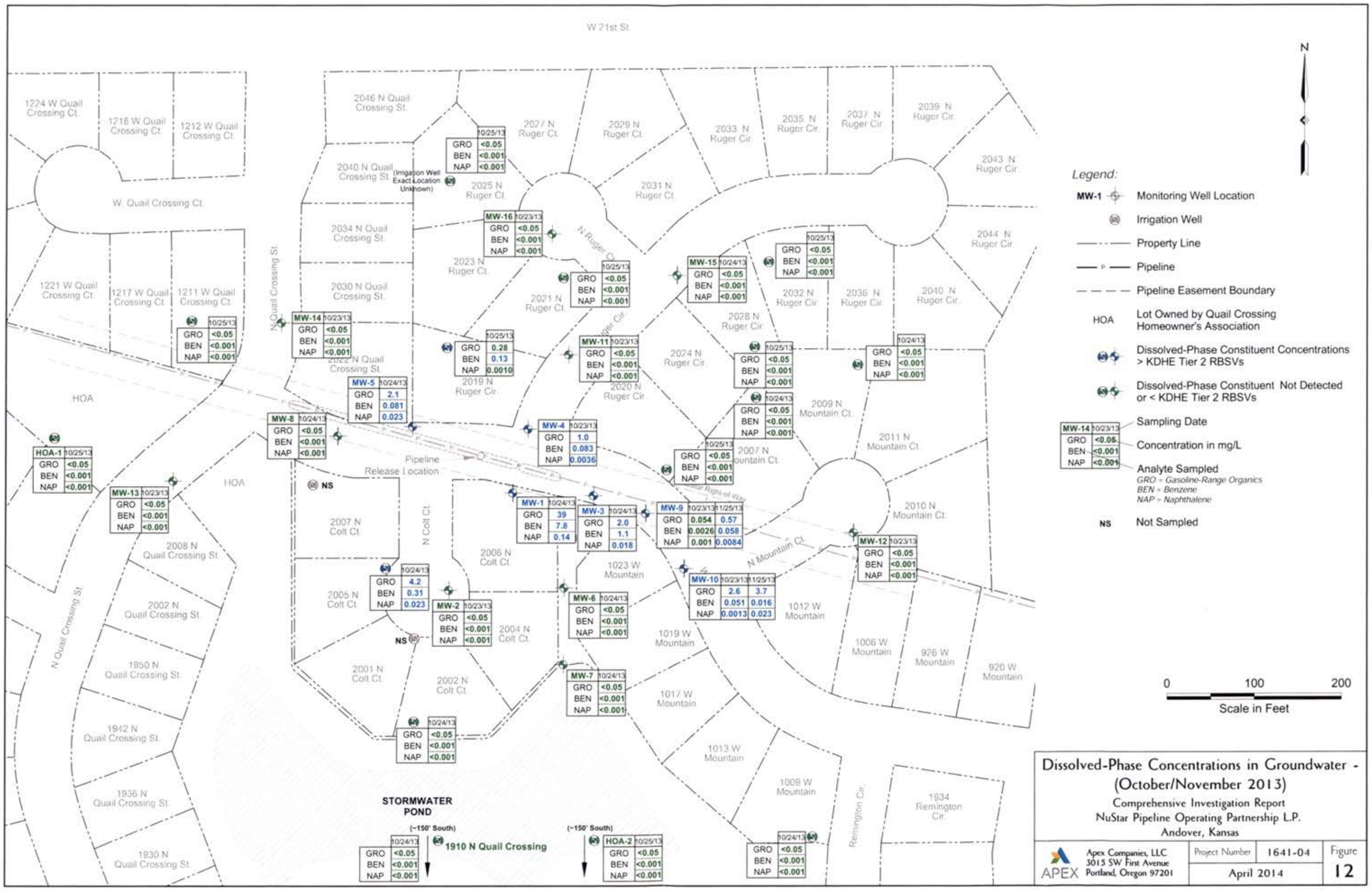
Apex Companies, LLC 3015 SW First Avenue Portland, Oregon 97201	Project Number 1641-04	Figure 11
	April 2014	



Dissolved-Phase Concentrations in Groundwater - (October/November 2013)

