FINAL

VAPOR COLLECTION SYSTEM OPERATION, MAINTENANCE, AND MONITORING PLAN

HARTFORD PETROLEUM RELEASE SITE

HARTFORD, ILLINOIS

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Table of Contents

1.0 INTRODUCTION 1-1

1.1 Purpose 1-2

1.2 General OMM Responsibilities 1-2

1.3 SVE System Configuration 1-3

1.3.1 Phase I and II 1-4

1.3.2 Phase III 1-4

1.3.3 Stingers 1-4

1.4 OMM Plan Organization 1-6

2.0 SVE SYSTEM OPERATION 2-1

2.1 Groundwater Triggers for SVE System Operation 2-1

2.2 Operations When Above Trigger Elevations 2-2

2.3 Operations When Below Trigger Elevations 2-3

3.0 ROUTINE MONITORING 3-1

3.1 Gauging Procedures 3-1

3.2 Flowrate Monitoring Procedures 3-2

3.3 Soil Vapor Screening Procedures 3-3

4.0 SYSTEM ADJUSTMENTS AND MAINTENANCE 4-1

4.1 Line Sweeping 4-1

4.2 Routine Well Adjustments 4-2

4.3 Non-routine Well Development 4-2

4.4 Troubleshooting Matrix 4-3

5.0 ROUTINE REPORTING 5-1

6.0 REFERENCES 6-1

List of Tables

1. Extraction Well and Stinger Detail Summary

List of Figures

1. Hartford SVE System Layout
2. Volatile Petroleum Hydrocarbons Recovered via SVE System
3. Cross-Section Locations
4. Zone 1 SVE System Cross Sections
5. Zone 2 SVE System Cross Sections
6. Zone 3 and Zone 4 SVE System Cross Sections
7. Zone 5 SVE System Cross Sections
8. Zone 6 SVE System Cross Sections
9. Typical SVE Wellhead Completion Detail
10. Photographs of Phase I/II and Phase III Typical SVE Wellhead Completion
11. Typical Stinger Detail
12. Rationale for Well Adjustments based on Open Screen and Flow Measurements
13. Rationale for Well Adjustments based on LNAPL Thickness Measurements

List of Appendices

A. AS-BUILT/RECORD DRAWING PACKAGE FOR SOIL VAPOR EXTRACTION SYSTEM

B. SUPPORTING DOCUMENTATION FOR DEVELOPMENT OF GROUNDWATER ELEVATION TRIGGERS FOR OPTIMIZATION OF SVE SYSTEM FOR MASS RECOVERY

C. FIELD DIRECT® ELECTRONIC FIELD FORMS

1.0 INTRODUCTION

A soil vapor extraction (SVE) system was installed by Clark Oil & Refining Corporation (now the Premcor Refining Group [Premcor]) at the Hartford Petroleum Release Site (Hartford Site) and operated from approximately 1992 until it was upgraded in 2005. The original SVE system consisted of 12 vapor control boreholes (URS 2014a) and was replaced in three phases beginning in 2004 by the Hartford Working Group. The current SVE system consists of a network of approximately 118 vapor extraction wells (Table 1) connected through a series of piping and valves to a single 12-inch pipe (referred to as the Main Header) that extends to the east beneath the railroad right-of-way to a series of four thermal oxidizers located on the Premcor Refinery. Figure 1 shows the general location of the SVE extraction wells and piping, as well as the SVE Effectiveness Zones (Zones 1 through 6) established for the purpose of evaluating the system performance. Well completion details are summarized on Table 1. As-built/record drawings prepared using historical information and survey data provided by previous contractors are provided in Appendix A.

The Hartford Working Group has operated the SVE system including the collection and thermal treatment system components since upgrades were completed in 2005, with the exception of the period from mid-2009 to September 2013. During this time, Apex Oil Company, Inc. (Apex) was responsible for operation, monitoring, and maintenance (OMM) of the collection system components located in the Village of Hartford. Detailed records of hydrocarbon recovery rates have been recorded for the SVE system since 2005. As shown on Figure 2, approximately 1 million gallons of volatile petroleum hydrocarbons have been recovered through the SVE system between May 2005 and December 2014. Vapor recovery has reached asymptotic conditions in areas to the south and west of the site while asymptotic conditions are not observed in the northern and eastern portions of the site, with the highest daily recovery occurring in late 2012, as low water table conditions were observed beneath the Hartford Site (RAM Group of Gannett Fleming, Inc. 2010).

On September 18, 2014, the United States Environmental Protection Agency (USEPA) sent Apex and the Hartford Working Group a letter describing reassignment of activities at the Hartford Site, which included OMM of the SVE system. The USEPA indicated that OMM of the collection system components will be assumed by Apex in April 2015. The vapor collection components includes those portions of the SVE system located within the Village of Hartford, up to and including the western-most vault (aka, Main Vault) for the conveyance lines. Whereas, the Main Header line extending to the east beneath the railroad right-of-way and all infrastructure situated on the Premcor Refinery, are considered the thermal treatment system. It is anticipated that transition of the thermal treatment system from the Hartford Working Group to Apex will occur in June 2015.

Apex plans to operate the vapor collection system in accordance with the *HSVE Monitoring and Maintenance Manual, Hartford Working Group* (URS 2014a) until approval of this draft *Vapor Collection System Operation, Maintenance, and Monitoring Plan, Hartford Petroleum Release Site, Hartford, Illinois* (*Vapor Collection System OMM Plan*). The following additional plans will also be adhered to following transition of the vapor collection system components on April 1, 2012:

1. Regional effectiveness monitoring, which includes quarterly screening within selected nested soil vapor monitoring wells, monitoring points, and monitoring wells will be performed in accordance with the *Effectiveness Monitoring Plan, Hartford Hydrocarbon Plume Site, Hartford, Illinois* (URS 2014c).
2. In-home monitoring, including weekly and quarterly screening of indoor air and sub-slab soil vapor within select homes across the Hartford Site, will be performed in accordance with the *Final Interim In-Home Effectiveness Monitoring Plan, Hartford Petroleum Release Site, Hartford, Illinois* (Trihydro 2014a).
3. River stage triggered monitoring will performed in accordance with the triggers and methods described in the *Final Interim In-Home Effectiveness Monitoring Plan, Hartford Petroleum Release Site, Hartford, Illinois* (Trihydro 2014a), as well as the *System Operation and Maintenance Response to River Rise, Groundwater Related and Sub-slab Triggers, Hartford Area Hydrocarbon Plume Site* (URS 2014b).

1.1 PURPOSE

The *Vapor Collection System OMM Plan* has been prepared to guide effective operation of the SVE system at the Hartford Site. The SVE system is a dynamic system that is routinely adjusted to optimize vapor removal and maintain pneumatic influence within the shallowest permeable units located beneath residences. Therefore, this plan is intended to be used as a reference for field personnel, project managers, and regulatory agencies and is subject to modification as warranted to optimize the SVE system performance.

1.2 GENERAL OMM RESPONSIBILITIES

Trihydro and Apex, working with other subcontractors as necessary, will conduct routine OMM of the SVE system as described herein. The following bullets present the general activities that will be performed:

- Training will be provided to all technicians and project team members conducting OMM activities.
- OMM will be performed in accordance with the procedures described in Sections 2.0, 3.0, and 4.0.
- Vapor samples will be collected from the SVE wells in accordance with the schedule and procedures outlined in Section 3.0.

- The collection system components will be maintained to maximize operational time of the SVE system.
- Troubleshooting will be performed to identify and resolve improper system operations.
- Corrective maintenance items will be identified and repairs performed to the collection system components including wells, piping, gauges, valves, vaults, etc. Repairs will be performed by specialists or subject matter experts (e.g., plumbers), as necessary.
- Logs and records will be maintained documenting OMM activities.
- System modifications will be communicated to field personnel, project managers, and regulatory agency personnel.
- Routine monitoring reports will be submitted to the USEPA and Illinois EPA, as described in Section 5.0.

1.3 SVE SYSTEM CONFIGURATION

The current SVE system was installed during three separate phases and is comprised of 118 operating wells (of which 98 have been operated in the past two years). As identified on Table 1, wells were generally installed within the shallow strata beneath the Hartford Site. Wells installed during Phases I and II were generally installed as nested pairs with an "S" indicating the shallow well and "D" identifying the deeper vapor recovery well. The shallow wells are typically screened within the North Olive stratum. The deep wells are screened within the Rand, Main Silt, and Main Sand strata but can have longer screen intervals that also extend into the shallower strata and clay lenses. In cases where nested wells were installed, the deep intervals overlap with the shallow intervals. Cross sections within each of the SVE Effectiveness Zones showing the screen intervals for the SVE wells relative to the lithology and historic LNAPL distribution are provided as Figures 3 through 8.

The individual wells connect to the SVE conveyance lines through a series of 32 control vaults (V1 through V32), as shown on the as-built/record drawing package included in Appendix A. The SVE conveyance line control vaults are of different sizes, but are generally larger than the HSVE well vaults. Fifteen of the vaults also contain sample/vacuum ports. The conveyance lines are connected to a single 12-inch line (Main Header) within the Main Vault that extends to the east beneath the railroad right-of-way and to the thermal treatment system located on the Premcor Refinery. System vacuum is induced using one or more of the four 75-horsepower blowers each with a flow capacity of 800 standard cubic feet per minute (scfm) and a corresponding vacuum of 150 to 160 in-H_2O. Typically, no more than three blowers are operated simultaneously depending on the number of extraction wells being operated and the cumulative flow rate through the SVE system." Recovered vapors are passed through a 470 gallon underground vapor liquid separator followed by a 1,000 gallon aboveground vapor liquid separator, as well as four individual 240 gallon vapor liquid separators prior to each of the four 75-horsepower blowers. After passing through the vapor liquid

separators and blowers, the recovered soil vapor is treated via four thermal oxidizers, each capable of processing 9 million British thermal units (BTU) per hour.

1.3.1 PHASE I AND II

SVE wells (HSVE-001 through HSVE-030) installed between 2004 and 2006 as part of the Phase I and Phase II modifications consist of a 4-inch diameter well connected to 4-inch diameter conveyance line. The individual well, valves, flow meters, and sample/vacuum ports are located in a single 4-foot by 4-foot steel vault. Some of the Phase I and II wells have been modified to allow for more accurate measurement of the flowrate by installing a 4-inch by 4-inch by 2-inch tee on the well to allow for the installation of a 2-inch diameter line for field measurements. The line then increases to 4-inches and connects to the SVE conveyance lines. Typical wellhead configuration for the SVE wells installed during Phase I and II are shown on Figure 9. Photographs of typical wellheads are included on Figure 10.

1.3.2 PHASE III

SVE wells (HSVE-031 through HSVE-103) installed during Phase III expansion between 2006 and 2011 consist of small radius well vault for the wellhead and a separate 4-foot by 4-foot steel control vault to house the valves, flow meter, and sample ports. The Phase III wells were installed with a 4-inch by 4-inch by 2-inch tee from the well with a 2-inch line that extends from the wellhead to the control vault. This 2-inch line then increases to 4-inches as it exits the control vault and connects to the SVE conveyance lines. Typical wellhead configuration for the SVE wells installed during Phase III are shown on Figure 9 and photographs of the typical wellheads are included on Figure 10.

1.3.3 STINGERS

The SVE system was initially designed to solely recover vapor. However after startup of the system, it was determined that groundwater levels would increase within many of the extraction wells under typical system vacuum, which led to screen occlusion and limited vapor recovery. Therefore, many of the SVE wells were retrofitted to allow for the installation of a stinger and extraction of groundwater as part of normal operations. A stinger is a small diameter hose or pipe that is inserted into the recovery well which allows for simultaneous extraction of groundwater and soil vapor. This configuration, typically referred to as multiphase extraction (MPE), or more specifically as two phase extraction (TPE), allows for dewatering and prevents occlusion of the screen within the extraction well during system operation. As groundwater begins to rise due to the applied vacuum, both groundwater and vapor are extracted through the stinger. The depth of the stinger can be adjusted to depress the water level in the extraction well. The stinger designs, summarized on Table 1, vary from well to well but generally can be described as follows:

- Flow Tube – Flow tubes consist of a 2-inch polyvinyl chloride (PVC) stinger that is installed several feet into the 4-inch well casing. Flow tubes were only installed in the Phase I wells and many of the flow tubes have been replaced with Viton® Seal stingers, described below. Currently only 13 of the SVE wells contain flow tubes.
- Straw Stinger – Several of the SVE wells were designed with a 1-inch flexible hose that tees from the SVE conveyance line within the well control vault into the SVE well vault. The 1-inch flexible hose is then extended through the well cap and into the well casing down to the upper portions of the water table, serving as a stinger. At the bottom of the flexible hose, a piece of 1-inch section of PVC pipe is connected to the flexible hose. The tip of the PVC portion of the stinger is cut at a 45 degree angle to assist with initial mixing of air and water. Vacuum for the straw stinger and the well casing is controlled separately in this design. This same approach was used on the recently installed wells on West Birch and West Arbor Streets (HSVE-105S/D, HSVE-106S/D, and HSVE-107S/D). Currently 21 wells have straw stingers installed.
- Viton® Seal Stingers – Viton® Seal stingers are between 0.75 and 1.5-inch PVC stingers that are installed through a Viton® seal. Viton® is a chemical and heat resistant polymer that is used to create an airtight seal with the well casing and around the stinger. The Viton® seal is placed near the top of the well casing, below the tee which ties vacuum to the well. Similar to the straw stinger design, the stinger extends to the water table and the tip of the stinger is cut at a 45 degree angle to assist with initial mixing of air and water. All of the fluid and vapor is carried through the stinger to the top of the well above the Viton® seal and is conveyed through the 2-inch line that connects the wellhead to the control vault. Currently there are 50 wells with Viton® Seal Stingers.

Typical stinger configurations are shown on Figure 11. The current SVE system does not have an oil/water separator, therefore LNAPL removal cannot be performed using the current configuration. Therefore, wells that have either historically or currently have measurable LNAPL are not operated with a stinger and only vapor is extracted from the well, when the water table is low enough to allow recovery.

In a subset of the SVE wells that have been retrofitted with a stinger, a port has also been installed to allow dilution air to be introduced into the casing with the intent of improving the flow of extracted vapors. For those wells with a straw stinger, dilution air is introduced through a small hole (approximately ¼-inch) drilled through the well cap. For those wells with a Viton® seal stinger, the dilution air is introduced by either drilling a small hole (approximately ¼”) through the well cap and then running tubing through the well cap along the stinger and beneath the Viton® seal or by drilling a hole through the well casing below the Viton® seal with the tubing extending up into the well vault to prevent ponded water present in the vault from entering the port. In a few instances, the open end of the tubing is fitted with a ball valve to allow for better control of the dilution air.

1.4 OMM PLAN ORGANIZATION

The remainder of the *Vapor Collection System OMM Plan* is organized as follows:

- Section 2.0 - This section includes a description of the operation of the SVE system, including groundwater triggers for determining system operating procedures
- Section 3.0 - This section describes the monitoring procedures for the collection system components, including soil vapor sample collection and field screening
- Section 4.0 - This section provides a troubleshooting guide for the maintenance of the SVE system
- Section 5.0 - This section contains a description of routine reporting for documenting OMM activities

2.0 SVE SYSTEM OPERATION

As described in Section 1.3.3, the SVE system was originally designed to prevent migration of volatile petroleum hydrocarbons from the subsurface into overlying structures (commonly referred to as vapor intrusion). However, due to well screen occlusion that occurs under typical system vacuum, many of the extraction wells were modified to allow for TPE. Specifically, stingers were installed within many of the extraction wells to allow removal of groundwater and air simultaneously. While the system installed at the Hartford Site is no longer operated for vapor extraction alone, it will continue to be referred to as an SVE system herein, to be consistent with the historical naming convention. However, wells which have been retrofitted with stingers will be referred to as TPE wells to distinguish monitoring and maintenance requirements for the different well configurations.

Vapor intrusion events at the Hartford Site have been correlated with a rapid increase in the Mississippi River stage and advective movement of volatile petroleum hydrocarbons associated with increasing groundwater elevations (Trihydro 2014a). These hydraulic conditions are present over short intervals (generally less than one week) during infrequent events (often less than three events each year) typically occurring between March and June (Trihydro 2014c). However, the SVE system has the additional recognized benefit of reducing the mass of petroleum hydrocarbons present in the various strata beneath the Hartford Site. This secondary benefit is enhanced when the groundwater table within the various strata is seasonally low and additional portions of the smear zone are exposed (Trihydro 2014b). Therefore, optimization of the SVE system includes separate operating procedures to achieve both of these goals.

2.1 GROUNDWATER TRIGGERS FOR SVE SYSTEM OPERATION

Operation of the SVE system will be adjusted according to groundwater triggers in the Rand Stratum. The system will be operated to mitigate potential vapor intrusion events when the water table is above trigger elevations and optimized for mass recovery when groundwater is below trigger elevations. While the rate of mass recovery is influenced by many factors, groundwater elevations in the Rand stratum appear to be the most predominant as occlusion of the well screen in many wells limits vapor recovery when the groundwater elevation within the Rand Stratum is elevated.

As identified on Table 1, the majority of the vapor extraction wells (130 of the 138 SVE wells) have been installed within the shallow strata beneath the Hartford Site, with the bottom of screen typically no greater than 28 feet below ground surface (above the Main Sand stratum). Therefore, the groundwater elevations within select multipurpose monitoring points and groundwater monitoring wells installed in the Rand stratum were compared to the daily mass removal rates from the SVE system in an effort to identify groundwater elevation triggers for optimizing the system. Wells and monitoring points were selected from several of the SVE effectiveness zones including: MP-079B (Zone 1),

MP-039B (Zone 2), HMW-044B (Zone 5), MP-053B (Zone 5), and MP-029C (Zone 6). These wells and monitoring points were selected based on (1) the availability of routine fluid level measurements (2) spatial representation of groundwater elevations across the Hartford Site, and (3) screen interval comparable to the majority of the SVE wells. SVE wells were excluded from consideration as trigger locations due to the difficulties in collecting representative fluid level measurements while vapor and groundwater are being extracted. Furthermore, many additional monitoring locations screened in the Rand Stratum were not considered due to infrequent fluid level measurements. Figures comparing the groundwater elevation within each of these five monitoring points and wells installed in the Rand stratum to the daily vapor recovery rates since the startup of the modified SVE system in 2005 are provided in Appendix B.

As shown on these figures there is a correlation between groundwater elevations in the Rand Stratum and daily mass recovery rates. For instance, when groundwater elevations in monitoring point MP-029C were below 406 feet above mean sea level (ft-amsl), vapor recovery rates are elevated compared to periods when the water table is above 406 ft-amsl. The same general correlation can be observed in each of the five selected locations, although for monitoring well HMW-044B and monitoring point MP-053B the trigger elevation may be when groundwater is below the bottom of the screen and water is perched within the sump. As shown on the figures in Appendix B, the trigger elevation associated with an increase in vapor recovery within the five selected locations is between 406 and 409 ft-amsl within the Rand Stratum. Operation of the SVE system will be optimized for mass recovery when the groundwater elevation within three of the five selected locations is below the following trigger elevations:

Monitoring Location	SVE Effectiveness Zone	Trigger Elevation (ft-amsl)
MP-079B	Zone 1	406.0
MP-039B	Zone 2	409.0
HMW-044B	Zone 5	406.5
MP-053B	Zone 5	406.5
MP-029C	Zone 6	408.0

The trigger elevations, as well as the selected trigger wells may be modified as additional data is collected during periods when operations are focused on optimizing mass recovery, as described in Section 2.3.

2.2 OPERATIONS WHEN ABOVE TRIGGER ELEVATIONS

When groundwater is above the trigger elevations, operation of the SVE system will focus on recovery of vapor in the shallow strata (primarily the North Olive and Rand) to prevent vapor intrusion events. The system will be operated using as many of the approximately 114 extraction wells that are installed in the shallow stratum and currently considered part of the system. There are many conditions that factor into wells being operable versus inoperable

including occlusion of the well screen with groundwater and reduced permeability associated with increasing water content within the pore space. These conditions can occur because of a rise in the Mississippi river stage, increases in the groundwater elevations, as well as, local precipitation events. It is difficult to predict how operations will be affected within individual SVE and TPE wells since one or more of these ambient conditions can exist simultaneously.

Operation of as many of the 114 wells as possible may result in lower operating vacuum and reduced flowrate within individual wells. Wells with low total volatile petroleum hydrocarbon (TVPH) concentrations that have reached asymptotic levels will continue to be operated in an effort to enhance pneumatic influence in the shallow strata beneath the Hartford Site. Operational criteria will be similar to historical operation as follows:

- Operating Vacuum: For both SVE and TPE type wells the operating vacuum will be between 80 and 120 inches of water (in-H_2O), provided that occasionally this may be reduced to prevent occlusion of the well screen as described in Section 4.2.
- Flowrate: The flowrate under these operating vacuums has been between 8 and 80 scfm, which will continue to be used as benchmarks.

2.3 OPERATIONS WHEN BELOW TRIGGER ELEVATIONS

When groundwater is below the trigger elevations, the SVE system will be operated to optimize mass recovery by increasing vacuum and flowrate within wells containing elevated TVPH concentrations. Wells with TVPH concentrations above 100 ppmv will continue to be operated for the purpose of mass recovery. For reference, the maximum TVPH concentration observed during 2014 through the middle of 2015 are summarized on Table 1 on a well-by-well basis. However, TVPH concentrations will be measured routinely to determine which wells should be operated. Extraction wells installed in the shallow strata with low TVPH concentrations (less than 100 ppmv) will be temporarily shut down or cyclically operated. This will allow higher operating vacuums within wells with higher TVPH concentrations screened in the shallow strata and the Main Sand stratum, including the multiphase extraction wells MPE-A001 through MPE-A005 (listed on Table 1). Extraction wells installed into the LNAPL smear zone within the Main Sand will be operated as long as the water table remains below the screened interval during operation. Operational criteria to maximize mass removal include:

- TPE wells: Operating casing vacuum between 110 and 135 in-H_20
- SVE wells: Operating casing vacuum between 80 and 120 in-H_20 (although this may be reduced to prevent occlusion of the well screen as described in Section 4.2)

To maintain these higher operating vacuums, cycling and/or temporarily suspending recovery within selected wells located on each of the transmission lines (shown on Figure 1) may be necessary. Operations will be evaluated on a line by line basis to determine which, if any, wells need to be cycled or temporarily shut down. It is important to note that these initial (groundwater trigger elevations) and secondary (total volatile hydrocarbons greater than 100 ppmv) criteria will be refined based on the performance of the SVE system during low water table conditions. In addition, if in-home monitoring results indicate that subsurface conditions are indicative of potential vapor intrusion within a specific structure (i.e., sub-slab concentrations greater than 150 ppmv), the SVE and TPE wells located near the affected structure will be operated in accordance with the procedures described in Section 2.2.

Extraction wells with deeper screen intervals and/or wells screened primarily across clay lenses, are more prone to occlusion with groundwater. Attempts will be made when the groundwater table is below trigger elevations to remove groundwater from the screen interval and improve the flowrate for extracted vapors within these wells. The following bullets provide a summary of wells that have historically had occluded well screens, listed by SVE Effectiveness Zone:

- Zone 1: HSVE-004R, HSVE-102, and HSVE-103
- Zone 2: HSVE-006R, HSVE-044, HSVE-045, and HSVE-047
- Zone 3: none
- Zone 4: HSVE-088, HSVE-090, HSVE-091, HSVE-093, and HSVE-094
- Zone 5: HSVE-028D, HSVE-079, HSVE-081, HSVE-084, HSVE-085, and HSVE-100
- Zone 6: HSVE-055 through HSVE-068, and HSVE-072 through HSVE-077

The majority of wells that typically have occluded well screens within SVE Effectiveness Zones 1 and 2 are installed in deeper portions of the subsurface that may be submerged when the water table is above trigger elevations. SVE wells HSVE-043, HSVE-44, and HSVE-045, located within Zone 2, have not operated for several years. These wells are screened across the B and C Clay. If dewatering of the wells screens is not successful, removal or replacement of these wells may be necessary.