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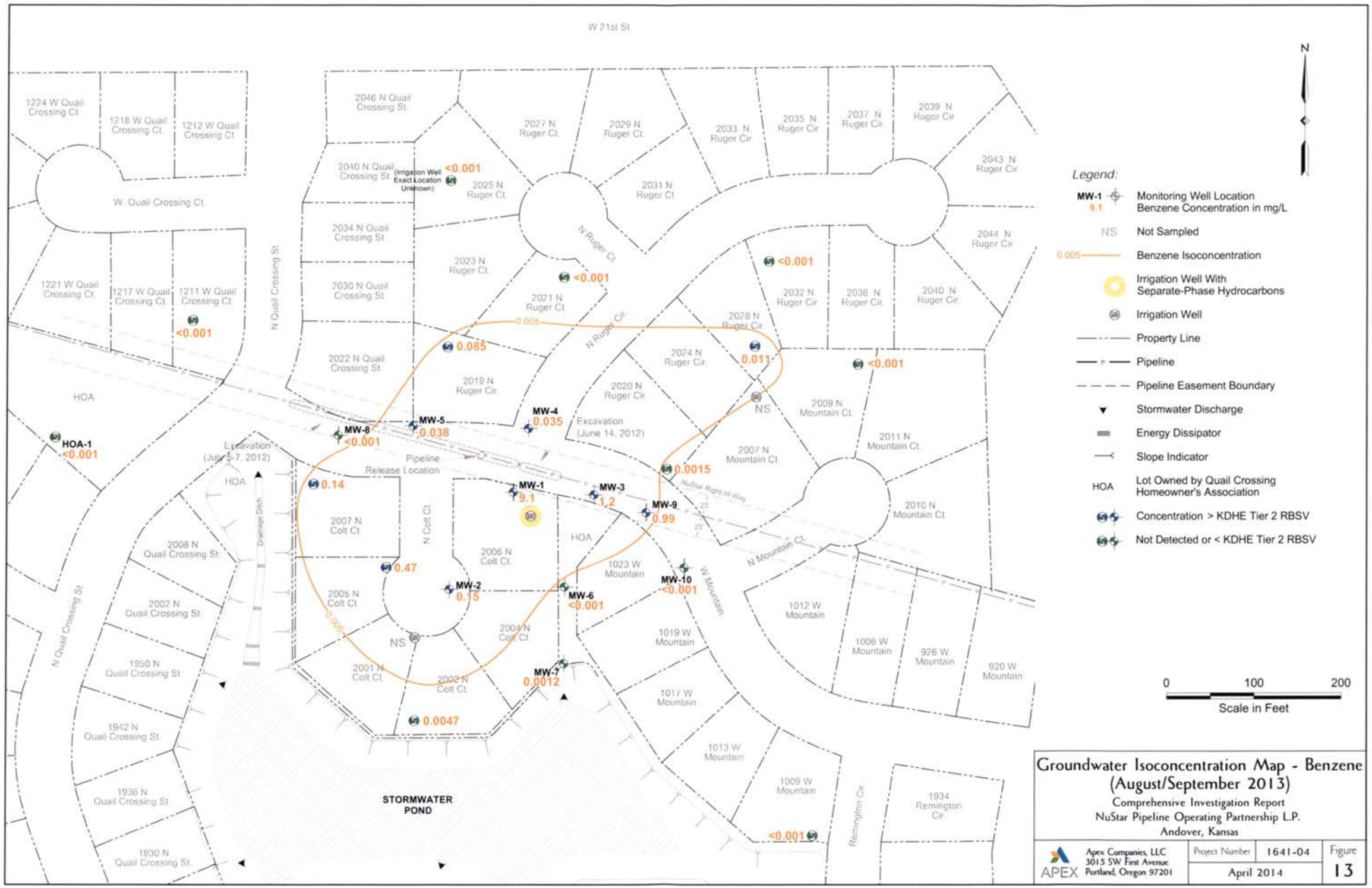
NuStar Pipeline Operating Partnership L.P.
Andover, Kansas

Apex Companies, LLC 3015 SW First Avenue Portland, Oregon 97201	Project Number	1641-04	Figure 12
	April 2014		