The majority of the wells which typically have occluded well screens within SVE Effectiveness Zones 4, 5, and 6 are located along North Olive Street and consist of wells with both shallow and deep screen intervals. In many cases the wells are screened at least partially across clay units, which contributes to occlusion. If the well screen cannot be successfully dewatered within these wells installed in SVE Effectiveness Zones 4, 5, and 6, removal or replacement may be warranted. A determination for removing or replacing these wells will be considered on a case-by-case basis as

ambient conditions allow for operation of these wells (i.e., low groundwater). If the well is not operable or has a limited range of conditions under which it can be operated, Apex will evaluate the spatial distribution of wells in each SVE Effectiveness Zone along with the mass recovery rate to determine if installation of replacement wells are warranted. It is important to note that these evaluations cannot be completed during high groundwater conditions due to well screen occlusion.

3.0 ROUTINE MONITORING

Routine monitoring of the extraction wells will be conducted on a biweekly or monthly basis. Routine biweekly monitoring will include gauging fluid levels and total depth and monthly monitoring will include: (1) measuring vapor recovery flowrate, and (2) field screening soil vapor within each of the operating SVE wells. More frequent monitoring (e.g., fluid level gauging) may be conducted within select extraction wells based on the groundwater elevations and variability observed during routine system and effectiveness monitoring.

Monitoring activities will be documented on electronic field forms using Trihydo's Field Direct® and Project Direct® Environmental Information Management System. Examples of the electronic field forms that will be used for routine system monitoring are included in Appendix C. Operation manuals for the meters that will be used for routine OMM activities are located in the Apex field office in Hartford, Illinois and are not reproduced herein.

Monthly monitoring will not be performed within extraction wells that are not in operation. Operating extraction wells may vary from month to month and will be documented within semiannual memos submitted to the USEPA and Illinois EPA (described in Section 5.0). Details regarding the procedures for monthly monitoring activities are provided in the sections below.

3.1 GAUGING PROCEDURES

The depth to LNAPL, depth to groundwater, and total depth in the extraction well will be gauged. These measurements will be recorded to determine if there is LNAPL present, the length of open screen, the amount of sediment present in the bottom of the well, and stinger placement. An oil/water interface probe (e.g., Solinst™ Interface Meter) will be used to gauge fluid levels and the total depth of each well in the following manner.

1. SVE wells without stingers, SVE wells with flow tubes, and TPE wells configured with straw stingers: An opening within the well cap will be uncovered and the oil/water interface probe will be placed through the opening. The applied vacuum in the extraction well will be maintained during gauging. The opening in the well cap will be covered after the interface probe is inserted into the well to maintain the system vacuum within the well.
2. TPE wells with Viton® Stingers: An opening in the well cap will be uncovered and the oil/water interface probe will be fed through the stinger. The vacuum will be shutoff just prior to gauging.

The interface probe will be slowly lowered into the extraction well or through the stinger during gauging activities. In general, a continuous tone will occur at the air/LNAPL interface once LNAPL is encountered. A discontinuous tone will occur at the LNAPL/water interface when groundwater is encountered. The total depth will be determined by

"tapping" the bottom of the well with the probe. The fluid level measurements will be confirmed by slowly raising and lowering the interface probe at the air/LNAPL and LNAPL/water interfaces. These fluid level and total depth measurements will be recorded to the nearest 0.01-foot. The point of reference for gauging activities will be the north side of the extraction well casing, unless otherwise specified. Following gauging activities, the interface probe will be decontaminated by wiping the surface of the tape using a paper towel soaked with a diluted solution of a phosphate-free cleaner/degreaser (e.g., Simple Green®) and rinsing the probe with a diluted solution of a phosphate-free cleaner/degreaser, distilled water, and alcohol (if necessary to remove LNAPL).

3.2 FLOWRATE MONITORING PROCEDURES

The rate of flow within each extraction well will be determined by measuring the casing vacuum, differential pressure, and temperature of the extracted vapor. Casing vacuum will be measured using a magnehelic gauge (e.g., Dwyer Instruments™ Magnehelic Gauge capable of measuring up to 150 in-H_2O) installed on the 2- or 4-inch horizontal line connecting the extraction well to the SVE transmission pipeline, prior to the flow control valve (Figure 9). An infrared thermometer (e.g., Milwaukee Laser Thermometer) will be used to record the surface temperature of the 2- or 4-inch horizontal line connecting the extraction well to the SVE transmission pipeline.

There are two types of devices used for measuring differential pressure: (1) Venturi flow meters and (2) pitot tubes. Differential pressure will be measured in wells constructed with a Venturi flow meter, by connecting a manometer (e.g., Dwyer Instruments™ Handheld Monometer capable of measuring up to 20 in-H_2O) to the quick connect ports on the Venturi flow meter. For wells without a Venturi flow meter (includes wells HSVE-001 through HSVE-030 installed during Phase I and II modifications, in addition to replacement well HSVE-004R), a pitot tube that is approximately 3-feet in length and designed for use within 4-inch ductwork (with the exception of well HSVE-004R, which utilizes an in-line pitot that is installed in the 4-inch transmission pipe within the well vault) will be used. In cases where a Phase I and II well has been retrofitted with a stinger, the flowrate measurement will be collected by inserting the pitot tube directly into the stinger. The pitot tube will be connected to the manometer (the top port of the pitot tube will be connected to the high pressure port on the manometer and the side port of the pitot tube will be connected to the low pressure port on the manometer). The pitot tube will be fully inserted into the well or stinger and the differential pressure will be recorded. The differential pressure measurements can vary within the extraction well while collecting flowrate measurements. Therefore, the maximum, minimum, and stable differential pressure measurements will be recorded.

3.3 SOIL VAPOR SCREENING PROCEDURES

Soil vapor samples will be collected within a Tedlar® bag and field screened for TVPH and methane concentrations using a flame ionization detector (FID). Fixed gases (including oxygen and carbon dioxide) will also be measured using a multigas meter. Vapor samples will be collected from the sample port located on the 2- or 4-inch horizontal line connecting the extraction well to the SVE transmission pipeline (Figure 9). Vapor samples will be collected in the following manner:

1. Record the extraction well location information, date, and time on the Tedlar® sample bag and on the electronic field form.
2. Connect a piece of flexible tubing to the sample port on the extraction well piping and insert the other end of the tubing into the peristaltic pump.
3. Open the sample port and purge the tubing for 60 seconds using the peristaltic pump.
4. Connect a Tedlar® bag to the discharge port on the peristaltic pump and open the valve on the Tedlar® bag. Once the bag is full, close the valve on the Tedlar® bag, turn off the peristaltic pump, close the sample port on the extraction well piping, and remove the flexible tubing.
5. Check Tedlar® bag for leaks. If no leaks are detected, carefully stow the bag for transport to the Apex field office.
6. Vapor samples will be screened within 24 hours of sample collection at the field office as follows:
    a. TVPH and methane concentrations will be measured using a FID (e.g., ThermoScientific™ TVA1000B®). The FID will be calibrated at least daily prior to use following the manufacturers recommended procedures for calibration of the equipment. The reported FID concentration will be checked against the calibration standards (commonly referred to as a bump check) approximately every two hours to document instrument stability. If the bump check indicates deviation greater than +/- 10%, the FID will be recalibrated. Calibration data will be documented on the electronic field form.
    b. Fixed gases including oxygen and carbon dioxide will be measured using a multigas meter (e.g., Landtec™ GEM2000®). The multigas meter will be calibrated at least daily prior to use following the manufacturers recommended procedures for calibration of the equipment. Bump checks will be performed approximately every two hours to document instrument stability. If the bump check indicates deviation greater than +/- 10%, the instrument will be recalibrated. Calibration data will be documented on the on the electronic field form.

4.0 SYSTEM ADJUSTMENTS AND MAINTENANCE

Well adjustments and maintenance activities will be performed based on the monthly SVE and quarterly effectiveness monitoring results. Effectiveness monitoring of the SVE system will be performed in select multipurpose monitoring points and nested vapor monitoring wells on a quarterly basis, as described within the *Effectiveness Monitoring Plan, Hartford Hydrocarbon Plume Site, Hartford, Illinois* (URS 2014c). Routine monitoring will be used to identify wells that require adjustments or maintenance due to: (1) presence of LNAPL, (2) occluded well screens, (3) reduced system vacuum, (4) low flowrate for vapor recovery, and/or (5) sediment accumulations. Well adjustments and maintenance activities will be conducted during weeks when routine monitoring is not being performed. Additionally, maintenance activities will include bi-weekly clearing of the SVE transmission lines, referred to as line sweeping.

4.1 LINE SWEEPING

Line sweeping within the SVE transmission lines to remove accumulated water and sediment will be performed on an as-needed basis dependent on reduction observed in the system vacuum. Typical operating vacuum is between 150 and 160 in-H_20, as measured on the main header of the SVE system). Line sweeping is performed by removing the well caps from select extraction wells, maximizing flow within these wells, and then increasing the overall system vacuum. Accumulated sediment and groundwater is then purged from the SVE transmission lines and stored within three frac tanks located at the thermal treatment system on the Premcor Refinery. Line sweeping can be performed on isolated lines or within multiple transmission lines simultaneously. Extraction wells included in line sweeping are summarized on Table 1. The following describes the general procedure for conducting line sweeping:

1. Coordinate with the thermal treatment system operator, who will reduce the system operating vacuum prior to beginning line sweeping.
2. Record the flow control valve position at each well that is included in line sweeping.
3. Remove the well cap and open the flow control valve to the maximum extent. Secure the area near the extraction well and place traffic cones around the well vault.
4. When all of the wells included in line sweeping have been opened, coordinate with thermal treatment system operator to increase the overall system vacuum.
5. The thermal treatment system operator will evaluate when the system vacuum has stabilized and line sweeping is completed. The operator will then reduce system vacuum.

6. Return the flow control valve at each extraction well to its original position just prior to beginning line sweeping. Replace the well cap and measure the casing vacuum to confirm that there is sufficient flow within the extraction well.
7. Once the caps are placed back onto each of the selected SVE wells, the thermal treatment system operator will adjust the system vacuum.

4.2 ROUTINE WELL ADJUSTMENTS

The SVE and TPE wells may require adjustments based on the length of open screen and flowrate. As shown on Figure 12, adjustments will be made in an effort to maintain more than two feet of open screen and a minimum flowrate of 8 scfm within the operating well. Adjustments may include changing the control valve position, removing groundwater within the extraction well, adjusting the stinger height, or temporarily suspending operation within the well until the groundwater elevation recedes. The SVE and TPE wells may continue to be operated if the flowrate can be maintained above 8 scfm, even if less than 2-feet of screen is exposed during operation. During river stage triggered events, SVE and TPE wells may continue to be operated even if the flowrate is below 8 scfm.

Additional adjustments may also be made to the SVE and TPE wells based on the presence of LNAPL. The system was not constructed with an oil-water separator and entrainment of LNAPL can result in a disruption in the operation of the thermal treatment units. Therefore, as shown on Figure 13, adjustments may include recovering LNAPL from the extraction well using a submersible pump or bailer, removing the stinger from a TPE well, reducing the flowrate, or temporarily suspending operations within an extraction well.

Additionally, as described in Section 2.3, when groundwater is below the trigger elevations, the SVE system will be operated to optimize mass recovery by increasing the vacuum and flowrate within those wells with higher TVPH concentrations. Extraction wells installed in the shallow strata with low TVPH concentrations will be temporarily shut down or cyclically operated. This will allow higher operating vacuums within wells with higher TVPH concentrations screened in the shallow strata and the Main Sand stratum, including the multiphase extraction wells MPE-A001 through MPE-A005.

4.3 NON-ROUTINE WELL DEVELOPMENT

If during routine gauging, it is identified that more than 20% of the bottom of the well screen is occluded by sediment, then redevelopment will be performed in the following manner:

1. Recover any sediment from the bottom of the extraction well using a stinger, sand pump, or sand bailer. Sediment removed during well maintenance is entrained within the groundwater that is simultaneously recovered from the extraction wells. The groundwater and entrained sediments are temporarily stored and subsequently transferred to the frac tanks located at the thermal treatment unit on the Premcor facility. Periodically, the sediment from the frac tanks is removed, characterized as hazardous or non-hazardous waste, and disposed of off-site accordingly.
2. Surge the well screen across 5-foot intervals (or less depending on the screen length) for a minimum of 10 minutes using a surge block specifically designed for a 4-inch diameter well. Surging will be performed across the top of the screen, moving downward. Care will be taken during surging to avoid damage to the well screen and filter pack. If water is not present in the extraction well above the top of the well screen, then the well will be jetted prior to surging to ensure that the entire well screen is cleaned.
3. Overpump groundwater within the well until the turbidity is below 100 NTUs or the well has been pumped dry.

4.4 TROUBLESHOOTING MATRIX

The following table summarizes conditions that are expected to be encountered during operation and monitoring of the SVE system, as well as the recommended adjustments and/or maintenance.

Condition	Possible Cause	Recommended Adjustment/Maintenance
Low flowrate with an extraction well (e.g., less than 8 scfm)	1. Occluded well screen 2. Biofouling within stinger 3. Reduced vacuum within SVE transmission line(s)	1. Gauge fluid levels and total depth to determine if the well screen is occluded by groundwater or sediment. If the well screen is occluded with groundwater then refer to Figure 12 for SVE and TPE well adjustments. If the well screen is occluded with sediment, then redevelop the extraction well as described in Section 4.3. 2. Remove and inspect the stinger within the TPE well for the presence of biofouling. If biofouling is present, clean or replace the stinger as necessary. 3. Measure casing vacuum to determine if there is reduced flow within the SVE transmission line(s) due to accumulated sediment and/or groundwater. If system vacuum is reduced, then perform line sweeping to remove accumulated groundwater and sediment as described in Section 4.1. If line sweeping is not successful, determine if the transmission line(s) need to be cleaned via chemical treatment, swabbing, water jetting, or an alternative approach.

Condition	Possible Cause	Recommended Adjustment/Maintenance
High flowrate (e.g., greater than 80 scfm)	1. Casing or stinger vacuum is too high 2. Stinger is damaged	1. Reduce flow control valve in the well vault, continue adjustments until flowrate is below 80 scfm. 2. Remove the stinger from the well and examine the stinger for cracked Viton® or well head seals.
High flowrate - continued (e.g., greater than 80 scfm)	3. Extraction well is short circuiting due to preferential flow pathways	3. Examine TVPH, methane, oxygen, and carbon dioxide field screening results. Determine if the sample collected from the well is primarily composed of atmospheric air. Examine boring log and well construction diagrams to evaluate thickness of A Clay. Determine if A Clay was excavated partially or completely during installation of the well vault(s). Examine well vault, piping, valves, and gauges to determine if short circuiting is a result of compromised wellhead components, damaged pipe, or compromised fittings. If the wellhead or vault components are not identified as the cause of short circuiting, the examine construction diagrams and lithology logs for nested or proximal extraction wells to determine if short circuiting could be occurring across overlapping well screens. Once cause of short circuiting has been identified, develop appropriate plan to resolve condition which may include adjusting operations, repairing compromised system components, terminating recovery, or replacing the well as necessary.

Condition	Possible Cause	Recommended Adjustment/Maintenance
Limited exposed screen interval (e.g., less than 2 feet of open well screen)	1. Occluded well screen 2. Biofouling within stinger 3. Stinger is damaged 4. Reduced vacuum within SVE transmission line(s)	1. Gauge fluid levels and total depth to determine if the well screen is occluded by groundwater or sediment. If the well screen is occluded with groundwater then refer to Figure 12 for SVE and TPE well adjustments. If the well screen is occluded with sediment, then redevelop the extraction well as described in Section 4.3. 2. Remove and inspect the stinger within the TPE well for the presence of biofouling. If biofouling is present, clean or replace the stinger as necessary. 3. Remove the stinger from the well and examine the stinger for cracked Viton® or well head seals. 4. Measure casing vacuum to determine if there is reduced flow within the SVE transmission line(s) due to accumulated sediment and/or groundwater. If system vacuum is reduced, then perform line sweeping to remove accumulated groundwater and sediment as described in Section 4.1. If line sweeping is not successful, determine if the transmission line(s) need to be cleaned via chemical treatment, swabbing, water jetting, or an alternative approach.
LNAPL is entrained with vapor and/or groundwater	1. LNAPL is being recovered within SVE or TPE well	1. Gauge fluid levels to determine if the well contains LNAPL or a sheen on the water table. If LNAPL or sheening is present then refer to Figure 13 for SVE and TPE well adjustments.

5.0 ROUTINE REPORTING

The results of the routine monitoring of the SVE collection system will be tabulated and submitted to the USEPA and Illinois EPA within a summary memo on a semiannual basis. This summary memo will include the following:

- Summary of daily groundwater and vapor recovery rates and operational vacuum at the main header
- Details regarding any maintenance items that might have been performed to the vapor collection system components
- Summary of line sweeping activities including the volume of water recovered
- Summary of non-routine well development
- Discrepancies from the proposed schedule and monitoring activities described herein
- SVE system flow balance for individual extraction wells compared with the total SVE system flow measured at the main header
- SVE system contaminant mass balance for the individual extraction wells compared with the total SVE system contaminants measured at the main header

Finally, any modifications to the *Vapor Collection System OMM Plan* will be proposed to the USEPA and Illinois EPA within the semiannual memos.

6.0 REFERENCES

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TABLE

TABLE 1. EXTRACTION WELL AND STINGER DETAIL SUMMARY
HARTFORD PETROLEUM RELEASE SITE, HARTFORD, ILLINOIS

Well ID	Zone	Shallow/ Deep	Screen Location	Considered Part of System[1] (Y/N)	Operated in Last Two Years (Y/N)	Line Sweeping (Y/N)	Top of Screen (ft-btoc)	Bottom of Screen (ft-btoc)	Screen Length (feet)	Stinger Type	Stinger Diameter (inches)	Flow Meter Type	Dillution Port Present?	Summary of Operation Parameters for 2014 through mid-2015					
														Air Flow Rate less than 8 scfm	TVPH Measurements (ppmv) < 10	< 100	< 1,000	< 10,000	> 10,000
HSVE-001D	Zone 6	Deep	N. Olive	Y	Y	N	5.76	15.76	10.00	Flow Tube	2.0	Pitot Tube							X
HSVE-001S	Zone 6	Shallow	N. Olive	Y	Y	N	6.69	11.09	4.40	Flow Tube	2.0	Pitot Tube					X		
HSVE-002D	Zone 1	Deep	Multiple Strata	N							**ABANDONED**								
HSVE-002S	Zone 1	Shallow	N. Olive	N							**ABANDONED**								
HSVE-003D	Zone 1	Deep	Multiple Strata	Y	Y	Y	6.77	26.17	19.40	Flow Tube	2.0	Pitot Tube							X
HSVE-003S	Zone 1	Shallow	N. Olive	Y	Y	Y	6.56	16.06	9.50	None	--	Pitot Tube						X	
HSVE-004D	Zone 1	Deep	Multiple Strata	Y	Y	N	6.67	26.07	19.40	None	--	Pitot Tube							X
HSVE-004R	Zone 1	Deep	Multiple Strata	Y	Y	Y	9.54	34.54	25.00	Viton Stinger	1.0	Pitot Tube							X
HSVE-004S	Zone 1	Shallow	N. Olive	Y	Y	N	6.56	16.06	9.50	None	--	Pitot Tube					X		
HSVE-005D[2]	Zone 2	Deep	Multiple Strata	N	N	N	6.69	26.09	19.40	None	--	Pitot Tube							
HSVE-005R	Zone 2	Deep	Rand	Y	Y	Y	11.20	19.07	7.87	Viton Stinger	1.0	Venturi						X	
HSVE-005S[2]	Zone 2	Shallow	N. Olive	N	N	N	5.81	10.31	4.50	None	--	Pitot Tube							
HSVE-006D	Zone 2	Deep	Rand	N	N	N	6.74	26.14	19.40	None	--	Pitot Tube							
HSVE-006R	Zone 2	Deep	Main Sand	Y	Y	N	27.12	31.12	4.00	None	--	Venturi							X
HSVE-006R2[3]	Zone 2	Deep	Multiple Strata	N	N	N	9.72	34.72	25.00	None	--	Pitot Tube							
HSVE-006S	Zone 2	Shallow	A Clay	N	N	N	6.27	10.67	4.40	None	--	Pitot Tube							
HSVE-007D	Zone 5	Deep	Multiple Strata	Y	Y	Y	6.74	26.14	19.40	Flow Tube	2.0	Pitot Tube						X	
HSVE-007S	Zone 5	Shallow	N. Olive	Y	Y	N	4.76	9.26	4.50	Flow Tube	2.0	Pitot Tube					X		
HSVE-008D	Zone 5	Deep	Multiple Strata	Y	N	N	6.75	26.15	19.40	None	--	Pitot Tube							
HSVE-008S	Zone 5	Shallow	N. Olive	Y	N	N	6.61	11.01	4.40	None	--	Pitot Tube							
HSVE-009D	Zone 5	Deep	Rand	Y	Y	N	6.73	26.13	19.40	None	--	Pitot Tube					X		
HSVE-009S	Zone 5	Shallow	A Clay	Y	Y	N	5.74	10.24	4.50	Flow Tube	2.0	Pitot Tube		X		X			
HSVE-010D	Zone 5	Deep	Multiple Strata	Y	Y	N	6.70	26.10	19.40	Flow Tube	2.0	Pitot Tube						X	
HSVE-010S	Zone 5	Shallow	N. Olive	Y	Y	N	7.83	12.33	4.50	None	--	Pitot Tube				X			
HSVE-011D	Zone 5	Deep	Multiple Strata	N							**ABANDONED**								
HSVE-011S	Zone 5	Shallow	N. Olive	N							**ABANDONED**								
HSVE-012D	Zone 4	Deep	Main Silt	Y	Y	N	6.74	26.14	19.40	Viton Stinger	1.0	Pitot Tube							X
HSVE-012S	Zone 4	Shallow	N. Olive	Y	Y	N	5.66	15.16	9.50	None	--	Pitot Tube				X			
HSVE-013	Zone 4	Shallow	Backfill	N	Y	N	6.09	10.49	4.40	None	--	Pitot Tube					X		
HSVE-014	Zone 4	Shallow	Backfill	N	Y	N	5.14	9.54	4.40	None	--	Pitot Tube				X			
HSVE-015	Zone 4	Shallow	Backfill	N	N	N	3.59	7.99	4.40	None	--	Pitot Tube							
HSVE-016	Zone 4	Shallow	Backfill	N	N	N	0.92	5.32	4.40	None	--	Pitot Tube							
HSVE-017D	Zone 4	Deep	Multiple Strata	Y	Y	N	6.63	26.03	19.40	Flow Tube	2.0	Pitot Tube						X	
HSVE-017S	Zone 4	Shallow	A Clay	Y	Y	Y	5.50	10.20	4.70	Flow Tube	2.0	Pitot Tube				X			
HSVE-018D	Zone 4	Deep	Multiple Strata	Y	Y	N	6.62	26.02	19.40	None	--	Pitot Tube					X		
HSVE-018S	Zone 4	Shallow	A Clay	Y	Y	Y	5.52	10.22	4.70	None	--	Pitot Tube		X		X			
HSVE-019D	Zone 4	Deep	Multiple Strata	Y	Y	N	6.66	26.06	19.40	None	--	Pitot Tube						X	
HSVE-019S	Zone 4	Shallow	N. Olive	Y	Y	Y	4.19	8.89	4.70	Viton Stinger	1.5	Pitot Tube				X			
HSVE-020D	Zone 1	Deep	Multiple Strata	Y	Y	Y	5.68	25.18	19.50	None	--	Pitot Tube							X
HSVE-020S	Zone 1	Deep	N. Olive	Y	Y	Y	5.69	14.49	8.80	None	--	Pitot Tube					X		
HSVE-021	Zone 3	Deep	Multiple Strata	Y	Y	Y	6.99	26.39	19.40	None	--	Pitot Tube					X		
HSVE-022	Zone 5	Deep	Main Silt	Y	Y	N	6.26	25.76	19.50	Flow Tube	2.0	Pitot Tube						X	
HSVE-023D	Zone 1	Deep	Multiple Strata	Y	Y	Y	6.51	25.91	19.40	None	--	Pitot Tube							X
HSVE-023S	Zone 1	Shallow	N. Olive	Y	Y	N	6.47	15.97	9.50	Flow Tube	2.0	Pitot Tube						X	

TABLE 1. EXTRACTION WELL AND STINGER DETAIL SUMMARY
HARTFORD PETROLEUM RELEASE SITE, HARTFORD, ILLINOIS

Well ID	Zone	Shallow/ Deep	Screen Location	Considered Part of System[1] (Y/N)	Operated in Last Two Years (Y/N)	Line Sweeping (Y/N)	Top of Screen (ft-btoc)	Bottom of Screen (ft-btoc)	Screen Length (feet)	Stinger Type	Stinger Diameter (inches)	Flow Meter Type	Dillution Port Present?	Summary of Operation Parameters for 2014 through mid-2015: Air Flow Rate less than 8 scfm	TVPH Measurements (ppmv): < 10	< 100	< 1,000	< 10,000	> 10,000
HSVE-024D	Zone 1	Deep	Multiple Strata	Y	Y	N	6.58	25.98	19.40	Flow Tube	2.0	Pitot Tube							X
HSVE-024S	Zone 1	Shallow	N. Olive	Y	Y	N	7.51	17.01	9.50	Flow Tube	2.0	Pitot Tube							X
HSVE-025D	Zone 1	Deep	Multiple Strata	Y	Y	Y	6.77	26.37	19.60	Viton Stinger	1.0	Pitot Tube						X	
HSVE-025S	Zone 1	Shallow	N. Olive	N						**ABANDONED**									
HSVE-026D	Zone 1	Deep	Multiple Strata	Y	Y	Y	6.53	26.13	19.60	Viton Stinger	1.0	Pitot Tube					X		
HSVE-026S	Zone 1	Shallow	N. Olive	N						**ABANDONED**									
HSVE-027D	Zone 1	Deep	Rand	Y	Y	N	19.16	25.66	6.50	Viton Stinger	1.0	Pitot Tube							X
HSVE-027S	Zone 1	Shallow	N. Olive	N						**ABANDONED**									
HSVE-028D	Zone 5	Deep	Rand	N	Y	N	18.12	24.62	6.50	None	--	Pitot Tube							X
HSVE-028S	Zone 5	Shallow	N. Olive	Y	Y	N	7.14	11.64	4.50	Viton Stinger	1.0	Pitot Tube					X		
HSVE-029D	Zone 5	Deep	Rand	Y	Y	N	18.62	25.12	6.50	Viton Stinger	1.0	Pitot Tube							X
HSVE-029S	Zone 5	Shallow	N. Olive	Y	Y	N	7.63	13.13	5.50	None	--	Pitot Tube				X			
HSVE-030D	Zone 6	Deep	Rand	Y	N	N	18.72	24.22	5.50	Viton Stinger	1.0	Pitot Tube							X
HSVE-030S	Zone 6	Shallow	N. Olive	Y	Y	N	7.38	12.88	5.50	Viton Stinger	1.5	Pitot Tube						X	
HSVE-031D	Zone 3	Deep	Main Silt	Y	Y	N	14.07	23.56	9.49	None	--	Venturi						X	
HSVE-031DP[4]	Zone 4	Deep	Main Silt	N	N	N	14.05	23.53	9.48	None	--	--							
HSVE-031S	Zone 6	Shallow	A Clay	N	N	N	6.09	8.09	2.00	None	--	Venturi							
HSVE-032H[5]	Zone 4	Shallow	Backfill	N	N	N	11.02	11.02	--	None	--	--							
HSVE-033	Zone 3	Deep	Main Silt	Y	Y	N	13.61	21.09	7.48	None	--	Venturi					X		
HSVE-034	Zone 3	Deep	Main Silt	Y	Y	Y	12.44	21.95	9.51	None	--	Venturi					X		
HSVE-035	Zone 2	Deep	Main Silt	Y	Y	Y	15.52	25.13	9.61	None	--	Venturi					X		
HSVE-036	Zone 2	Deep	Main Silt	Y	Y	Y	12.15	24.68	12.53	Viton Stinger	1.0	Venturi							X
HSVE-037	Zone 2	Deep	Main Silt	Y	Y	Y	12.81	22.32	9.51	None	--	Venturi						X	
HSVE-038	Zone 2	Deep	Main Silt	Y	Y	N	12.18	21.70	9.52	None	--	Venturi						X	
HSVE-039	Zone 2	Deep	Main Silt	Y	Y	Y	14.13	23.65	9.52	Viton Stinger	1.0	Venturi							X
HSVE-040	Zone 2	Deep	Main Silt	Y	Y	N	14.69	24.19	9.50	Viton Stinger	1.5	Venturi							X
HSVE-041	Zone 2	Deep	Main Silt	Y	Y	Y	14.86	23.43	8.57	Viton Stinger	1.0	Venturi							X
HSVE-042	Zone 2	Deep	Main Silt	Y	Y	N	16.47	25.00	8.53	Viton Stinger	1.0	Venturi							X
HSVE-043	Zone 2	Deep	Rand	Y	Y	N	17.31	21.79	4.48	None	--	Venturi					X		
HSVE-044	Zone 2	Deep	Rand	Y	Y	N	19.00	22.51	3.51	None	--	Venturi			X				
HSVE-045	Zone 2	Deep	Rand	Y	N	N	19.19	23.67	4.48	Straw Stinger	0.5	Venturi			X				
HSVE-047	Zone 2	Deep	Rand	Y	Y	N	16.19	20.68	4.49	Viton Stinger	1.0	Venturi						X	
HSVE-048	Zone 2	Deep	Main Silt	Y	Y	Y	16.95	26.47	9.52	Viton Stinger	1.0	Venturi							X
HSVE-049	Zone 2	Deep	Main Silt	Y	Y	N	17.04	24.64	7.60	Viton Stinger	1.0	Venturi							X
HSVE-050	Zone 2	Deep	Main Silt	Y	Y	N	14.27	23.78	9.51	Viton Stinger	1.0	Venturi							X
HSVE-051	Zone 2	Deep	Main Silt	Y	Y	N	15.02	24.54	9.52	Viton Stinger	1.5	Venturi							X
HSVE-052	Zone 5	Deep	Rand	Y	Y	Y	17.63	22.12	4.49	Viton Stinger	1.0	Venturi							X
HSVE-053	Zone 5	Deep	Rand	Y	Y	Y	16.44	20.93	4.49	Viton Stinger	1.5	Venturi							X
HSVE-054	Zone 5	Deep	Multiple Strata	Y	Y	Y	13.56	23.08	9.52	None	--	Venturi						X	
HSVE-055	Zone 6	Deep	Rand	Y	N	Y	17.41	23.96	6.55	None	--	Venturi							X
HSVE-056	Zone 6	Deep	Rand	Y	N	Y	16.57	23.12	6.55	Straw Stinger	0.5	Venturi							X
HSVE-057	Zone 6	Deep	Rand	Y	N	N	20.46	27.07	6.61	Straw Stinger	0.5	Venturi							X
HSVE-058	Zone 6	Shallow	N. Olive	Y	Y	N	9.59	15.12	5.53	Viton Stinger	1.0	Venturi							X
HSVE-059	Zone 6	Deep	Rand	Y	N	N	17.54	25.11	7.57	Straw Stinger	0.5	Venturi						X	

TABLE 1. EXTRACTION WELL AND STINGER DETAIL SUMMARY
HARTFORD PETROLEUM RELEASE SITE, HARTFORD, ILLINOIS

Well ID	Zone	Shallow/ Deep	Screen Location	Considered Part of System[1] (Y/N)	Operated in Last Two Years (Y/N)	Line Sweeping (Y/N)	Top of Screen (ft-btoc)	Bottom of Screen (ft-btoc)	Screen Length (feet)	Stinger Type	Stinger Diameter (inches)	Flow Meter Type	Dillution Port Present?	Summary of Operation Parameters for 2014 through mid-2015: Air Flow Rate less than 8 scfm	TVPH Measurements (ppmv): < 10	< 100	< 1,000	< 10,000	> 10,000
HSVE-060	Zone 6	Deep	Rand	Y	Y	N	17.83	24.31	6.48	Straw Stinger	0.5	Venturi					X		
HSVE-061	Zone 6	Shallow	N. Olive	Y	Y	N	11.75	16.24	4.49	Straw Stinger	0.5	Venturi		X					X
HSVE-062	Zone 6	Shallow	N. Olive	Y	Y	Y	6.12	9.65	3.53	Viton Stinger	1.0	Venturi							X
HSVE-063	Zone 6	Deep	Rand	Y	Y	Y	14.55	21.07	6.52	Straw Stinger	0.5	Venturi				X			
HSVE-064	Zone 6	Shallow	N. Olive	Y	Y	Y	8.41	10.91	2.50	None	--	Venturi					X		
HSVE-065	Zone 6	Deep	Rand	Y	N	N	14.48	21.02	6.54	Straw Stinger	0.5	Venturi				X			
HSVE-066	Zone 6	Deep	Rand	Y	N	N	17.54	21.06	3.52	Straw Stinger	0.5	Venturi			X				
HSVE-067	Zone 6	Shallow	N. Olive	Y	Y	N	8.48	12.00	3.52	Straw Stinger	0.5	Venturi				X			
HSVE-068	Zone 6	Deep	Rand	Y	Y	N	17.47	20.98	3.51	Straw Stinger	0.5	Venturi					X		
HSVE-069	Zone 6	Deep	Rand	Y	Y	N	18.59	22.10	3.51	Straw Stinger	0.5	Venturi					X		
HSVE-070	Zone 6	Shallow	N. Olive	Y	Y	N	8.60	13.08	4.48	Viton Stinger	1.0	Venturi						X	
HSVE-071	Zone 6	Deep	Rand	Y	Y	Y	17.58	25.13	7.55	Viton Stinger	1.0	Venturi							X
HSVE-072	Zone 6	Deep	Rand	Y	Y	Y	17.70	22.19	4.49	Viton Stinger	1.0	Venturi	X						X
HSVE-073	Zone 6	Deep	Rand	Y	N	N	17.55	21.07	3.52	Straw Stinger	0.5	Venturi					X		
HSVE-074	Zone 6	Shallow	N. Olive	Y	Y	N	9.49	13.00	3.51	Viton Stinger	1.0	Venturi				X			
HSVE-075	Zone 6	Deep	Rand	Y	N	N	19.54	23.06	3.52	None	--	Venturi					X		
HSVE-076	Zone 6	Deep	Rand	Y	Y	N	18.66	22.17	3.51	Viton Stinger	1.0	Venturi	X						X
HSVE-077	Zone 6	Shallow	N. Olive	Y	Y	N	8.65	13.13	4.48	Viton Stinger	1.0	Venturi							X
HSVE-078	Zone 5	Deep	Rand	Y	Y	Y	17.55	21.08	3.53	Viton Stinger	1.0	Venturi		X					X
HSVE-079	Zone 5	Deep	Rand	Y	Y	N	17.23	20.75	3.52	None	--	Venturi	X	X					X
HSVE-080	Zone 5	Shallow	N. Olive	Y	Y	N	8.67	13.16	4.49	None	--	Venturi						X	
HSVE-081	Zone 5	Deep	Rand	Y	Y	N	18.42	21.94	3.52	None	--	Venturi							X
HSVE-082	Zone 5	Shallow	N. Olive	Y	Y	N	9.62	13.13	3.51	Straw Stinger	0.5	Venturi						X	
HSVE-083	Zone 5	Deep	Rand	Y	Y	N	19.17	22.67	3.50	None	--	Venturi							X
HSVE-084	Zone 5	Deep	Rand	Y	Y	N	19.77	23.29	3.52	None	--	Venturi							X
HSVE-085	Zone 5	Deep	Rand	Y	Y	N	18.38	22.38	4.00	Viton Stinger	1.0	Venturi							X
HSVE-086	Zone 5	Shallow	N. Olive	Y	Y	N	8.47	12.95	4.48	Viton Stinger	1.0	Venturi					X		
HSVE-087	Zone 4	Deep	Rand	Y	Y	N	18.72	23.21	4.49	Viton Stinger	1.5	Venturi							X
HSVE-088	Zone 4	Deep	Rand	Y	Y	N	20.25	22.74	2.49	Viton Stinger	1.0	Venturi	X						X
HSVE-089	Zone 4	Shallow	N. Olive	Y	Y	N	8.36	14.91	6.55	Viton Stinger	1.5	Venturi						X	
HSVE-090	Zone 4	Deep	Main Silt	Y	Y	N	21.36	24.88	3.52	Viton Stinger	1.0	Venturi	X						X
HSVE-091	Zone 4	Deep	Main Silt	Y	Y	N	21.54	25.05	3.51	Viton Stinger	1.0	Venturi							X
HSVE-092	Zone 4	Shallow	N. Olive	Y	Y	N	9.28	13.77	4.49	Viton Stinger	1.5	Venturi					X		
HSVE-093	Zone 4	Deep	Main Silt	Y	Y	N	22.54	26.05	3.51	Viton Stinger	1.0	Venturi	X						X
HSVE-094	Zone 4	Deep	Main Silt	Y	Y	N	22.23	26.22	3.99	Viton Stinger	1.0	Venturi	X	X					X
HSVE-095	Zone 4	Deep	Main Silt	Y	Y	Y	17.73	25.82	8.09	Viton Stinger	1.5	Venturi							X
HSVE-096	Zone 4	Deep	Rand	Y	Y	Y	17.83	24.83	7.00	Viton Stinger	1.5	Venturi						X	
HSVE-097	Zone 4	Deep	Rand	Y	Y	Y	13.32	22.85	9.53	None	--	Venturi							X
HSVE-098	Zone 2	Shallow	A/B Clay	Y	Y	N	6.60	10.98	4.38	Viton Stinger	0.75	Venturi						X	
HSVE-099	Zone 6	Shallow	Multiple Strata	Y	Y	Y	9.08	15.37	6.29	Viton Stinger	1.0	Venturi	X						X
HSVE-100	Zone 5	Shallow	N. Olive	Y	Y	Y	8.77	15.08	6.31	Viton Stinger	1.0	Venturi							X
HSVE-101	Zone 5	Shallow	N. Olive	Y	Y	N	9.11	14.92	5.81	Viton Stinger	1.5	Venturi						X	
HSVE-102	Zone 1	Shallow	N. Olive	Y	Y	Y	12.60	16.60	4.00	Viton Stinger	1.0	Venturi						X	
HSVE-103	Zone 1	Shallow	A/B Clay	Y	Y	Y	6.60	16.00	9.40	Viton Stinger	1.0	Venturi	X					X	

TABLE 1. EXTRACTION WELL AND STINGER DETAIL SUMMARY
HARTFORD PETROLEUM RELEASE SITE, HARTFORD, ILLINOIS

Well ID	Zone	Shallow/ Deep	Screen Location	Considered Part of System[1] (Y/N)	Operated in Last Two Years (Y/N)	Line Sweeping (Y/N)	Top of Screen (ft-btoc)	Bottom of Screen (ft-btoc)	Screen Length (feet)	Stinger Type	Stinger Diameter (inches)	Flow Meter Type	Dillution Port Present?	Summary of Operation Parameters for 2014 through mid-2015					
														Air Flow Rate less than 8 scfm	TVPH Measurements (ppmv) < 10	< 100	< 1,000	< 10,000	> 10,000
HSVE-104[3]	Zone 1	Deep	Multiple Strata	N	N	N	9.65	34.65	25.00	None	--	Venturi							
HSVE-105S	Zone 1	Shallow	North Olive	Y	Y	N	13.06	18.06	5.00	Straw Stinger	--	Venturi							X
HSVE-105D	Zone 1	Deep	Main Sand	Y	Y	N	32.68	42.68	10.00	None	1.0	Venturi							
HSVE-106S	Zone 1	Shallow	North Olive	Y	Y	N	9.16	14.16	5.00	None	1.0	Venturi							X
HSVE-106D	Zone 1	Deep	Main Sand	Y	Y	N	29.13	39.13	10.00	Straw Stinger	--	Venturi							X
HSVE-107S	Zone 1	Shallow	North Olive	Y	Y	N	13.03	18.03	5.00	Straw Stinger	1.0	Venturi							X
HSVE-107D	Zone 1	Deep	Main Sand	Y	Y	N	32.80	42.80	10.00	Straw Stinger	1.0	Venturi							X
MPE-A001	Zone 5	Deep	Main Sand	N	Y	N	27.22	49.58	19.47	None	--	Venturi		X					X
MPE-A002	Zone 5	Deep	Main Sand	N	Y	N	27.86	50.15	19.35	None	--	Venturi							X
MPE-A003	Zone 5	Deep	Main Sand	N	Y	N	26.06	48.62	19.45	None	--	Venturi		X					X
MPE-A004	Zone 5	Deep	Main Sand	N	Y	N	28.71	50.06	19.41	None	--	Venturi		X					X
MPE-A005	Zone 5	Deep	Main Sand	N	Y	N	28.22	49.98	19.46	None	--	Venturi							X

Notes:
[1] - Wells are included in the description of soil vapor extraction system provided within the *HSVE Monitoring and Maintenance Manual, Hartford Working Group* (URS 2014a)
[2] - Wells were paved over during recent road repairs performed by the Village of Hartford
[3] - HSVE-006R2 and HSVE-104 were installed but never connected to the SVE system
[4] - HSVE-031DP is a one-inch probe collocated with well HSVE-031D
[5] - HSVE-032H is a horizontal vapor extraction well
ft-btoc - feet below top of casing
NA - not available
-- - not applicable
scfm - standard cubic feet per minute
TVPH - total volatile organic compounds
ppmv - parts per million by volume

FIGURES

EXPLANATION

- ACTIVE SOIL VAPOR EXTRACTION WELL LOCATION
- INACTIVE SOIL VAPOR EXTRACTION WELL LOCATION
- PHASE 1 & 2 VAULT
- PHASE 3 VAULT WITH CLEANOUT ONLY
- PHASE 3 VAULT WITH VALVE & CLEANOUT
- SOIL VAPOR EXTRACTION LINE
- SVE EFFECTIVENESS ZONE

N

0 200 '

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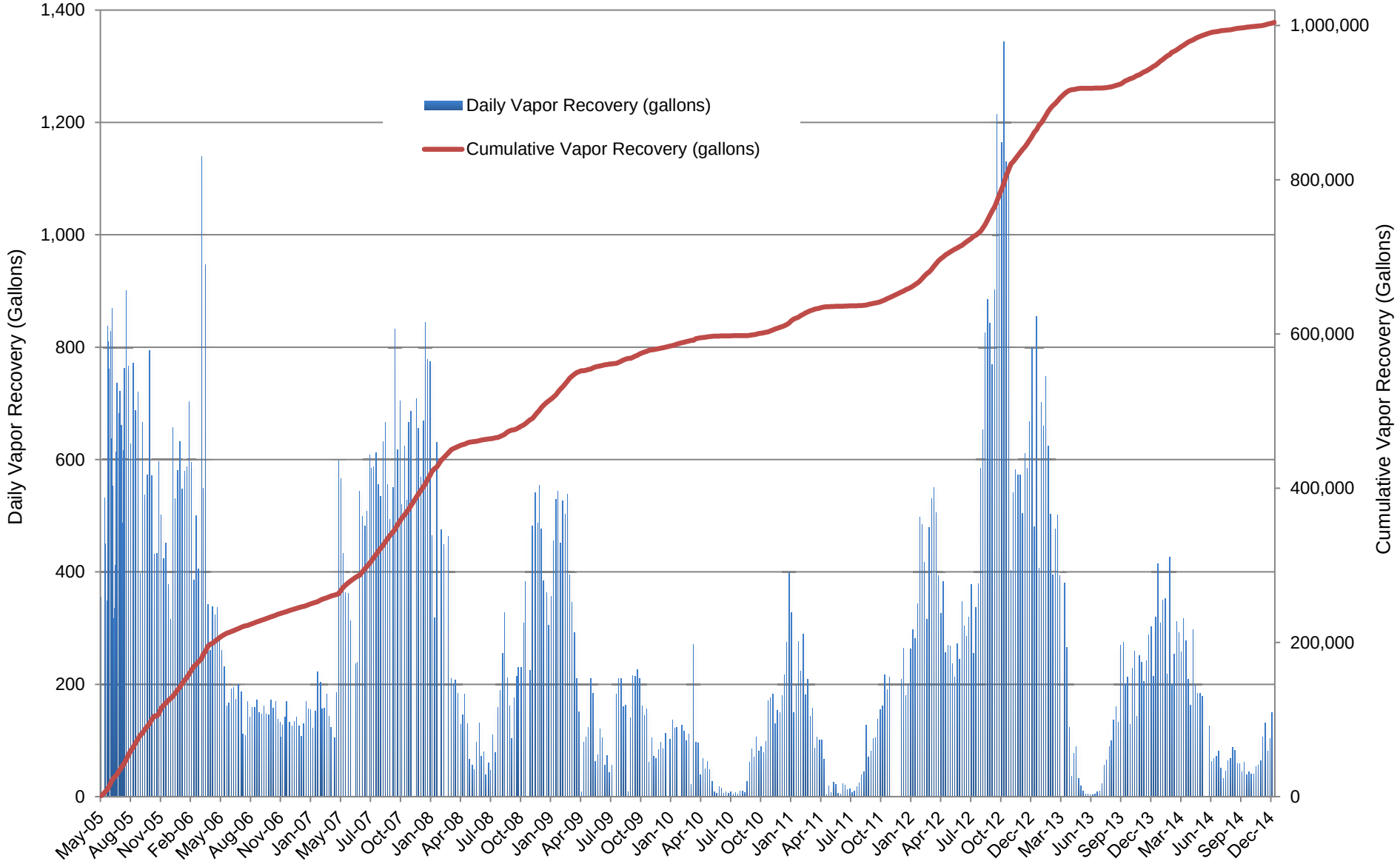
FIGURE 1

HARTFORD SVE SYSTEM LAYOUT

HARTFORD PETROLEUM RELEASE SITE
HARTFORD, ILLINOIS

Drawn By: BR	Checked By: ST	Scale: 1 " = 200 '	Date: 9/4/15	File: Fig1_AOC_SVE_System.mxd

FIGURE 2. VOLATILE PETROLEUM HYDROCARBONS RECOVERED VIA SOIL VAPOR EXTRACTION SYSTEM
HARTFORD PETROLEUM RELEASE SITE
HARTFORD, ILLINOIS



EXPLANATION

- ACTIVE SOIL VAPOR EXTRACTION WELL LOCATION
- INACTIVE SOIL VAPOR EXTRACTION WELL LOCATION
- LINE OF CROSS-SECTION DESIGNATION
- SOIL VAPOR EXTRACTION LINE
- SVE EFFECTIVENESS ZONE

N

0 200 '