Groundwater Isoconcentration Map - Benzene (August/September 2013)

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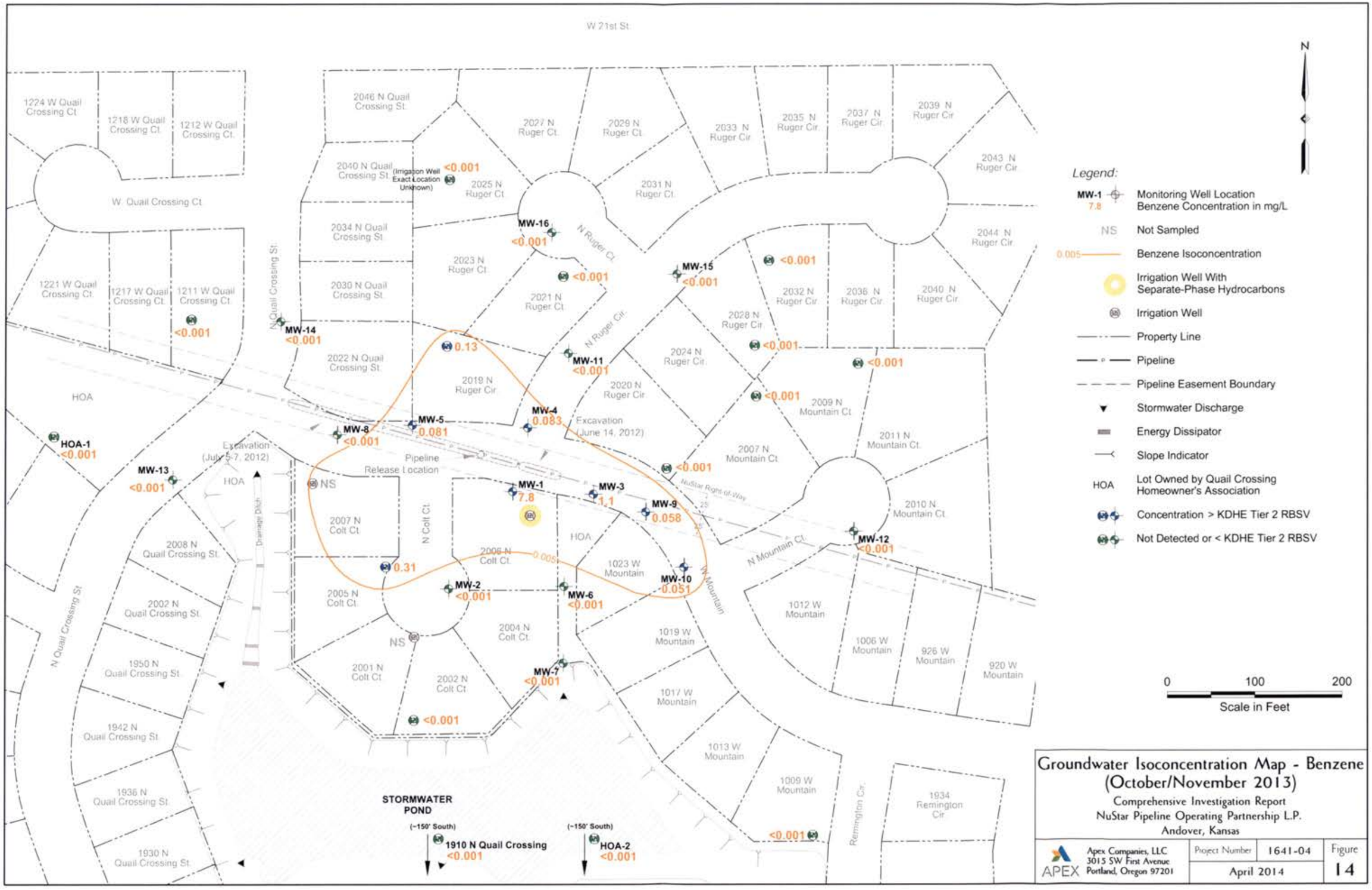
Andover, Kansas

Apex Companies, LLC 3015 SW First Avenue Portland, Oregon 97201	Project Number	1641-04	Figure 13
	April 2014		