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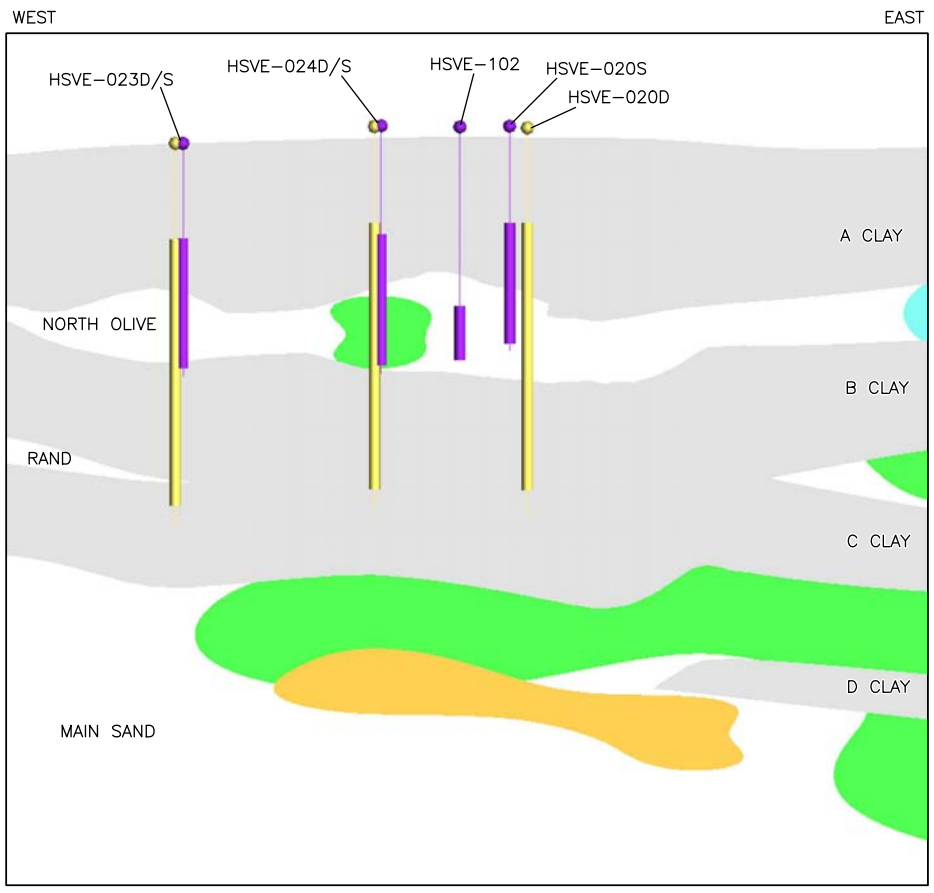
FIGURE 3

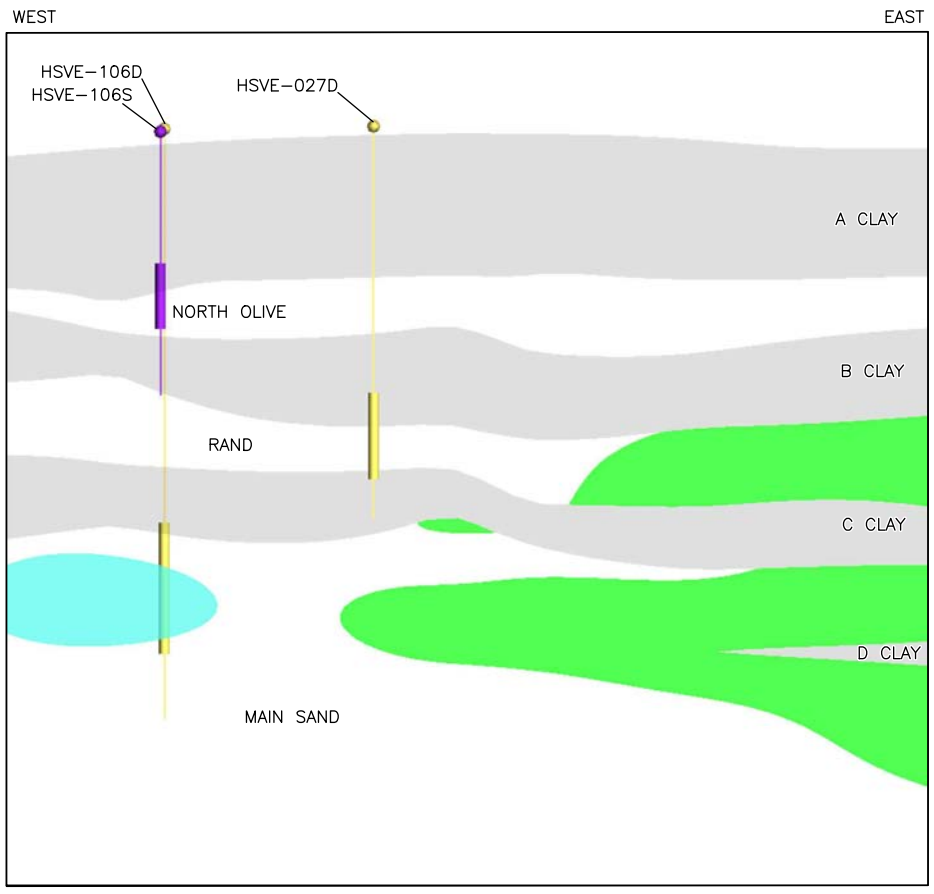
CROSS SECTION LOCATIONS

HARTFORD PETROLEUM RELEASE SITE
HARTFORD, ILLINOIS

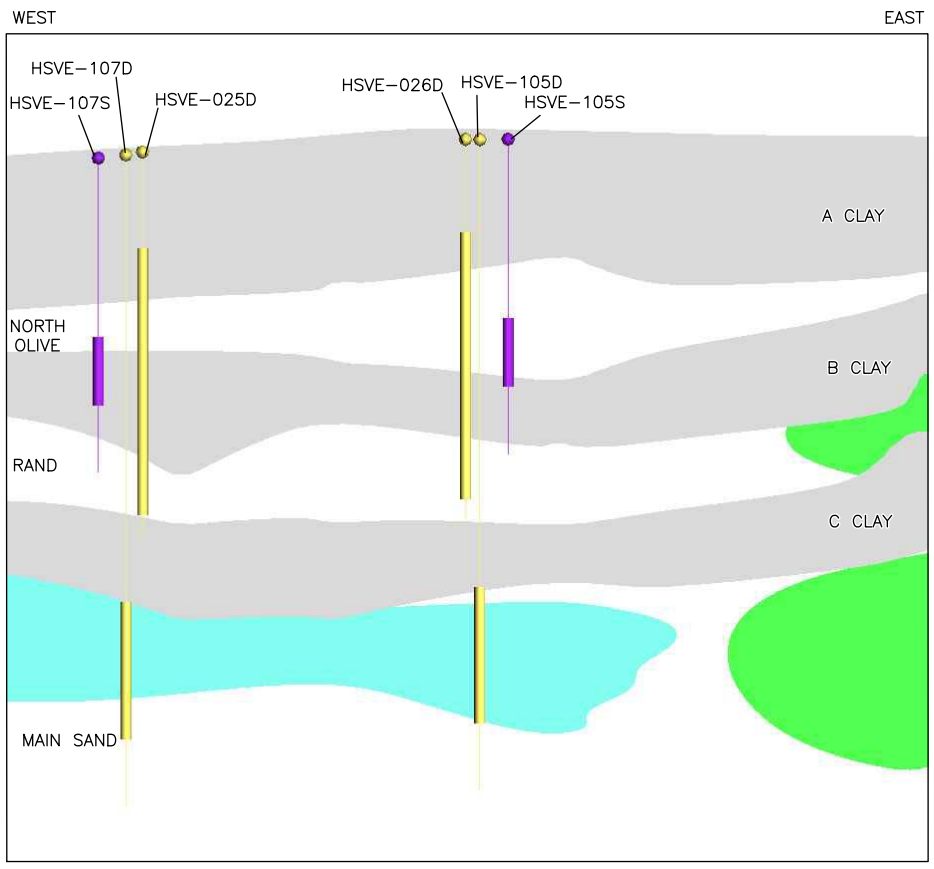
Drawn By: BR	Checked By: ST	Scale: 1 " = 200 '	Date: 9/4/15	File: Fig3_AOC_SVE_xseclocs.mxd



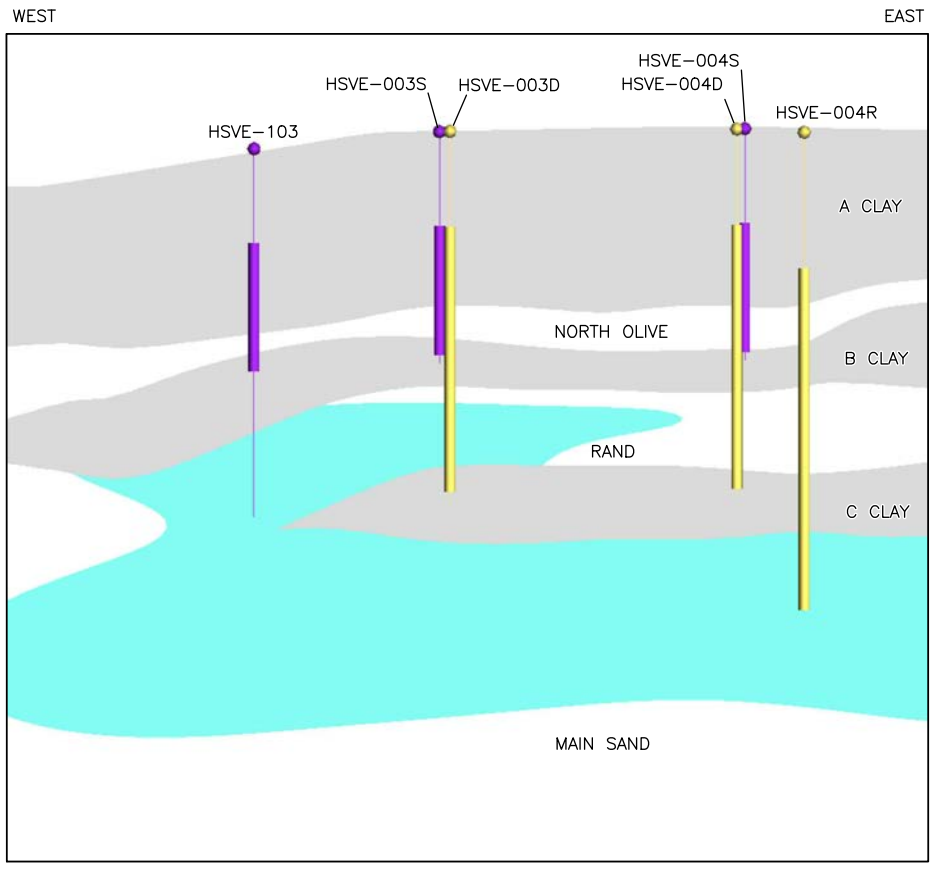
A **COMMUNITY CENTER SECTION**
NOT TO SCALE
VERTICAL EXAGGERATION = 10X



B **WEST ARBOR STREET SECTION**
NOT TO SCALE
VERTICAL EXAGGERATION = 10X



C **WEST BIRCH STREET SECTION**
NOT TO SCALE
VERTICAL EXAGGERATION = 10X



D **WEST CHERRY STREET SECTION**
NOT TO SCALE
VERTICAL EXAGGERATION = 10X

EXPLANATION

- LIGHT-RANGE LNAPL
- MID-RANGE LNAPL
- HEAVY-RANGE LNAPL
- DEEP SVE WELL SCREEN
- SHALLOW SVE WELL SCREEN

NOTE:

1. HSVE-024S AND HSVE-024D ARE LOCATED SOUTH OF THE COMMUNITY CENTER AND ARE PROJECTED ON SECTION A.

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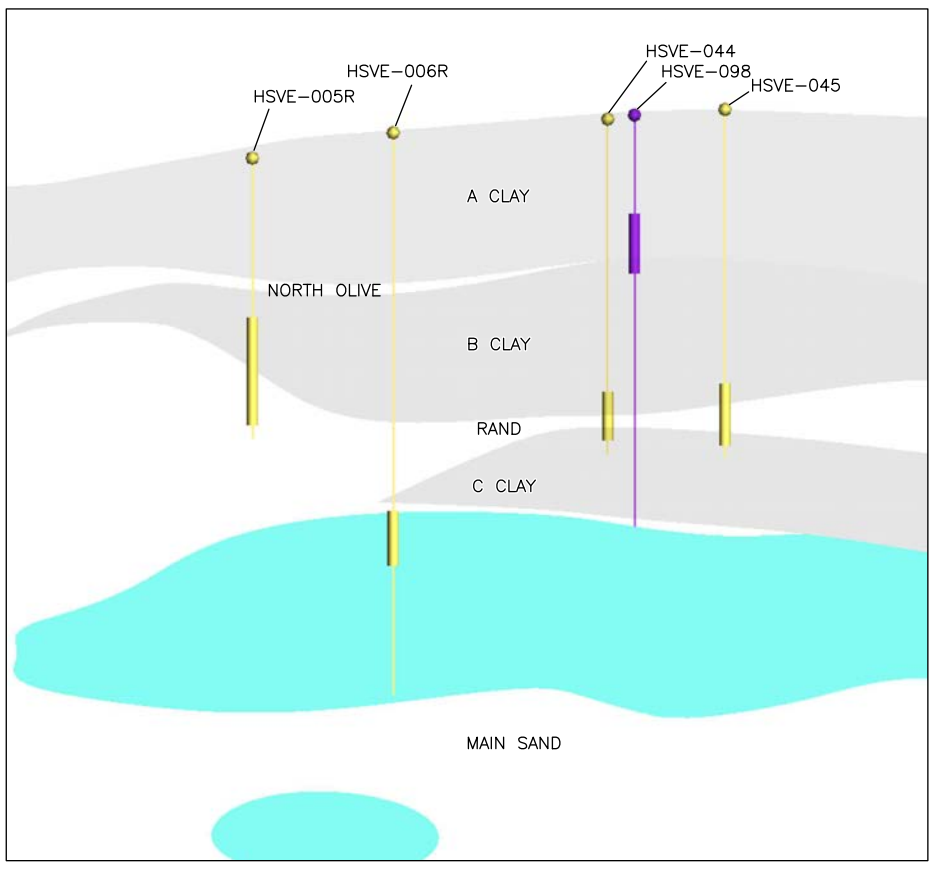
FIGURE 4

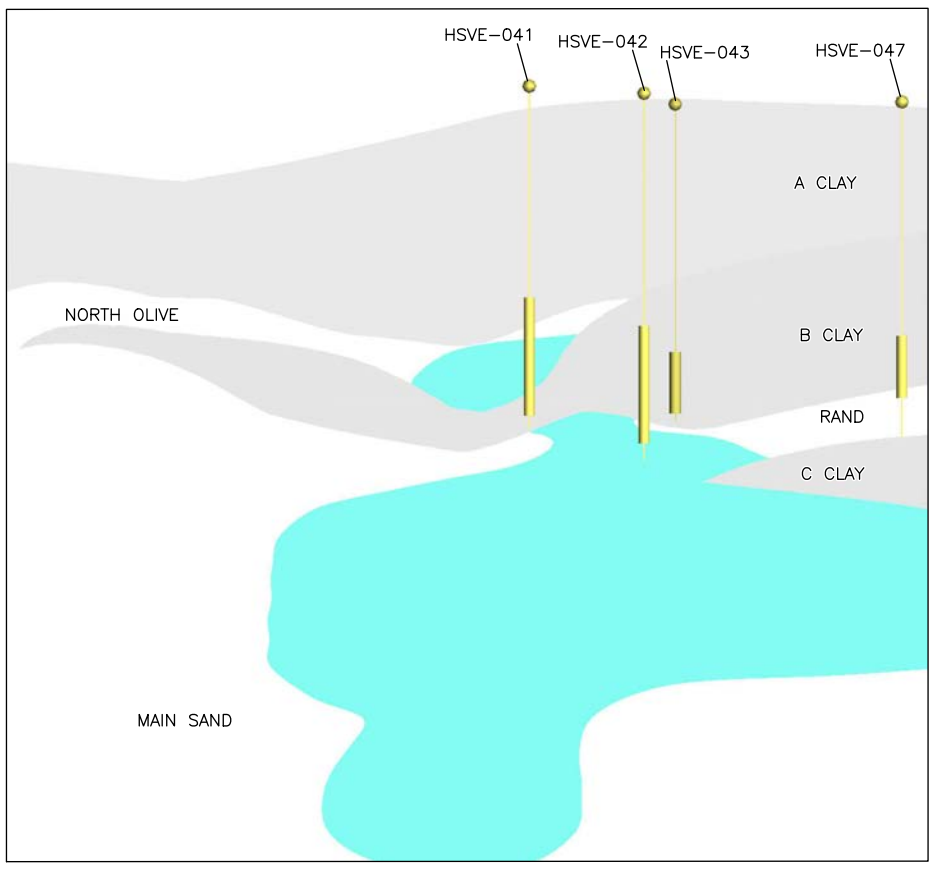
ZONE 1 SVE SYSTEM CROSS SECTIONS

HARTFORD PETROLEUM RELEASE SITE
HARTFORD, ILLINOIS

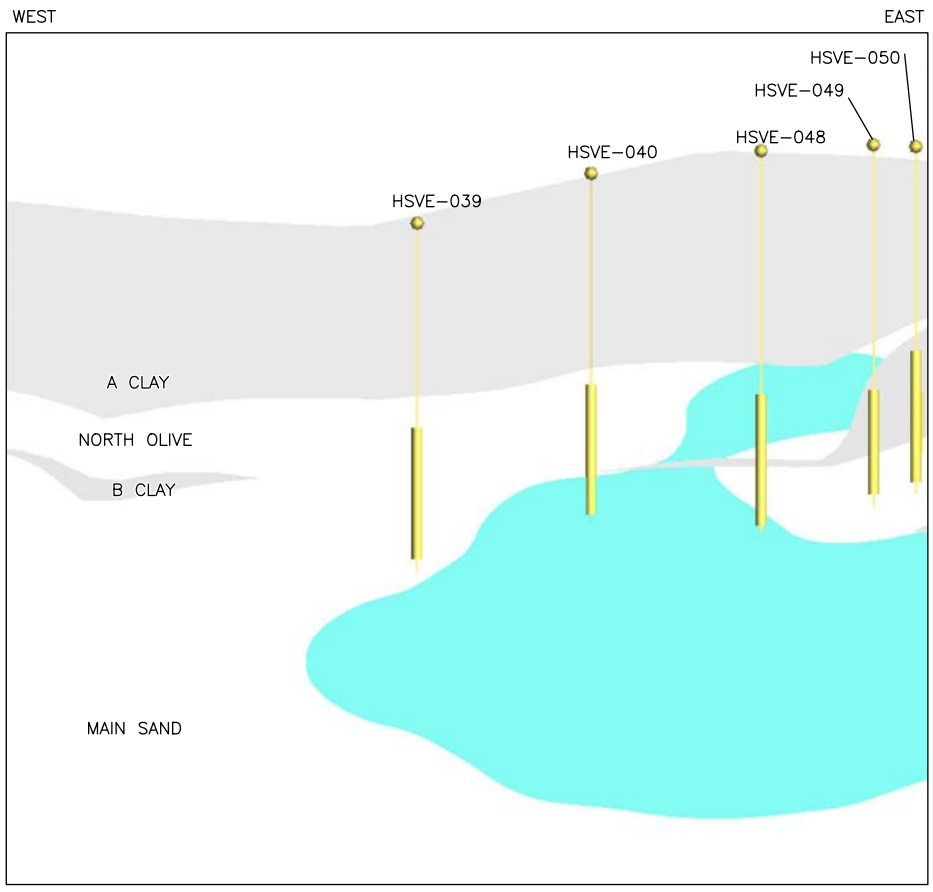
Drawn By: CG	Checked By: ST	Scale: NOT TO SCALE	Date: 4/14/15	File: 24S_HSVE_1_201502



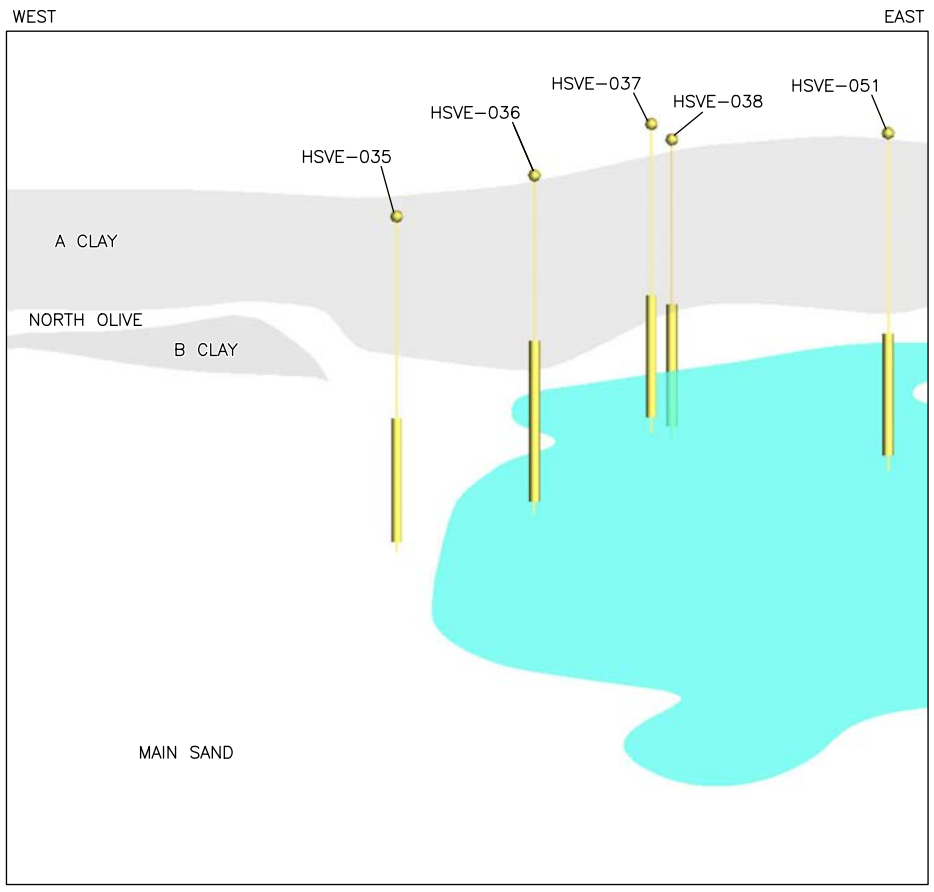
E **WEST DATE STREET SECTION**
NOT TO SCALE
VERTICAL EXAGGERATION = 10X



F **ALLEY BETWEEN WEST DATE STREET AND WEST ELM STREET SECTION**
NOT TO SCALE
VERTICAL EXAGGERATION = 10X



G **WEST ELM STREET SECTION**
NOT TO SCALE
VERTICAL EXAGGERATION = 10X



H **ALLEY BETWEEN WEST ELM STREET AND WEST FOREST STREET SECTION**
NOT TO SCALE
VERTICAL EXAGGERATION = 10X

EXPLANATION

- LIGHT-RANGE LNAPL
- MID-RANGE LNAPL
- HEAVY-RANGE LNAPL
- DEEP SVE WELL SCREEN
- SHALLOW SVE WELL SCREEN

NOTES:

1. HSVE-044 AND HSVE-098 ARE LOCATED NORTH OF WEST DATE STREET AND ARE PROJECTED ON SECTION E.
2. HSVE-043 IS LOCATED NORTH OF THE ALLEY BETWEEN WEST DATE STREET AND WEST ELM STREET AND IS PROJECTED ON SECTION F.
3. HSVE-050 IS LOCATED SOUTH OF WEST ELM STREET AND IS PROJECTED ON SECTION G.
4. HSVE-038 IS LOCATED NORTH OF THE ALLEY BETWEEN WEST ELM STREET AND WEST FOREST STREET AND IS PROJECTED ON SECTION H.

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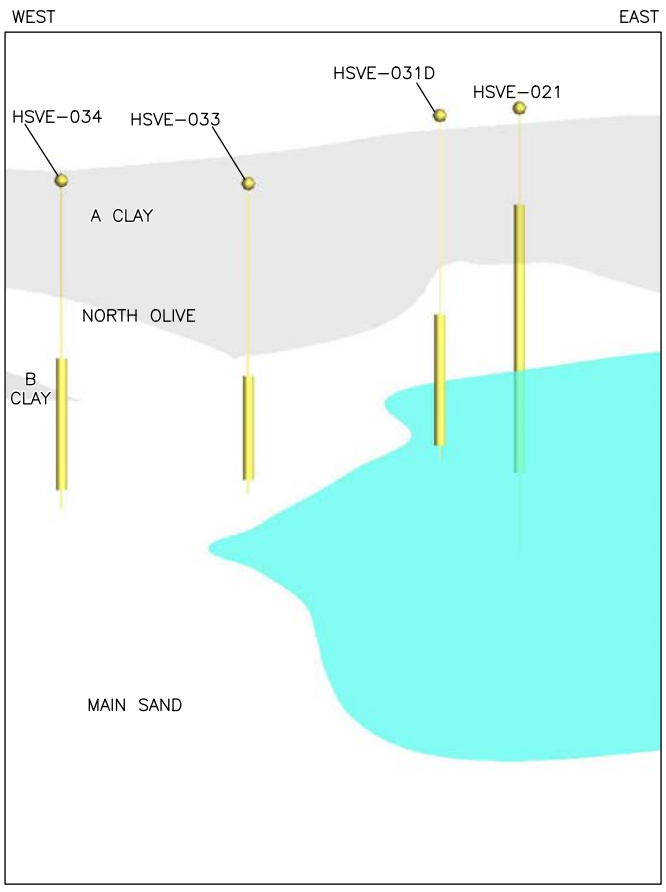
FIGURE 5

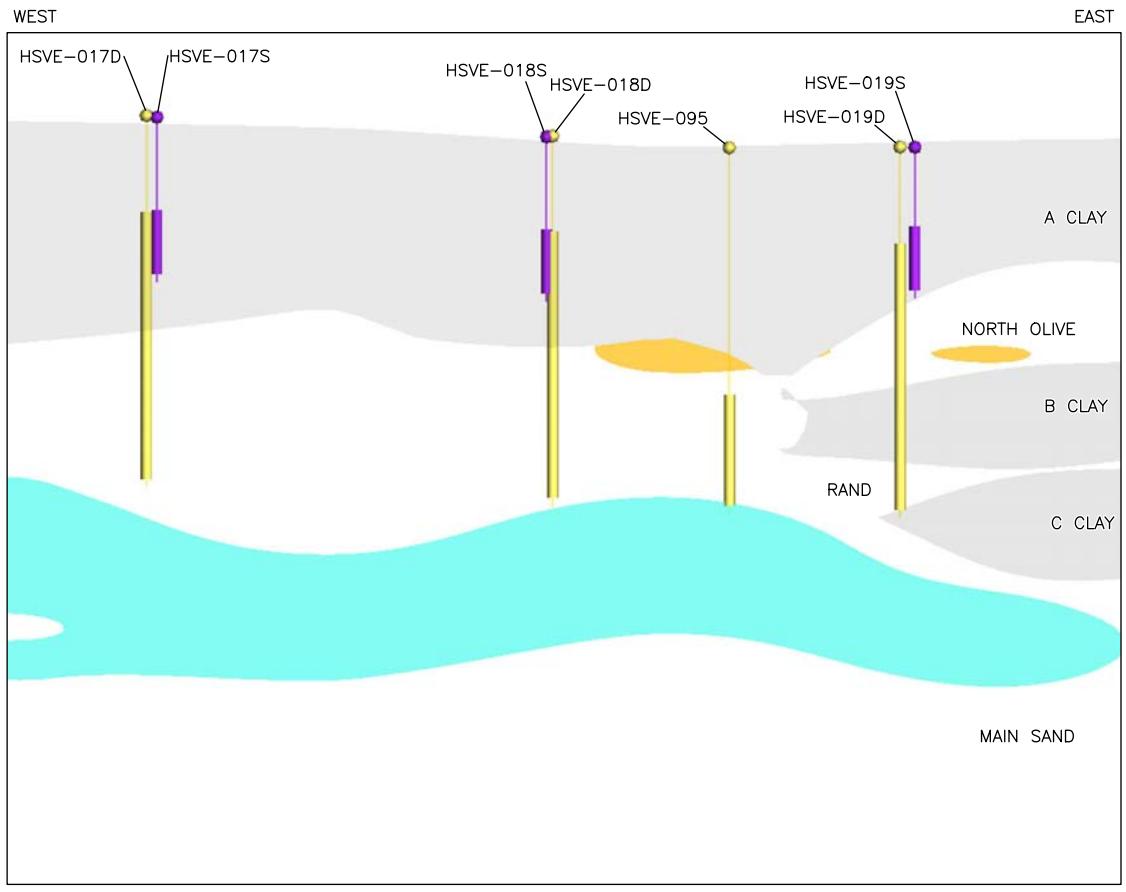
ZONE 2 SVE SYSTEM CROSS SECTIONS

HARTFORD PETROLEUM RELEASE SITE
HARTFORD, ILLINOIS

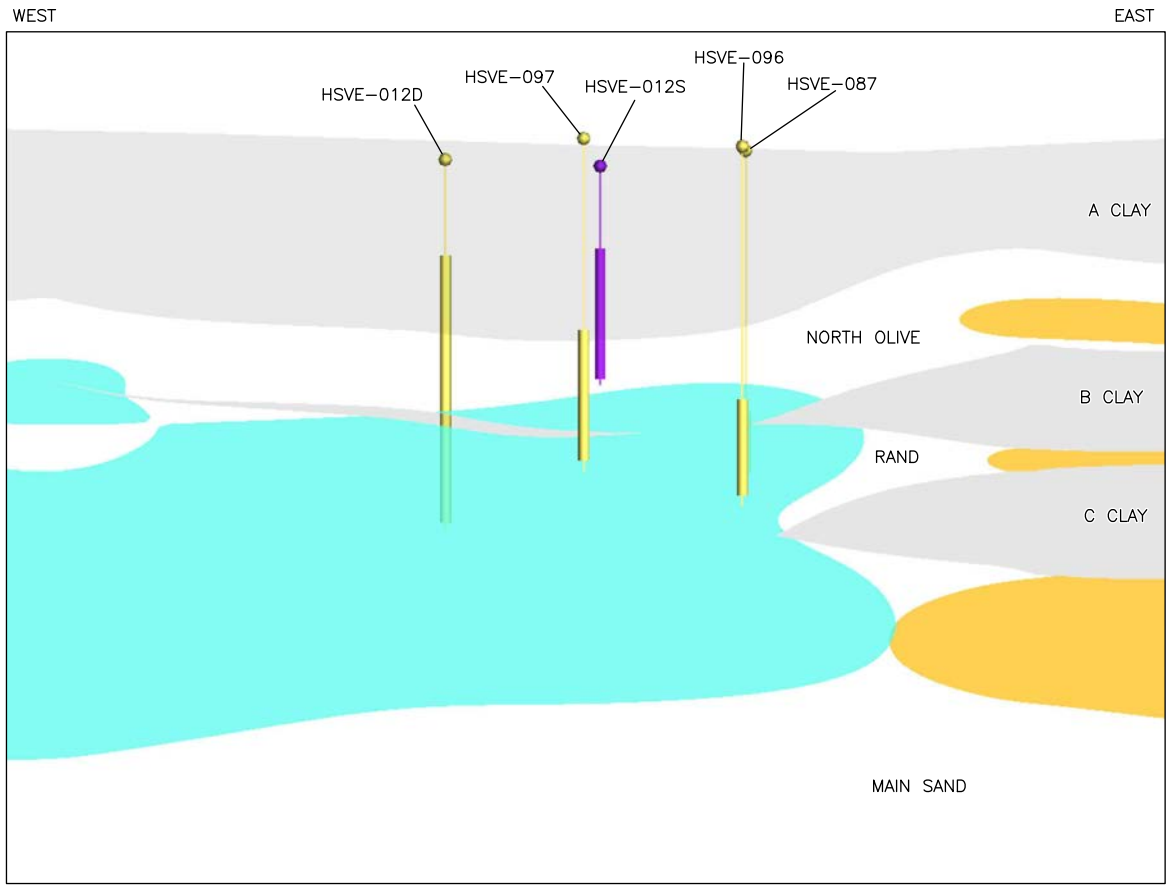
Drawn By: CG	Checked By: ST	Scale: NOT TO SCALE	Date: 4/14/15	File: 24S_HSVE_2_201502



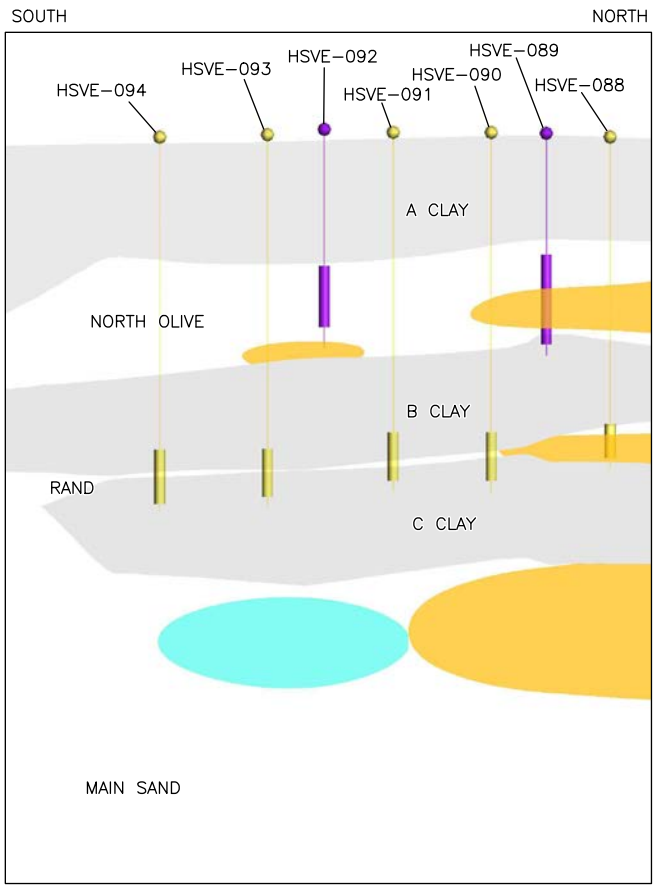
I **WEST FOREST STREET SECTION**
NOT TO SCALE
VERTICAL EXAGGERATION = 10X



J **EAST WATKINS STREET SECTION**
NOT TO SCALE
VERTICAL EXAGGERATION = 10X



K **EAST FOREST STREET SECTION**
NOT TO SCALE
VERTICAL EXAGGERATION = 10X



L **NORTH OLIVE AVENUE BETWEEN EAST FOREST STREET AND EAST WATKINS STREET SECTION**
NOT TO SCALE
VERTICAL EXAGGERATION = 10X

NOTE:

1. HSVE-021 IS LOCATED TO THE NORTH OF WEST FOREST STREET AND IS PROJECTED ON SECTION I.
2. HSVE-096 AND HSVE-097 ARE LOCATED SOUTH OF EAST FOREST STREET (IN THE ALLEY BETWEEN EAST FOREST STREET AND EAST WATKINS STREET) AND ARE PROJECTED ON SECTION K.
3. SECTION I IS LOCATED IN ZONE 3, WHILE SECTIONS J, K AND L ARE LOCATED IN ZONE 4.

EXPLANATION

- LIGHT-RANGE LNAPL
- MID-RANGE LNAPL
- HEAVY-RANGE LNAPL
- DEEP SVE WELL SCREEN
- SHALLOW SVE WELL SCREEN

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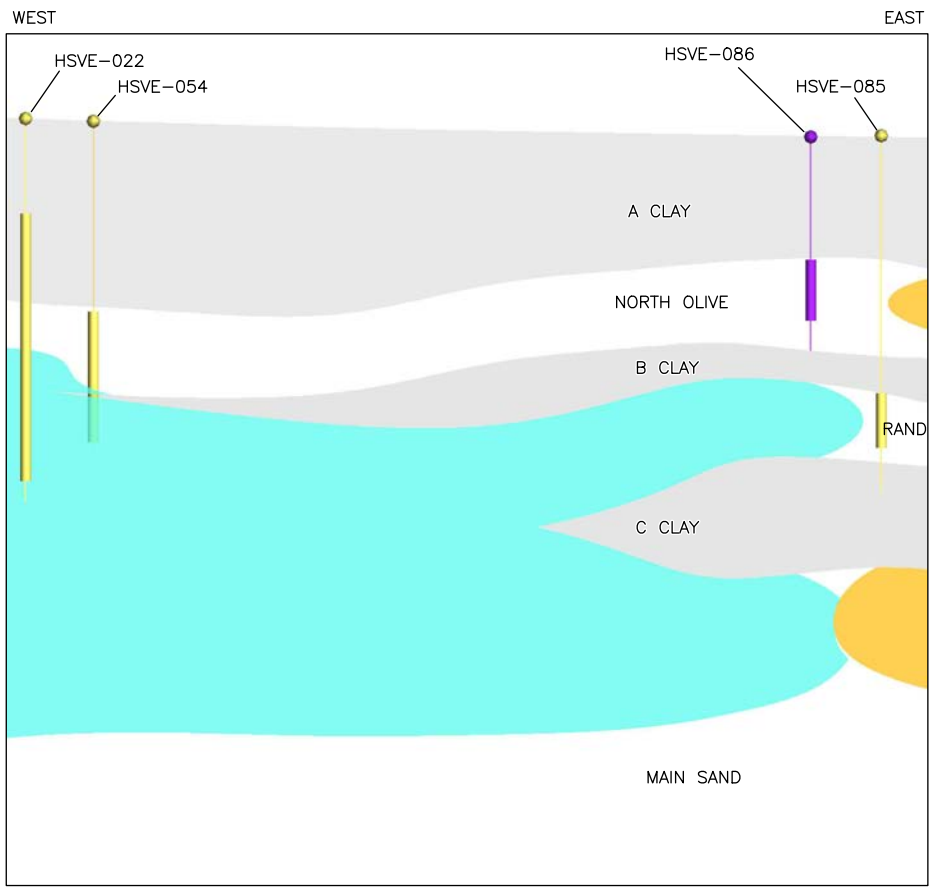
FIGURE 6

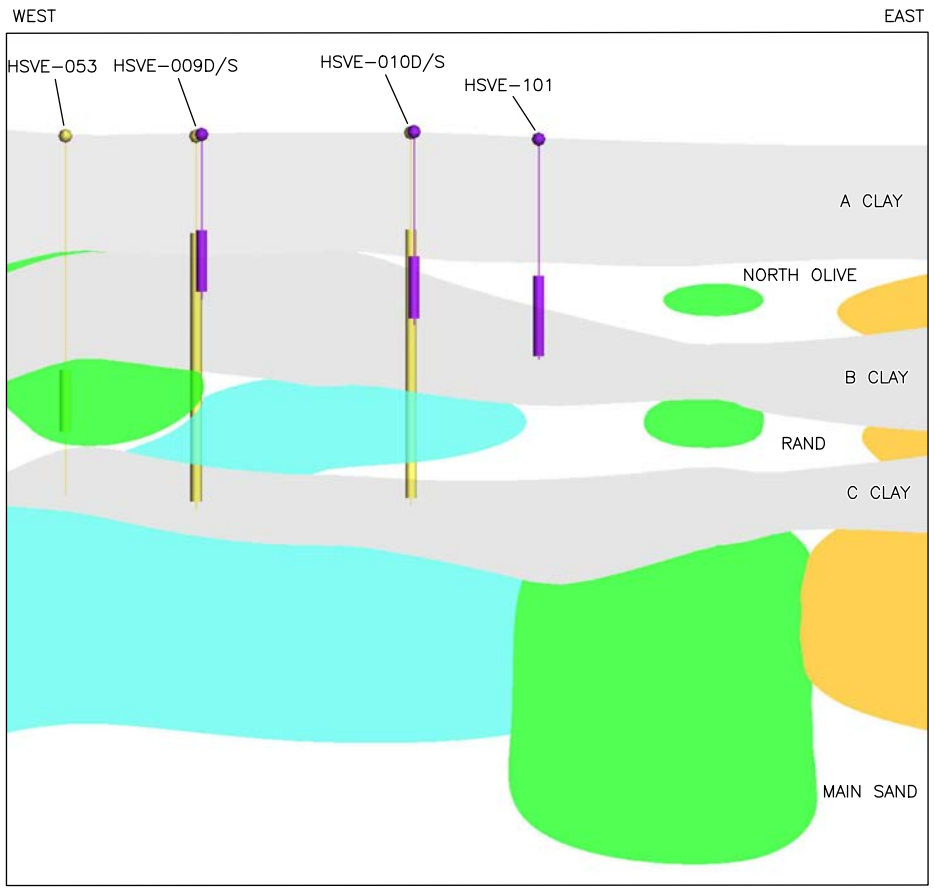
ZONES 3 AND 4 SVE SYSTEM CROSS SECTIONS

HARTFORD PETROLEUM RELEASE SITE
HARTFORD, ILLINOIS

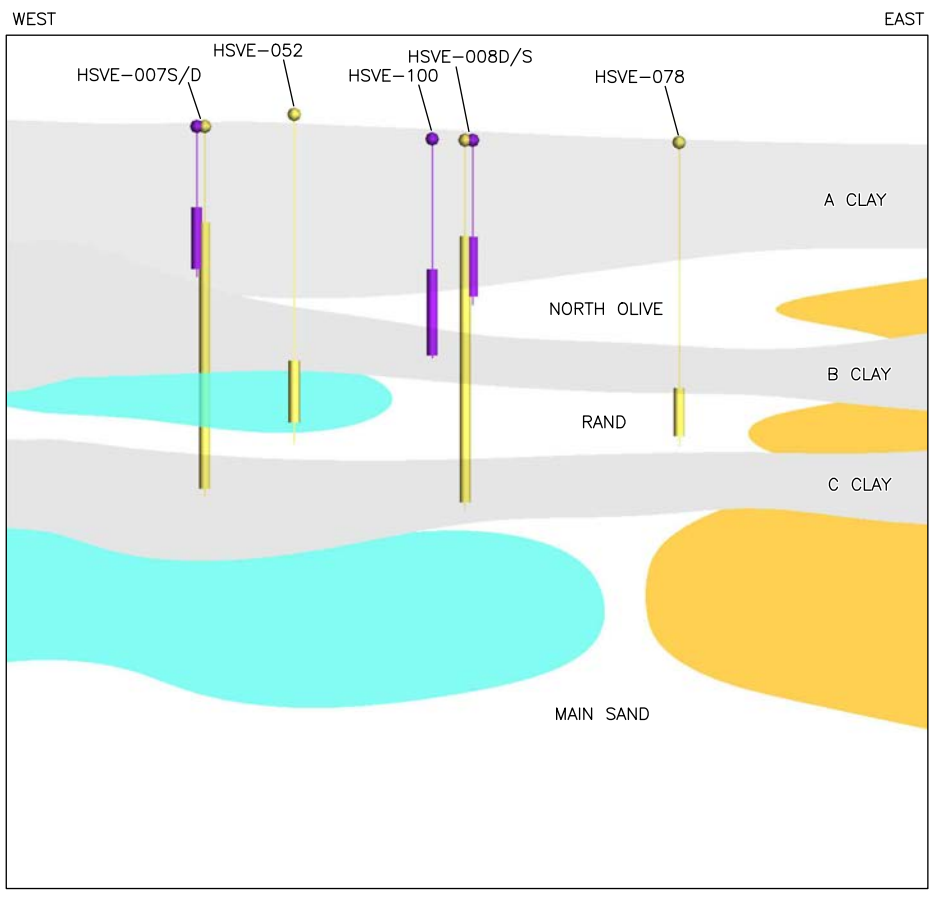
Drawn By: CG	Checked By: ST	Scale: NOT TO SCALE	Date: 9/4/15	File: 24S_HSVE_4_201502



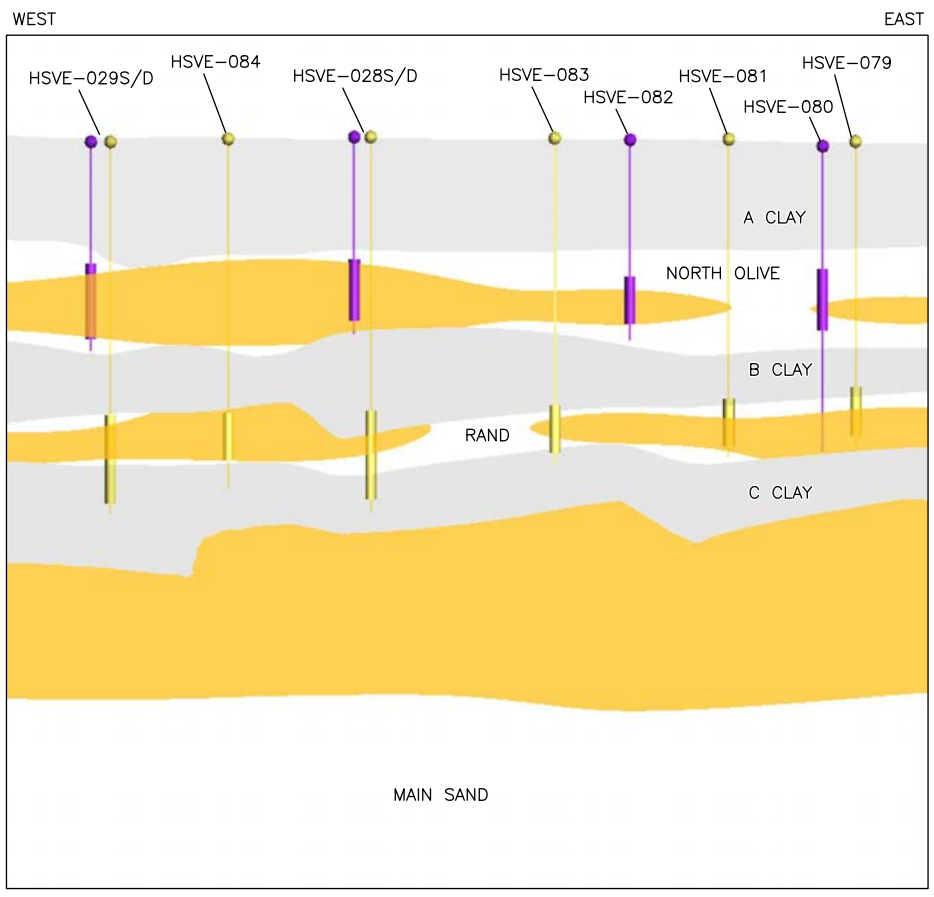
M **EAST FOREST STREET SECTION**
NOT TO SCALE
VERTICAL EXAGGERATION = 10X



N **EAST ELM STREET SECTION**
NOT TO SCALE
VERTICAL EXAGGERATION = 10X



O **EAST DATE STREET SECTION**
NOT TO SCALE
VERTICAL EXAGGERATION = 10X



P **NORTH OLIVE AVENUE BETWEEN EAST DATE STREET AND EAST FOREST STREET SECTION**
NOT TO SCALE
VERTICAL EXAGGERATION = 10X

EXPLANATION

- LIGHT-RANGE LNAPL
- MID-RANGE LNAPL
- HEAVY-RANGE LNAPL
- DEEP SVE WELL SCREEN
- SHALLOW SVE WELL SCREEN

NOTE:

1. HSVE-054 IS LOCATED TO THE NORTH OF EAST FOREST STREET (IN THE ALLEY BETWEEN EAST FOREST STREET AND EAST ELM STREET) AND IS PROJECTED ON SECTION M.
2. HSVE-052 IS LOCATED NORTH OF EAST ELM STREET (IN THE ALLEY BETWEEN EAST ELM STREET AND EAST DATE STREET) AND IS PROJECTED ON SECTION O.