Groundwater Isoconcentration Map - Benzene (October/November 2013)

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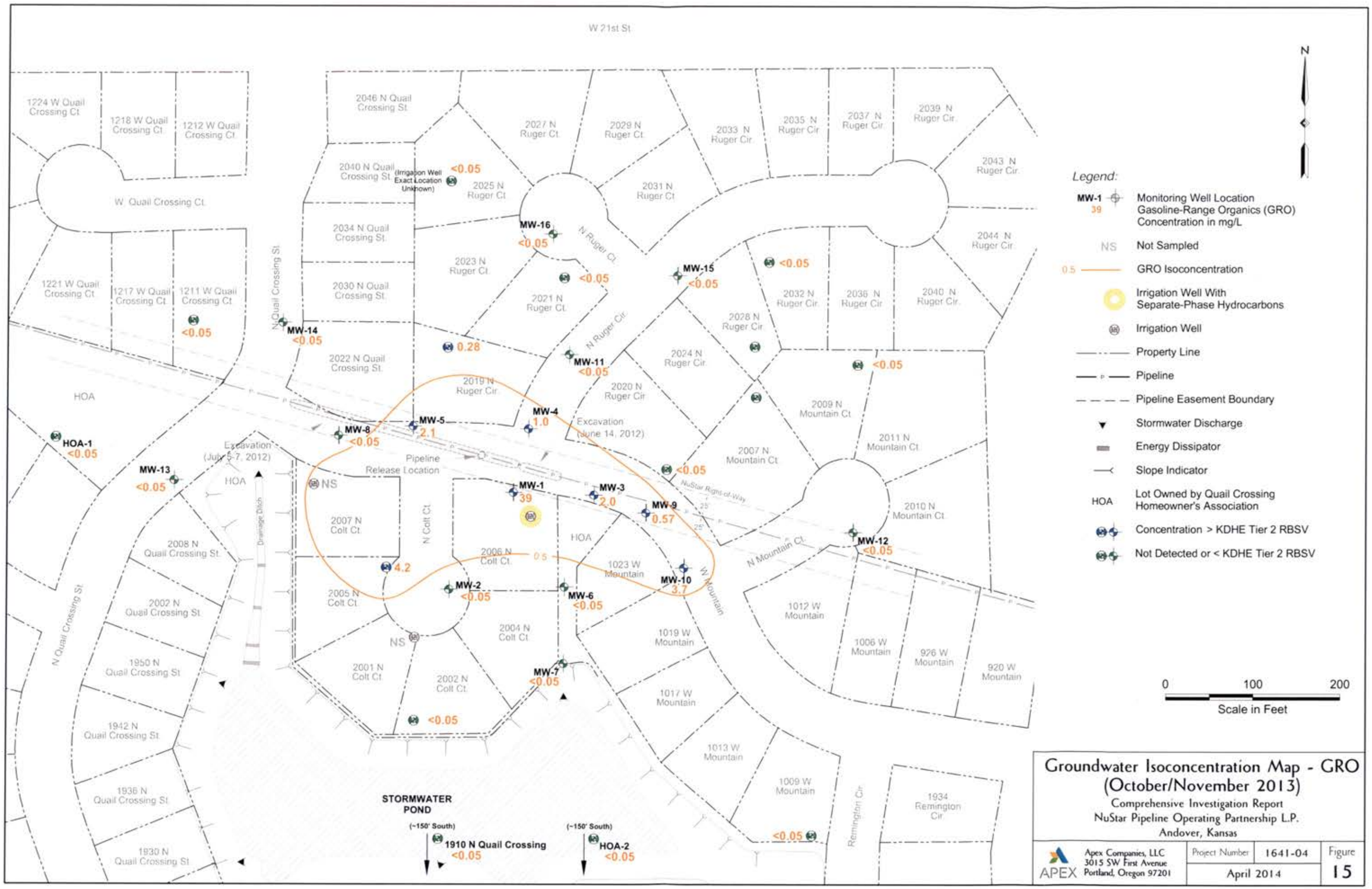
Andover, Kansas

Apex Companies, LLC 3015 SW First Avenue Portland, Oregon 97201	Project Number	1641-04	Figure 14
APEX	April 2014		