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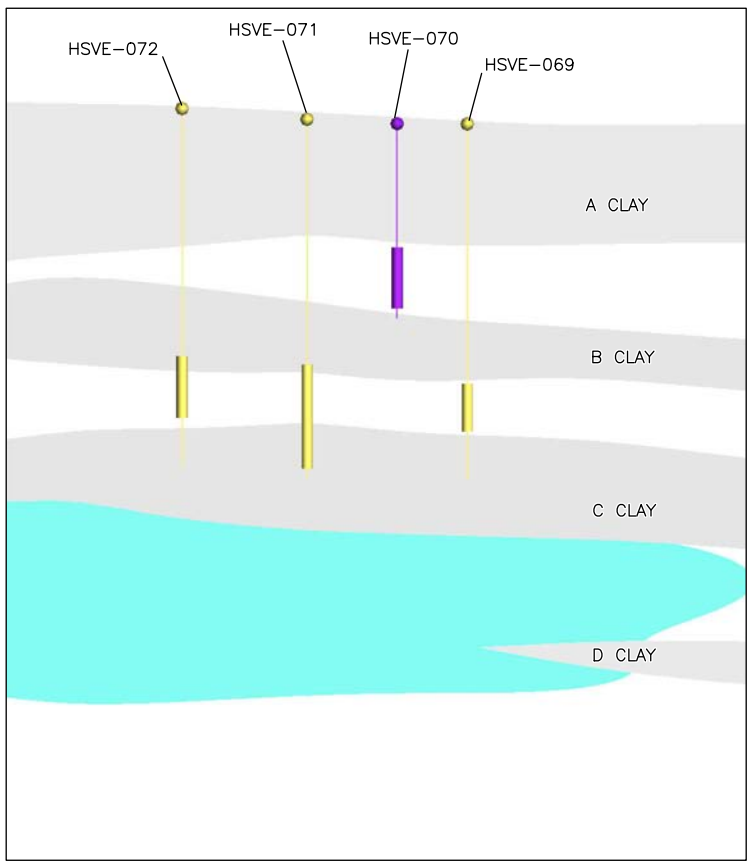
FIGURE 7

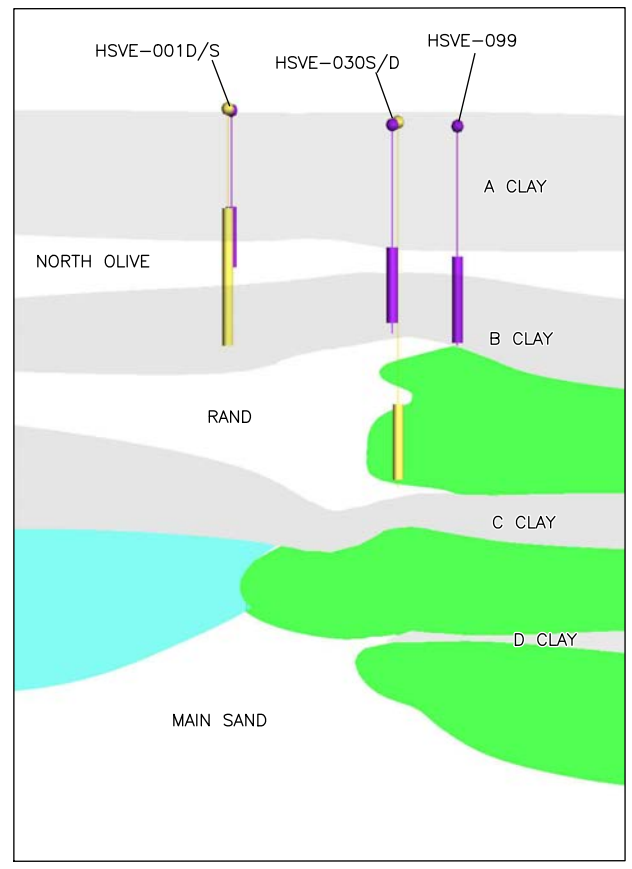
ZONE 5 SVE SYSTEM CROSS SECTIONS

HARTFORD PETROLEUM RELEASE SITE
HARTFORD, ILLINOIS

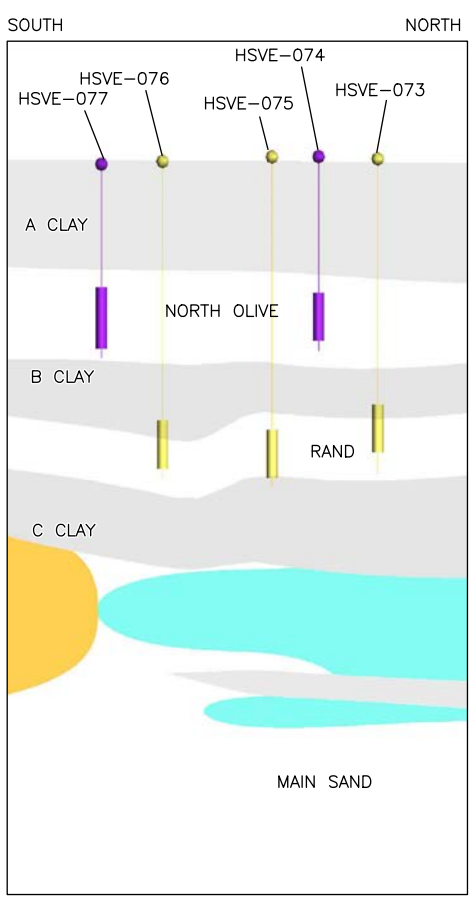
Drawn By: CG	Checked By: ST	Scale: NOT TO SCALE	Date: 4/14/15	File: 24S_HSVE_5_201502



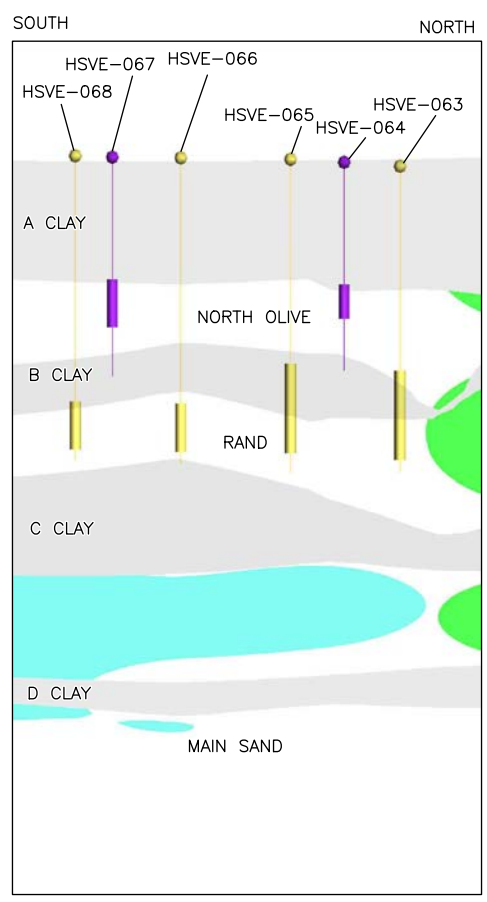
Q **EAST CHERRY STREET SECTION**
NOT TO SCALE
VERTICAL EXAGGERATION = 10X



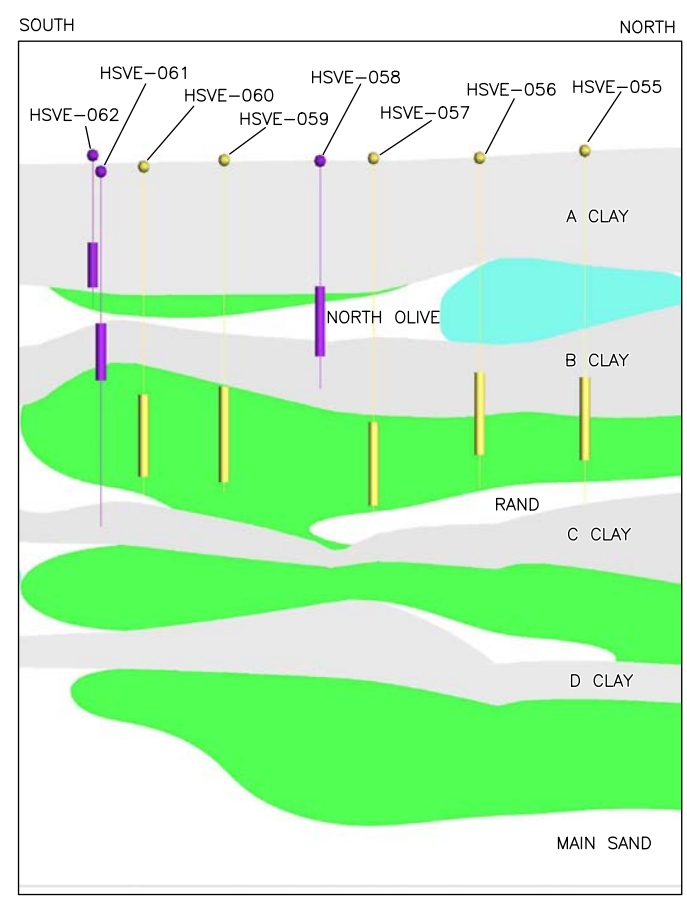
R **ALLEY BETWEEN NORTH MARKET STREET AND NORTH OLIVE AVENUE SECTION**
NOT TO SCALE
VERTICAL EXAGGERATION = 10X



S **NORTH OLIVE AVENUE BETWEEN EAST CHERRY STREET AND EAST DATE STREET SECTION**
NOT TO SCALE
VERTICAL EXAGGERATION = 10X



T **NORTH OLIVE AVENUE BETWEEN EAST BIRCH STREET AND EAST CHERRY STREET SECTION**
NOT TO SCALE
VERTICAL EXAGGERATION = 10X



U **NORTH OLIVE AVENUE BETWEEN WEST RAND AVENUE AND EAST BIRCH STREET SECTION**
NOT TO SCALE
VERTICAL EXAGGERATION = 10X

EXPLANATION

- LIGHT-RANGE LNAPL
- MID-RANGE LNAPL
- HEAVY-RANGE LNAPL
- DEEP SVE WELL SCREEN
- SHALLOW SVE WELL SCREEN

NOTE:

1. HSVE-062 IS LOCATED TO THE WEST OF NORTH OLIVE AVENUE AND IS PROJECTED ON SECTION U.

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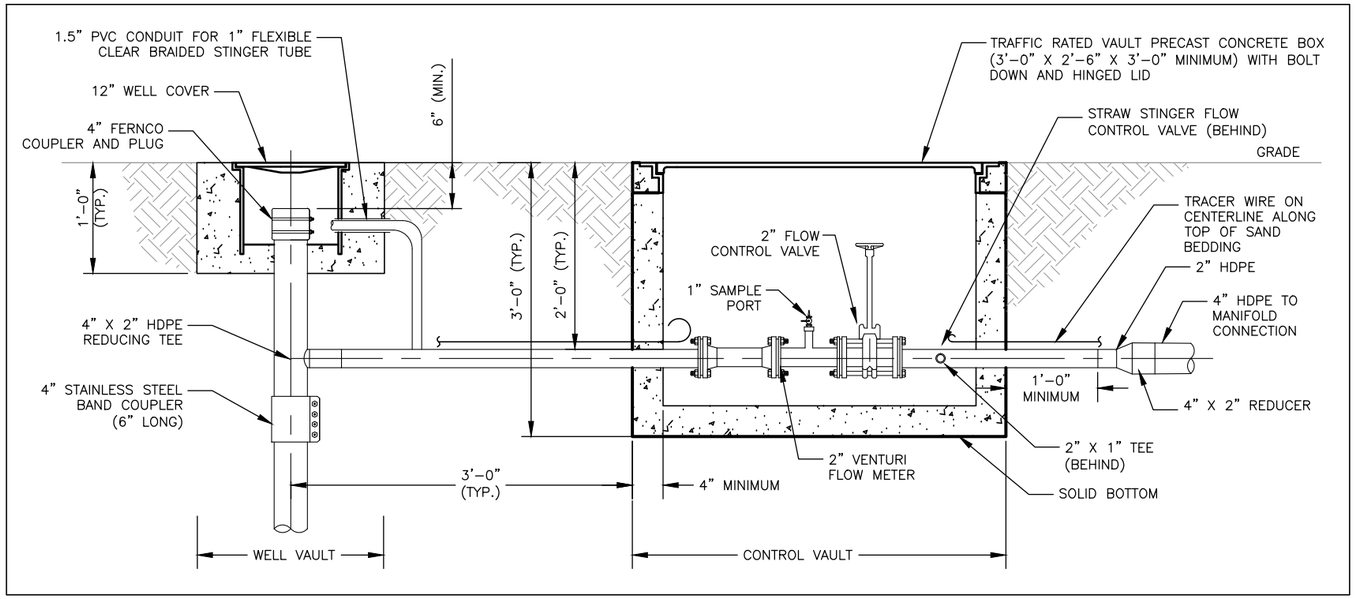
FIGURE 8

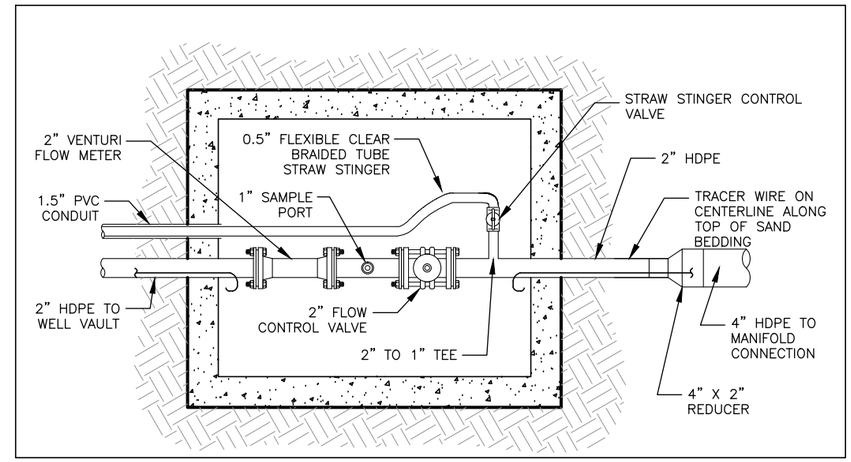
ZONE 6 SVE SYSTEM CROSS SECTIONS

HARTFORD PETROLEUM RELEASE SITE
HARTFORD, ILLINOIS

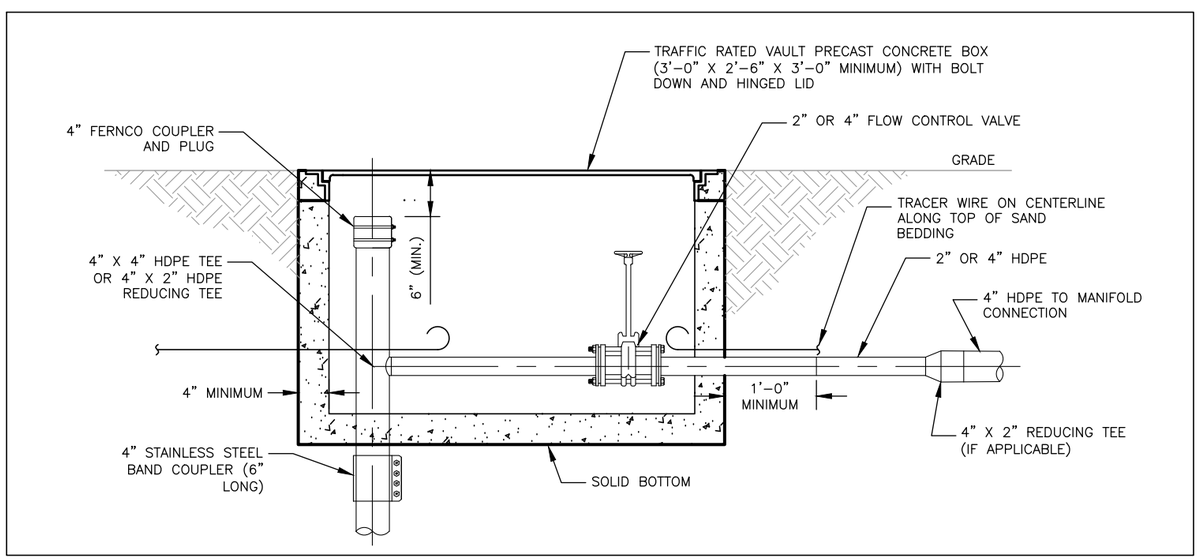
Drawn By: CG	Checked By: ST	Scale: NOT TO SCALE	Date: 4/14/15	File: 24S_HSVE_6_201502



A **PHASE III TYPICAL WELLHEAD COMPLETION - ELEVATION**
NOT TO SCALE



B **PHASE III TYPICAL CONTROL VAULT - PLAN VIEW**
NOT TO SCALE



C **PHASE I/II WELLHEAD COMPLETION ELEVATION**
NOT TO SCALE

NOTE:
SEE FIGURE 11 FOR STINGER DETAILS

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FIGURE 9

TYPICAL SVE WELLHEAD COMPLETION DETAIL

HARTFORD PETROLEUM RELEASE SITE
HARTFORD, ILLINOIS

Drawn By: CG	Checked By: ST	Scale: NOT TO SCALE	Date: 8/13/2015	File: 24S_TYPSVEDETAILS-201502

A **WELL VAULT FOR PHASE III TYPE WELL WITH STRAW STINGER**
NOT TO SCALE

B **CONTROL VAULT FOR PHASE III TYPE WELL WITH STRAW STINGER**
NOT TO SCALE

C **PHASE I/II TYPE WELL WITH CONTROL VALVE AND WELLHEAD INSTALLED WITH SINGLE CONTROL VAULT**
NOT TO SCALE

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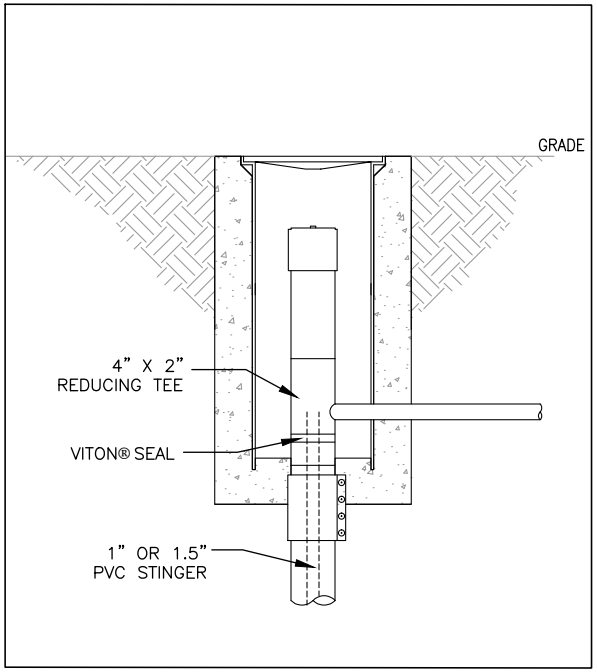
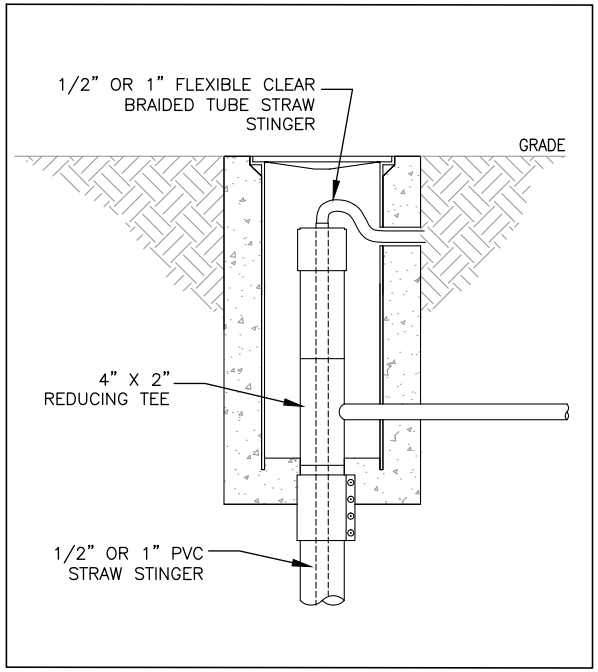
FIGURE 10
PHOTOGRAPHS OF PHASE I/II AND PHASE III TYPICAL SVE WELLHEAD COMPLETION

HARTFORD PETROLEUM RELEASE SITE
HARTFORD, ILLINOIS

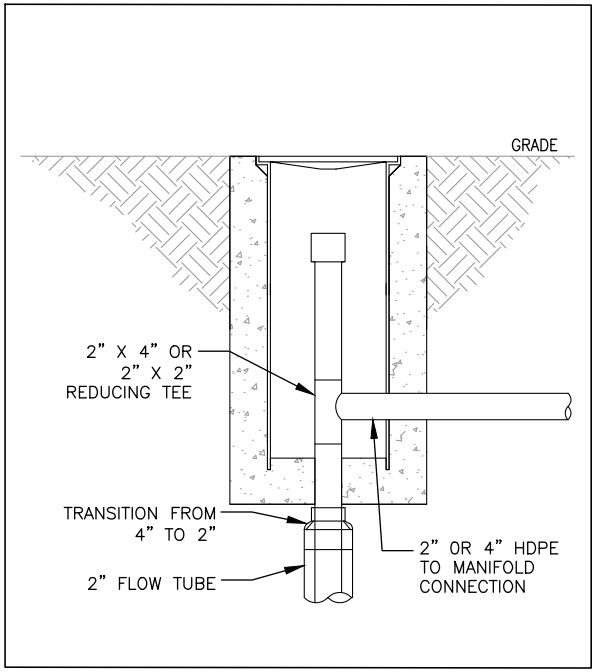
Drawn By: CG	Checked By: JGP	Scale: NOT TO SCALE	Date: 8/13/2015	File: 24S_TYPSVEDETAILS-201502



A **VITONÈ SEAL STINGER DETAIL**
NOT TO SCALE



B **STRAW STINGER DETAIL**
NOT TO SCALE



C **FLOW TUBE DETAIL**
NOT TO SCALE

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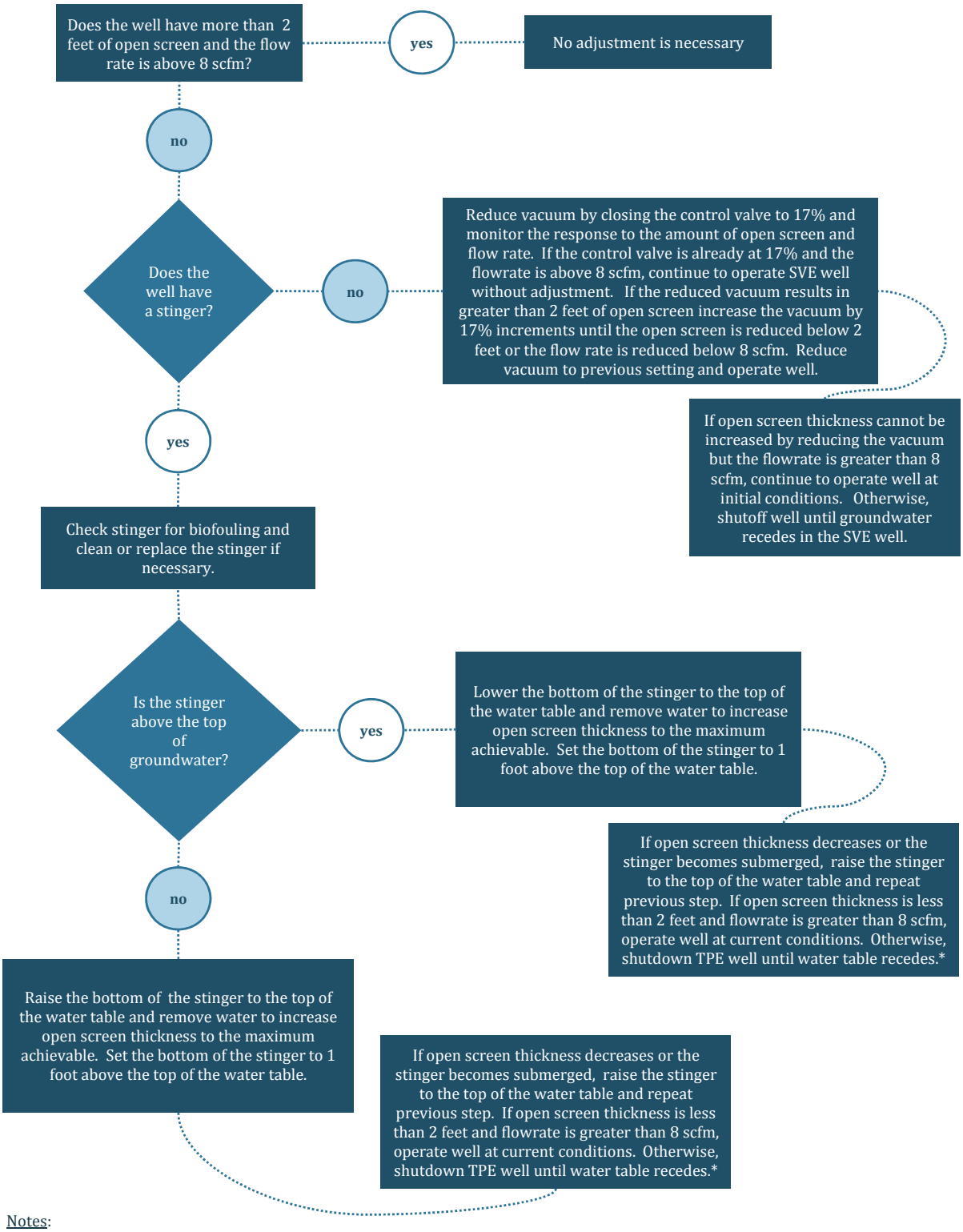
FIGURE 11

TYPICAL STINGER DETAIL

HARTFORD PETROLEUM RELEASE SITE
HARTFORD, ILLINOIS

Drawn By: CG	Checked By: ST	Scale: NOT TO SCALE	Date: 8/13/2015	File: 24S_TYPSVEDETAILS-201502

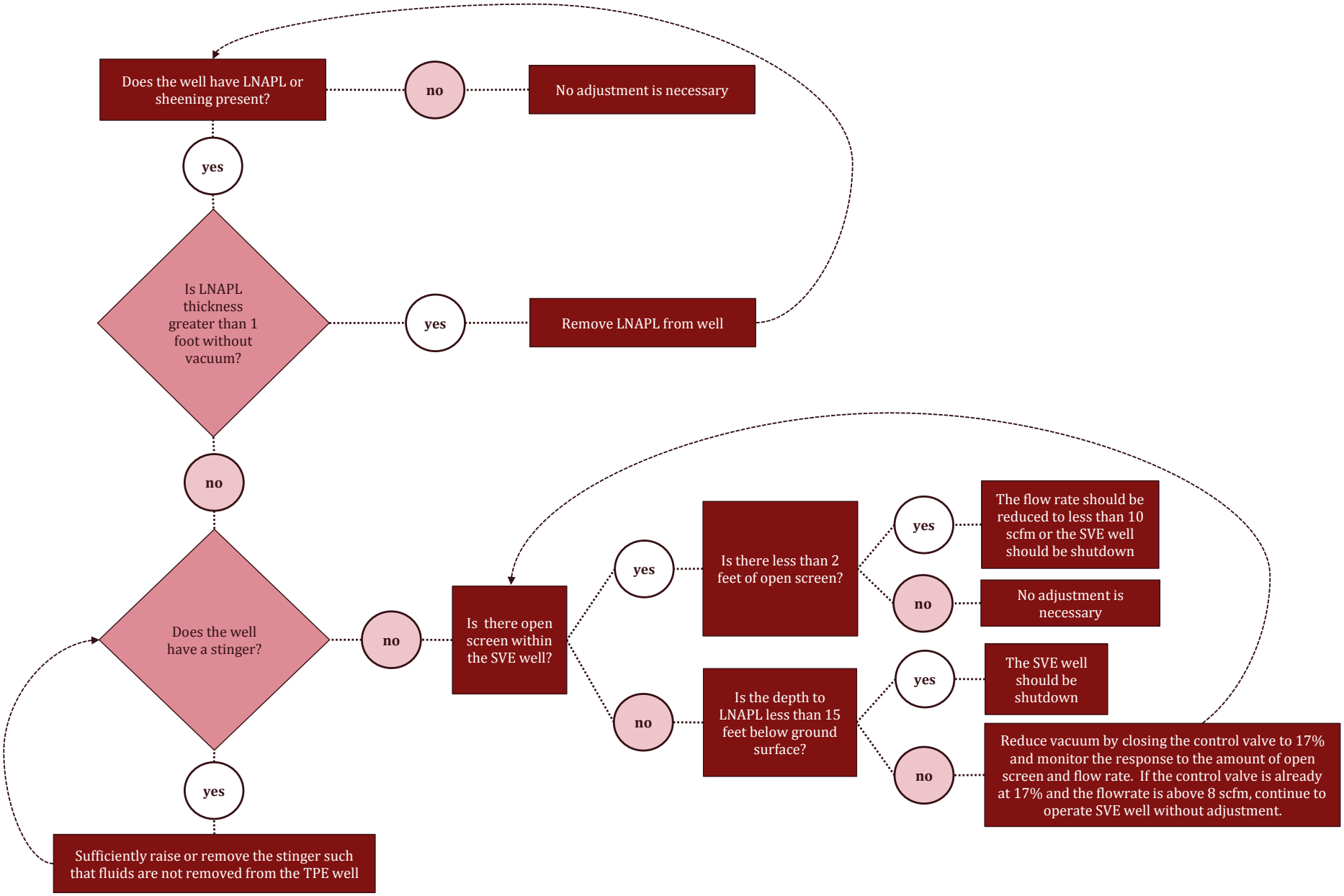
FIGURE 12. RATIONALE FOR WELL ADJUSTMENTS BASED ON OPEN SCREEN AND FLOW MEASUREMENTS HARTFORD PETROLEUM RELEASE SITE, HARTFORD, ILLINOIS



Notes:

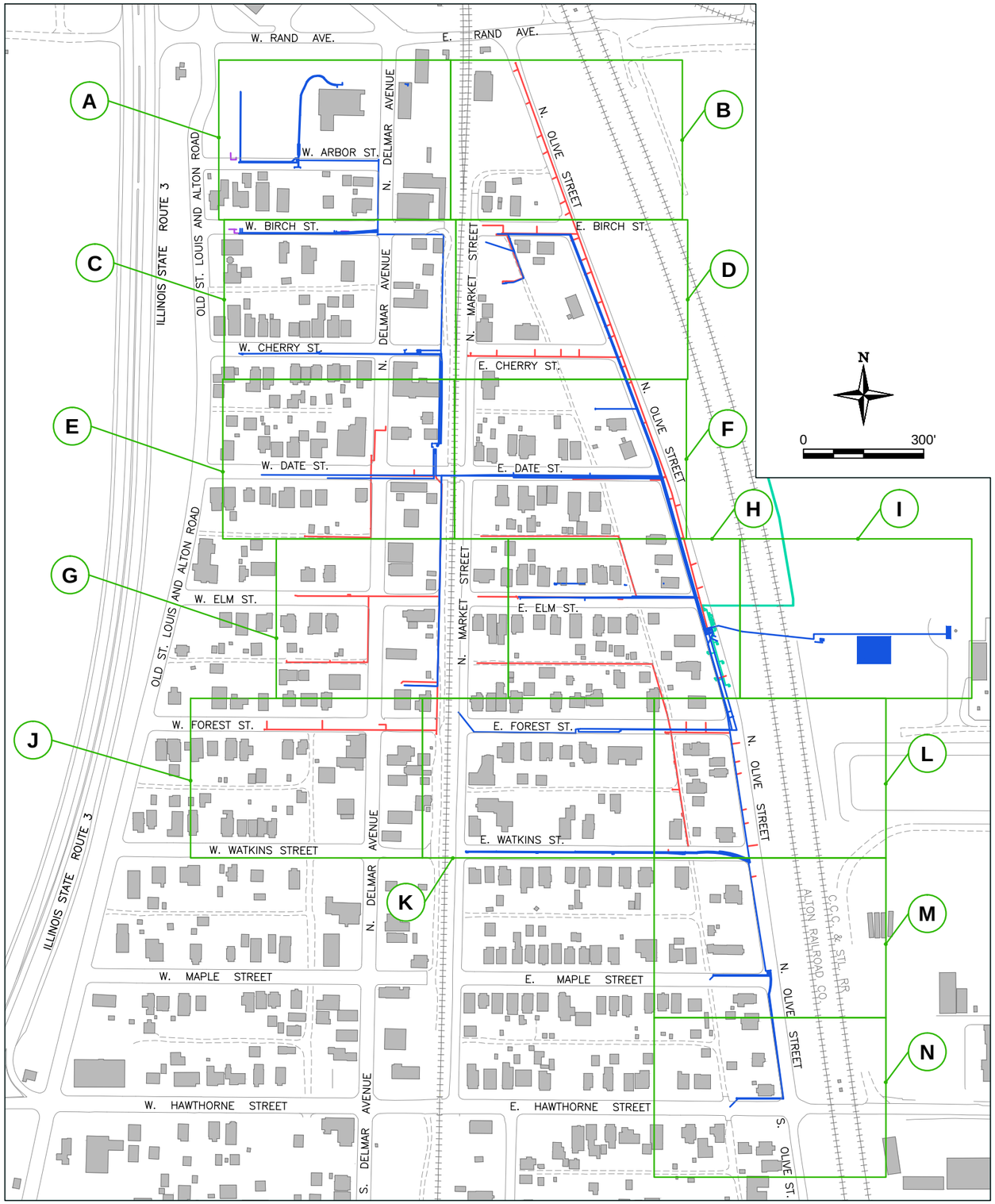
* If there is a river stage triggered event, operation of a TPE well may continue as long as there is some open screen and the flowrate is greater than 0 scfm. Alternatively, if there are low water table conditions in the Rand stratum and the open screen is greater than 2 feet and the flowrate is greater than 8 scfm, the well may be shutdown if the total volatile hydrocarbon concentration measured using a flame ionization detector is below 100 ppmv. These modifications will be evaluated on a well by well basis and communicated with the Agencies.

FIGURE 13. RATIONALE FOR WELL ADJUSTMENTS BASED ON LNAPL THICKNESS MEASUREMENTS
HARTFORD PETROLEUM RELEASE SITE, HARTFORD, ILLINOIS



APPENDIX A

AS-BUILT/RECORD DRAWING PACKAGE FOR SOIL VAPOR EXTRACTION SYSTEM



NOTE:

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EXPLANATION

- BUILDING OR OTHER STRUCTURE (WHEN PROVIDED, SHOWN WITH ADDRESS NUMBER ON DETAIL AREA SHEETS)
- RAILROAD CENTERLINE
- PAVED ROAD EDGE
- UNPAVED ROAD EDGE
- ST — STORM SEWER LINE
- SS — SANITARY SEWER LINE
- W — WATER LINE
- G — GAS LINE
- T — COMMUNICATION LINE
- G — GAS LINE
- MANHOLE
- STORM INLET
- MPE — MULTI-PHASE EXTRACTION
- HMW-040A — MONITORING WELL AND DESIGNATION
- MPE-A004 — PRODUCTION WELL AND DESIGNATION
- RW-002 — RECOVERY WELL AND DESIGNATION
- VP-001 — VAPOR POINT AND DESIGNATION
- VCB-001 — VAPOR CONTROL BORING AND DESIGNATION (ABANDONED CIRCA 2005)
- H — DETAIL AREA SHEET CALLOUTS
- PHASES 1 AND 2
- PHASE 3
- MPE SYSTEM
- 2015 EXPANSION
- PHASES 1 AND 2 LINES (ON DETAIL AREA SHEETS)
- PHASE 3 LINES (ON DETAIL AREA SHEETS)
- MPE SYSTEM (ON DETAIL AREA SHEETS)
- 2015 EXPANSION LINES (ON DETAIL AREA SHEETS)
- PHASES 1 AND 2 VAULT
- PHASES 3 VAULT
- MPE SYSTEM VAULT
- 2015 EXPANSION VAULT
- HSVE-017S — SOIL VAPOR EXTRACTION WELL AND DESIGNATION
- HSVE-027S — SOIL VAPOR EXTRACTION WELL AND DESIGNATION (ABANDONED)
- VMP-042S — SOIL VAPOR MONITORING WELL AND DESIGNATION
- MP-069 — SOIL VAPOR OR GROUNDWATER MONITORING WELL AND DESIGNATION

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OVERVIEW MAP

RECORD DRAWING SET FOR UTILITY LOCATION
HARTFORD PETROLEUM RELEASE SITE
HARTFORD, ILLINOIS

SHEET 1 1 OF 15

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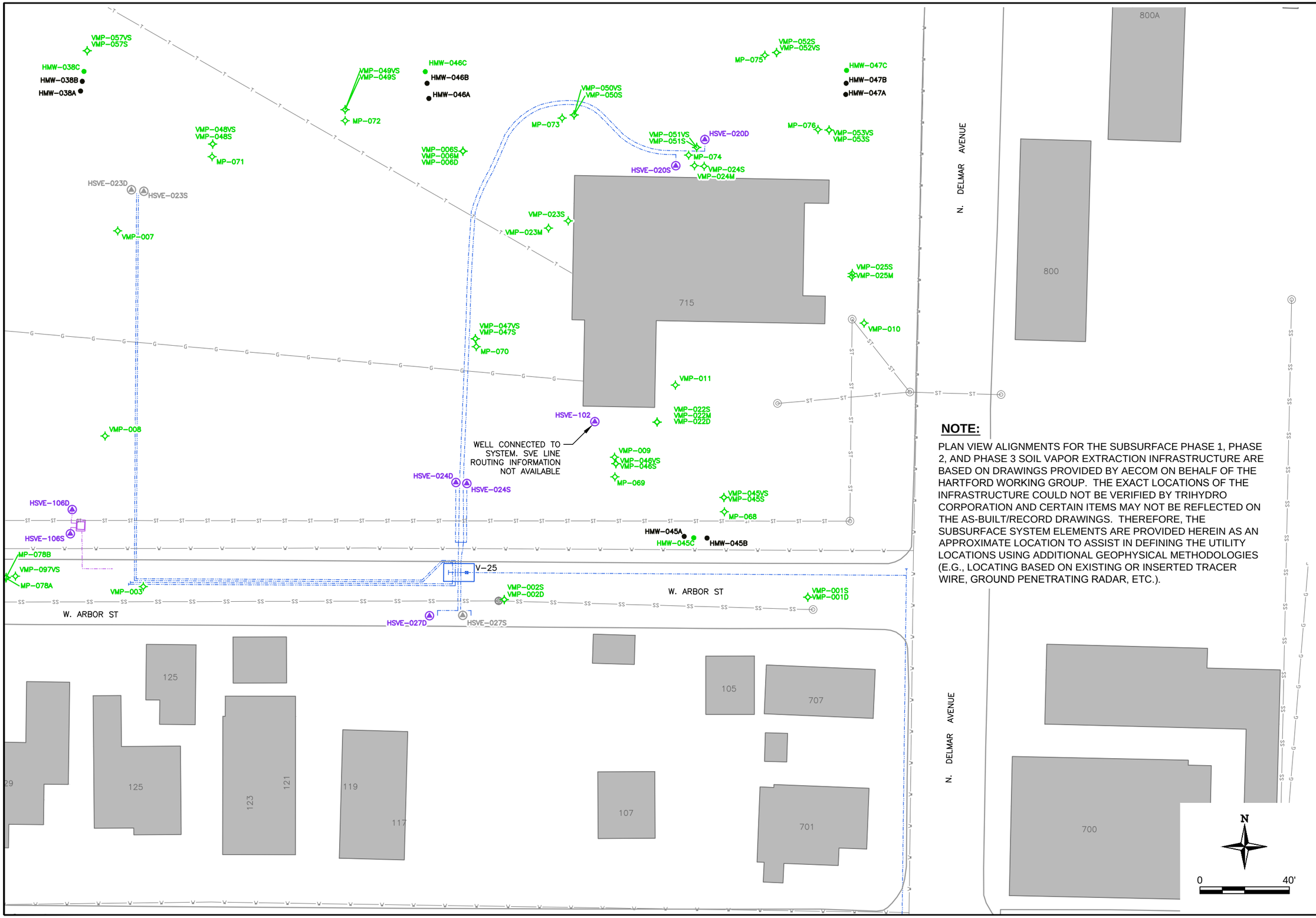

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DETAIL AREA A

RECORD DRAWING SET FOR UTILITY LOCATION
HARTFORD PETROLEUM RELEASE SITE
HARTFORD, ILLINOIS

SHEET 2 OF 15

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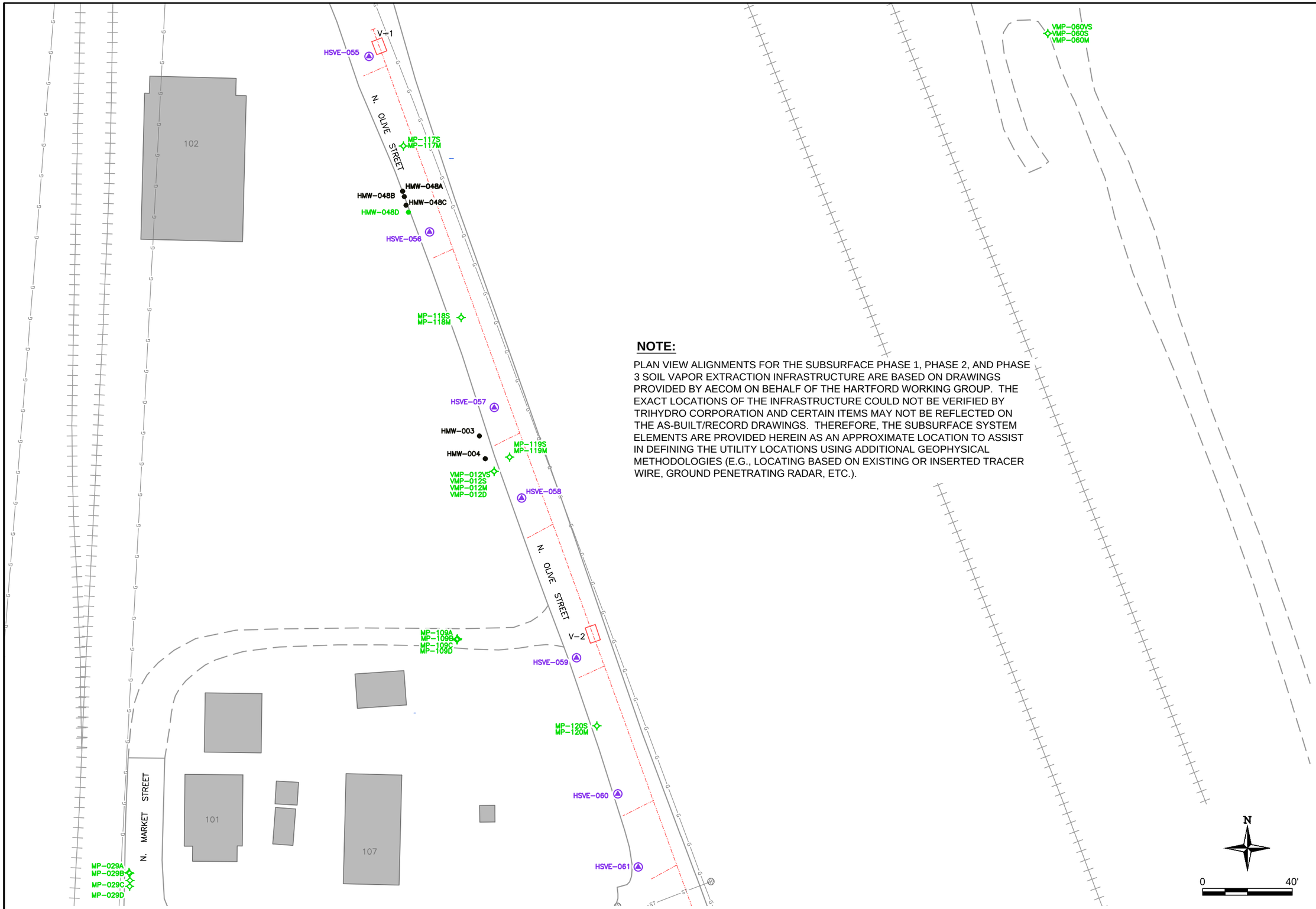

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DETAIL AREA B

RECORD DRAWING SET FOR UTILITY LOCATION
HARTFORD PETROLEUM RELEASE SITE
HARTFORD, ILLINOIS

SHEET 3 OF 15

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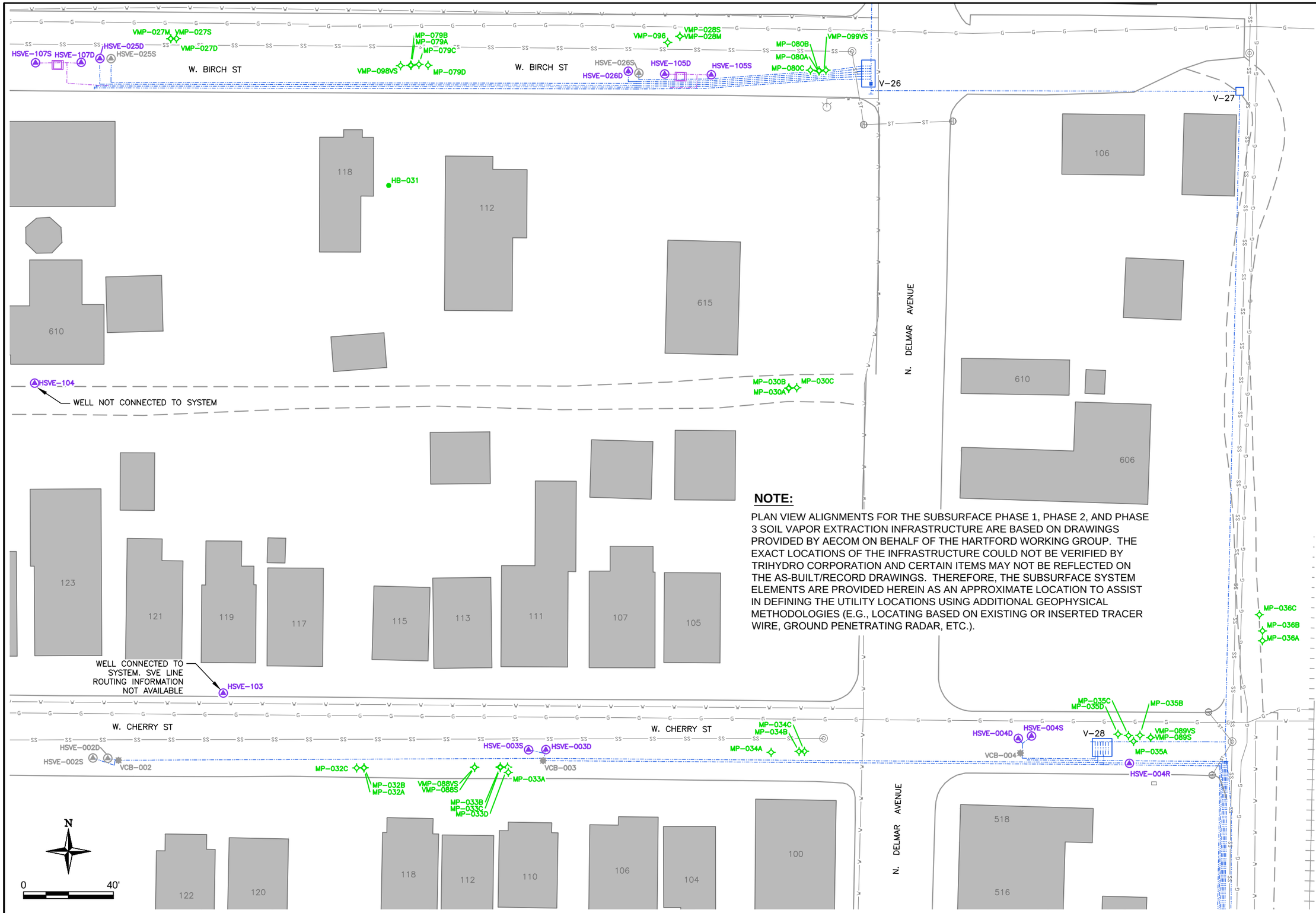