Groundwater Isoconcentration Map - GRO (October/November 2013)

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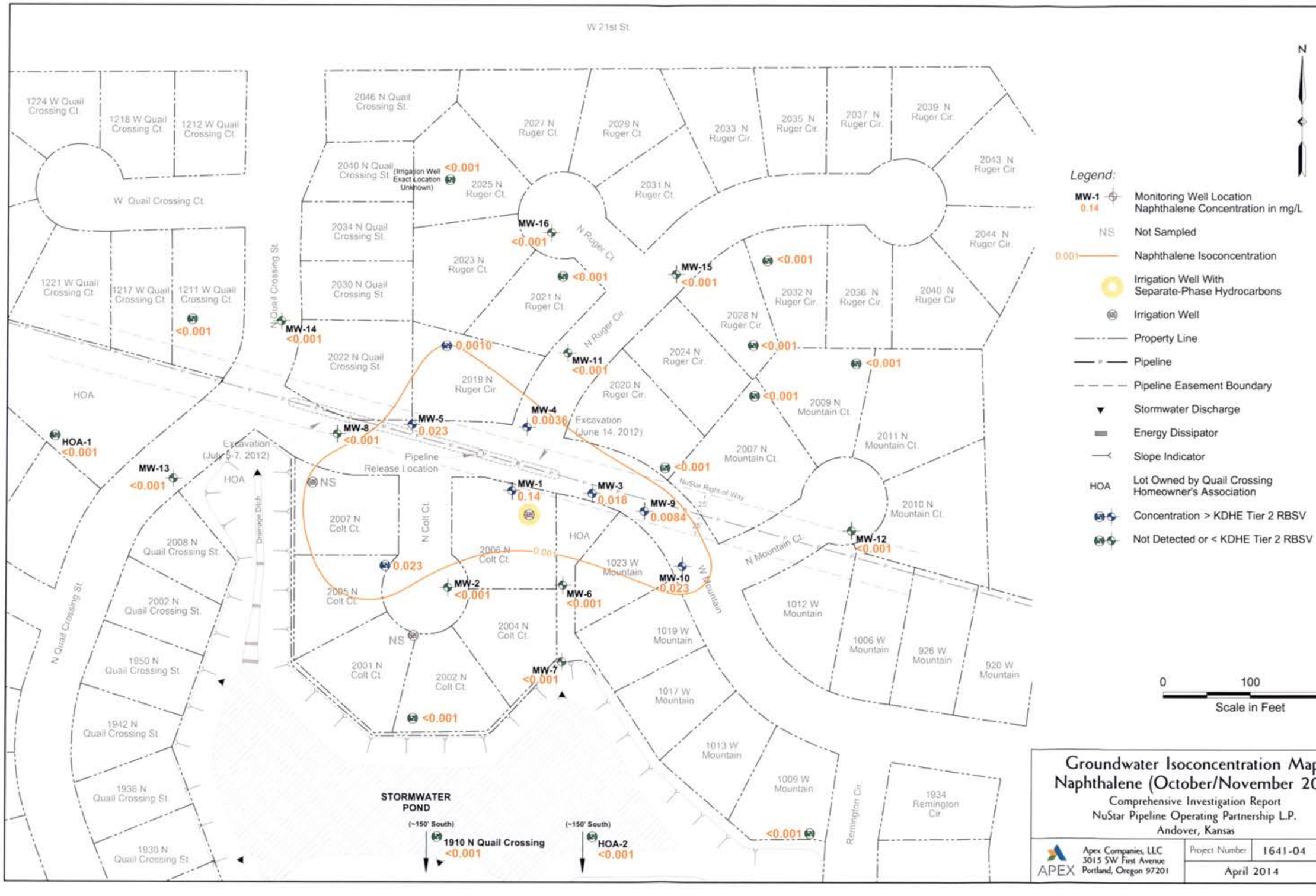
Apex Companies, LLC 3015 SW First Avenue Portland, Oregon 97201	Project Number	1641-04	Figure 15
	April 2014		



Groundwater Isoconcentration Map - Naphthalene (October/November 2013)

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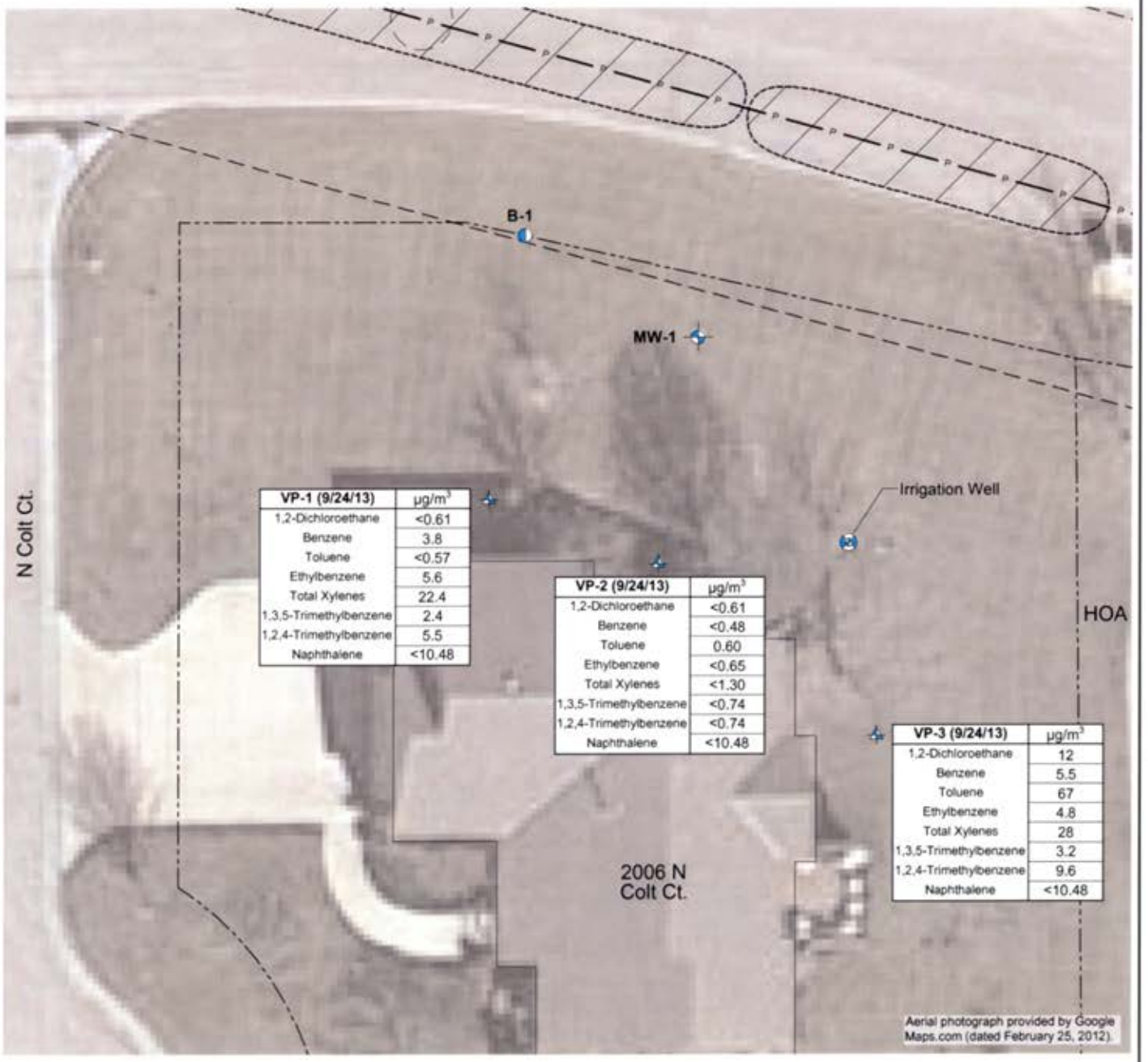
Andover, Kansas

APEX Apex Companies, LLC 3015 SW First Avenue Portland, Oregon 97201	Project Number	1641-04	Figure 16
	April 2014		



VP-1 (9/24/13)	µg/m³
1,2-Dichloroethane	<0.61
Benzene	3.8
Toluene	<0.57
Ethylbenzene	5.6
Total Xylenes	22.4
1,3,5-Trimethylbenzene	2.4
1,2,4-Trimethylbenzene	5.5
Naphthalene	<10.48

VP-2 (9/24/13)	µg/m³
1,2-Dichloroethane	<0.61
Benzene	<0.48
Toluene	0.60
Ethylbenzene	<0.65
Total Xylenes	<1.30
1,3,5-Trimethylbenzene	<0.74
1,2,4-Trimethylbenzene	<0.74
Naphthalene	<10.48

VP-3 (9/24/13)	µg/m³
1,2-Dichloroethane	12
Benzene	5.5
Toluene	67
Ethylbenzene	4.8
Total Xylenes	28
1,3,5-Trimethylbenzene	3.2
1,2,4-Trimethylbenzene	9.6
Naphthalene	<10.48

Legend:

- **MW-1** Monitoring Well Location
- Irrigation Well
- **VP-1** Soil Vapor Monitoring Point
- **B-1** Boring Location
- Property Line
- Pipeline
- Pipeline Easement Boundary
- HOA Lot Owned by Quail Crossing Homeowner's Association
- µg/m³ micrograms per cubic meter

N

0 20 40

Scale in Feet

Soil Vapor Analytical Results - September 2013

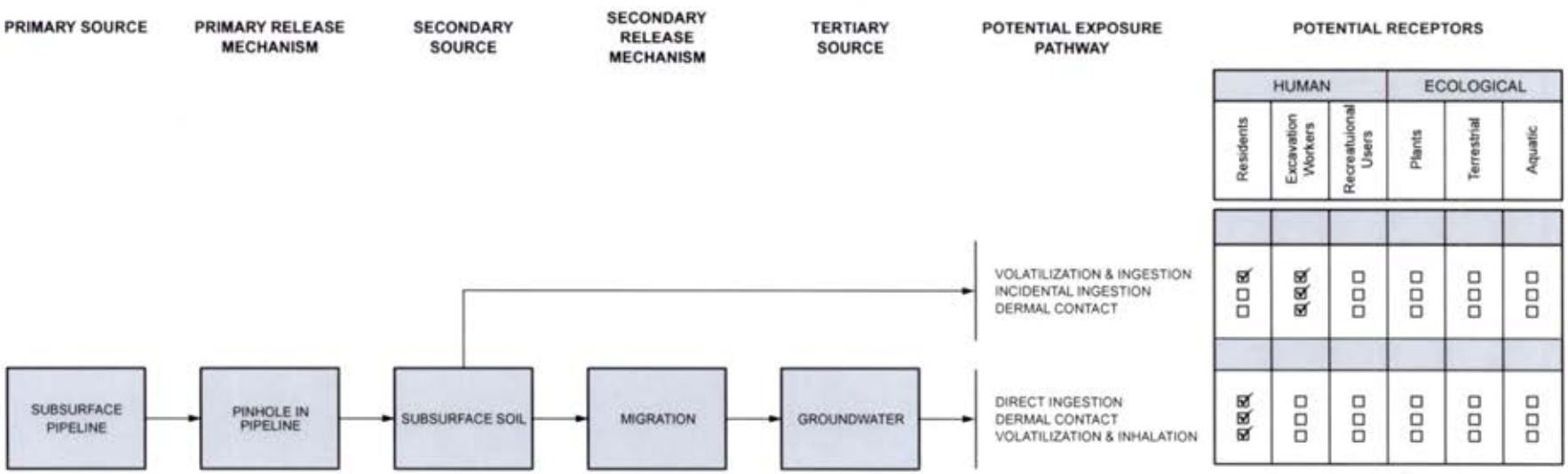
Comprehensive Investigation Report
NuStar Pipeline Operating Partnership L.P.
Andover, Kansas

APEX Apex Companies, LLC
3015 SW First Avenue
Portland, Oregon 97201

Project Number 1641-04

April 2014

Figure 17



Legend:

- ☑ Potential Exposure Pathway (May Require Management or Remediation)
- ☐ Incomplete Exposure Pathway

Conceptual Site Model

Comprehensive Investigation Report
NuStar Pipeline Operating Partnership L.P.
Andover, Kansas

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	April 2014		