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RECORD DRAWING SET FOR UTILITY LOCATION
HARTFORD PETROLEUM RELEASE SITE
HARTFORD, ILLINOIS

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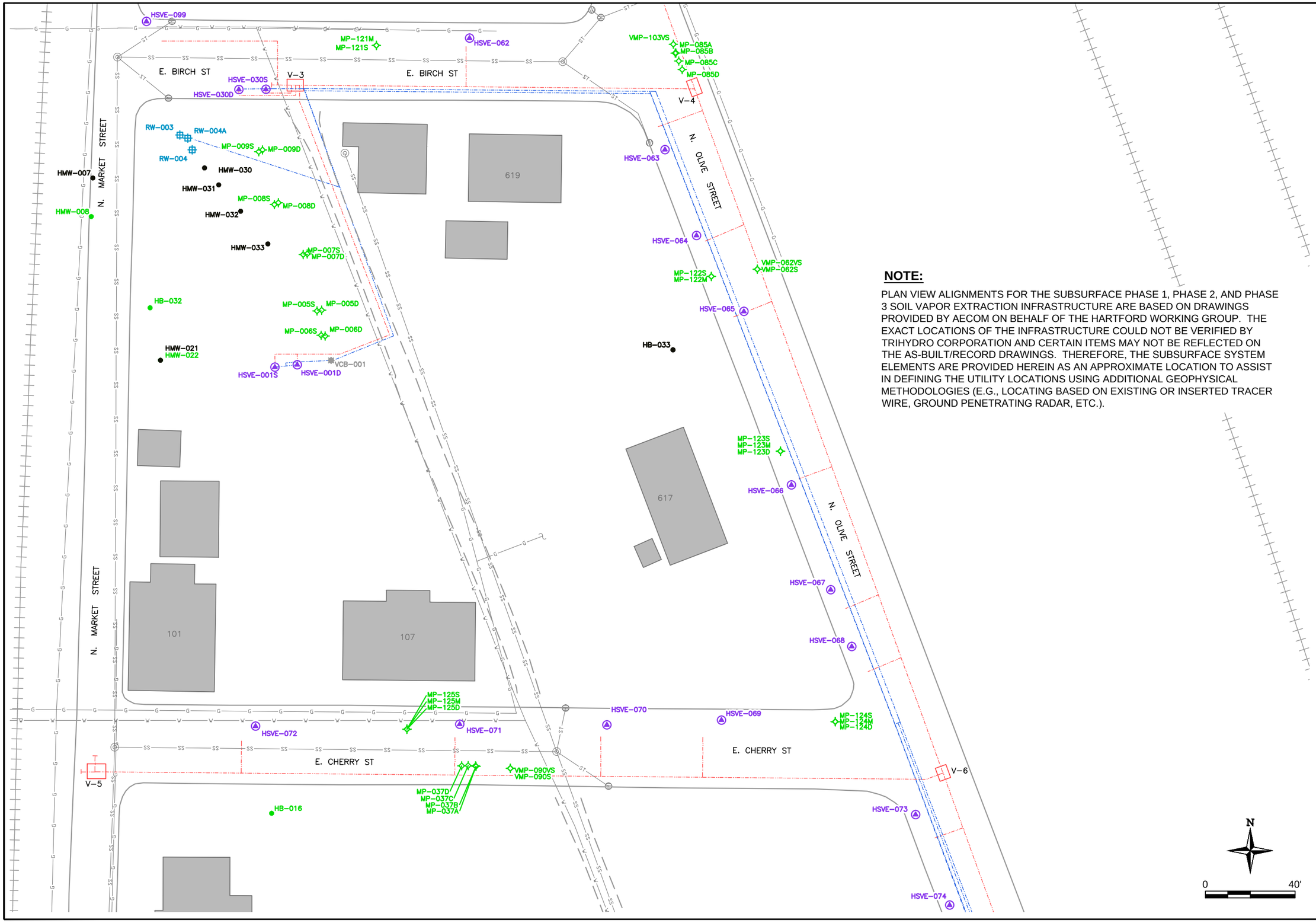

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RECORD DRAWING SET FOR UTILITY LOCATION
HARTFORD PETROLEUM RELEASE SITE
HARTFORD, ILLINOIS

SHEET 5
5 OF 15
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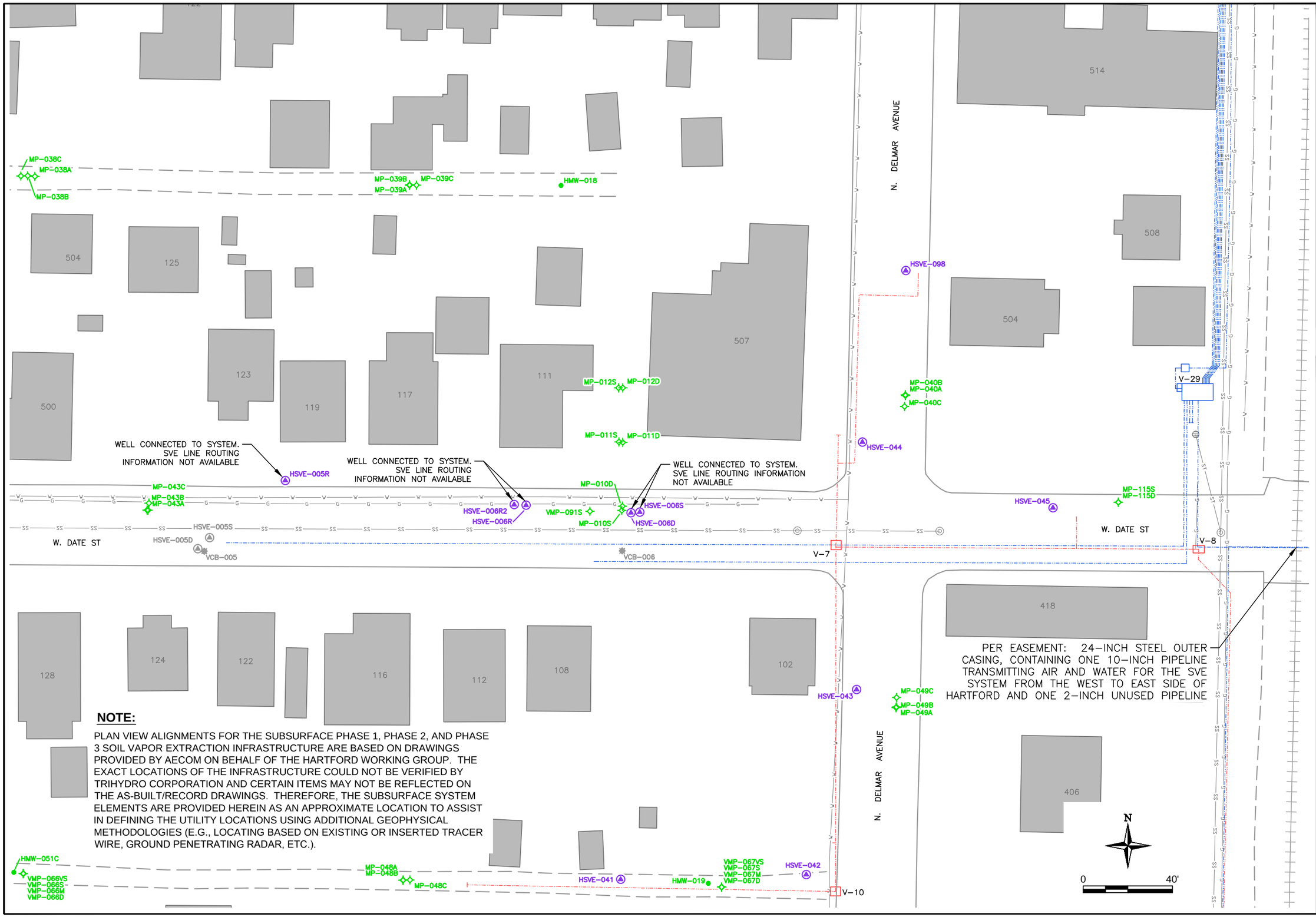

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HARTFORD, ILLINOIS

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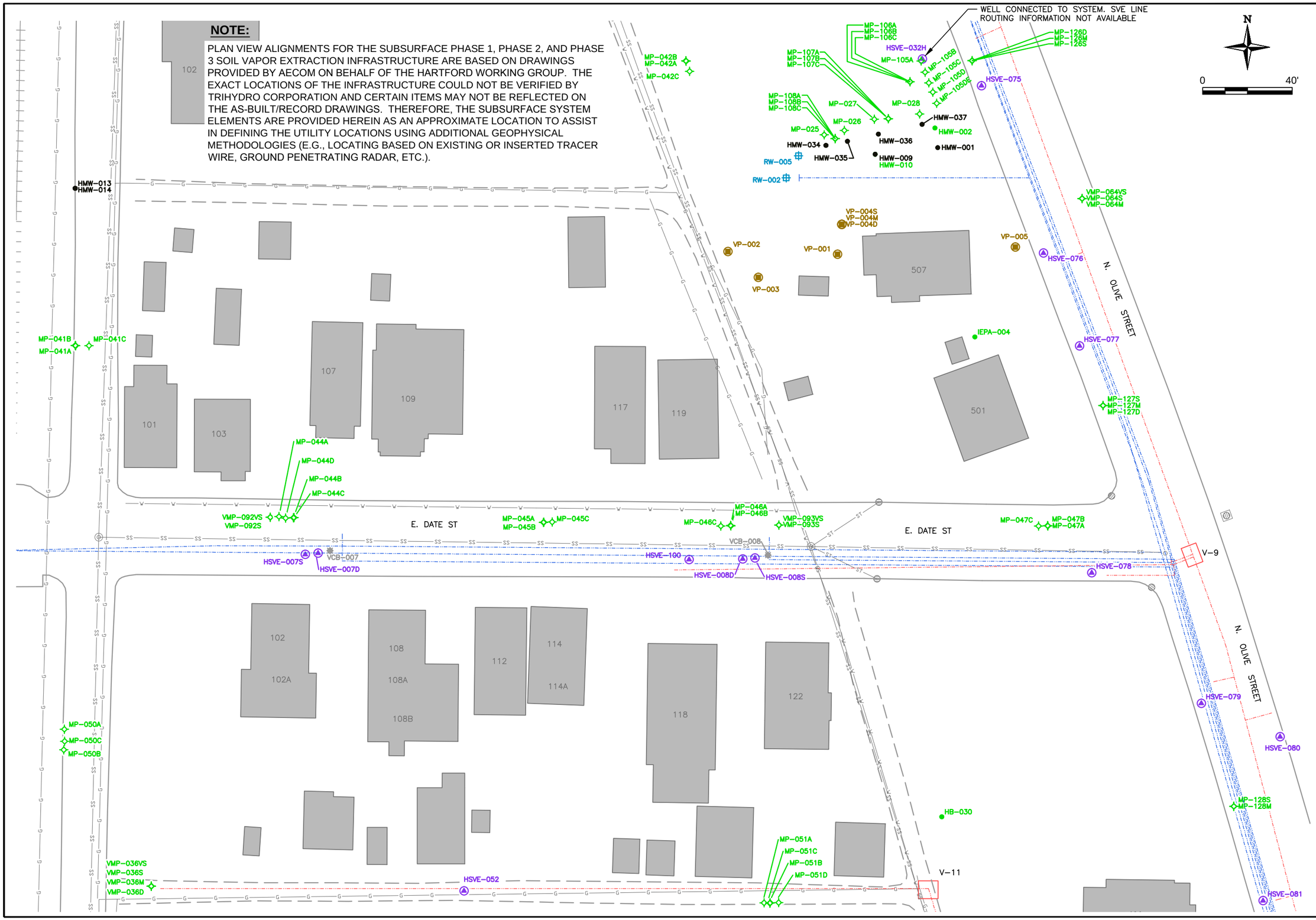

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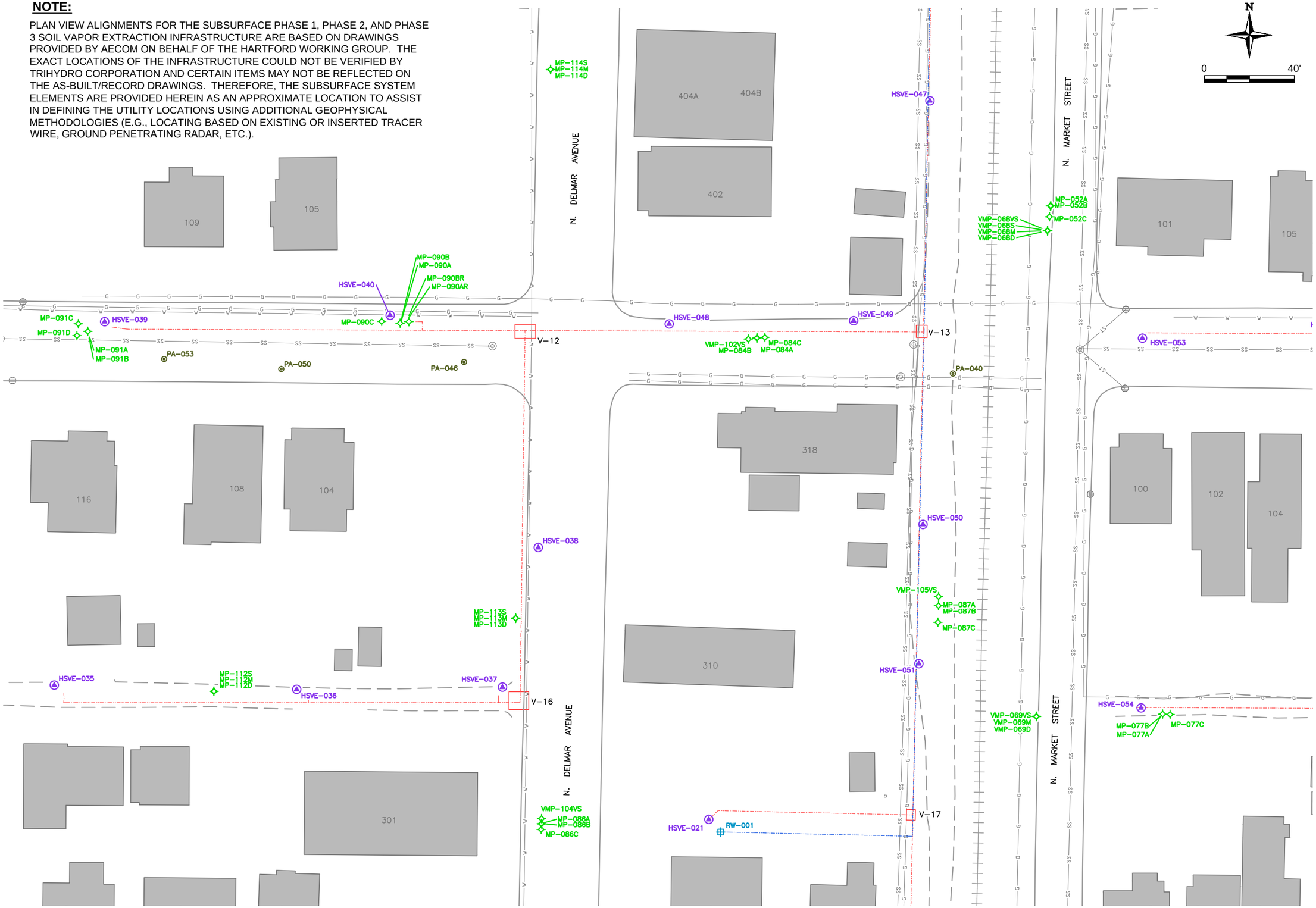

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SHEET 8 OF 15

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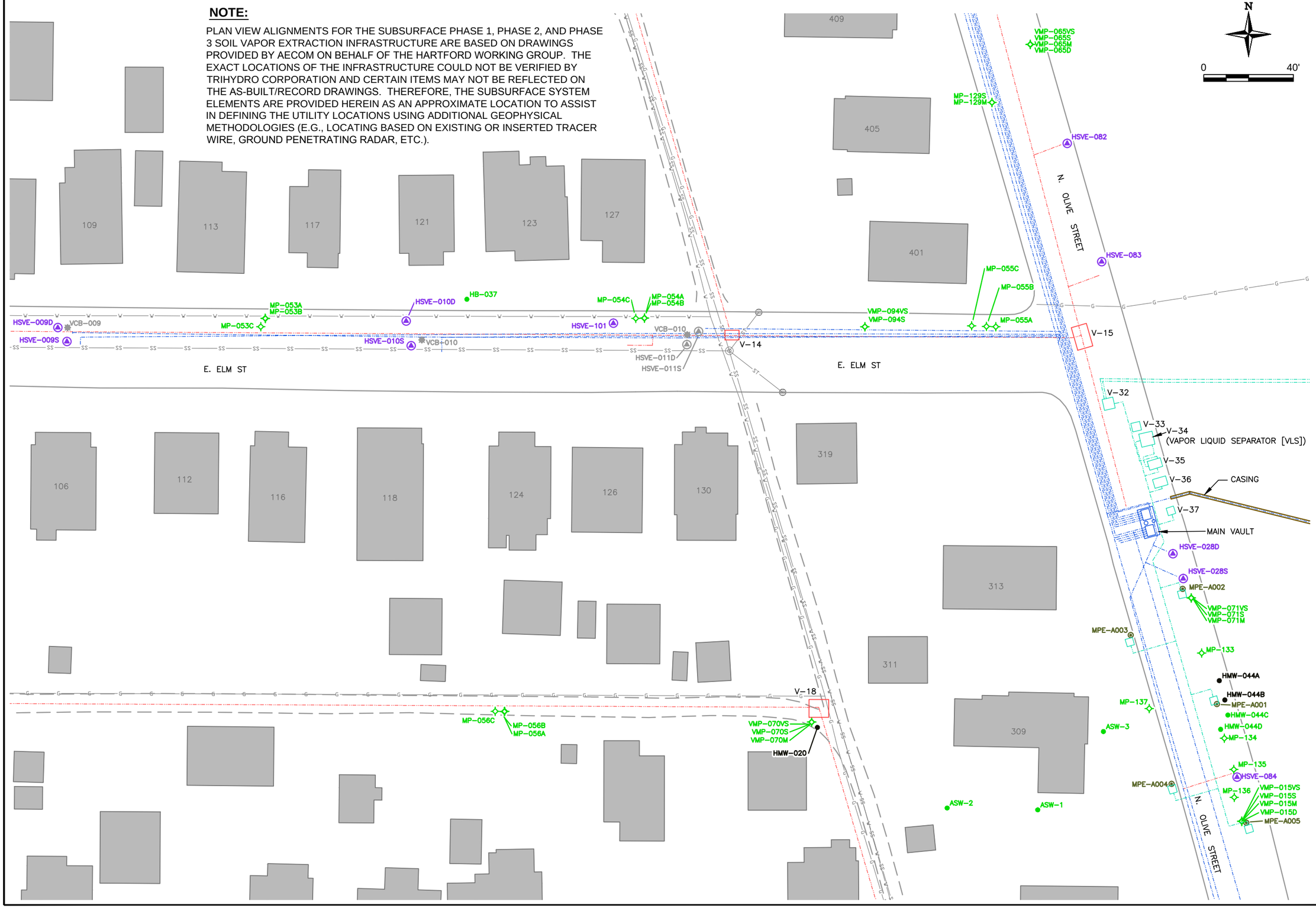

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HARTFORD PETROLEUM RELEASE SITE
HARTFORD, ILLINOIS

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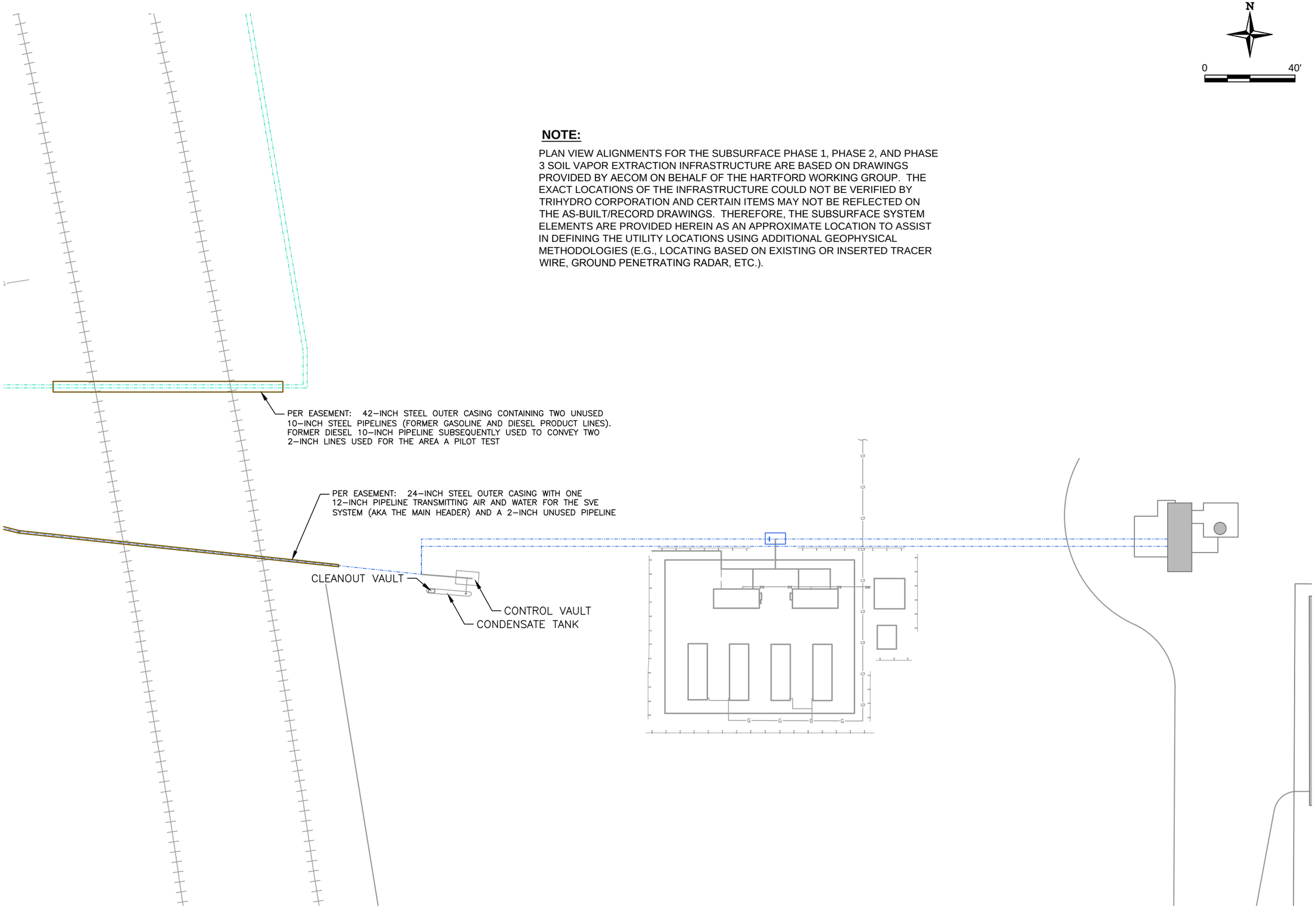

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SHEET 10
10 OF 15

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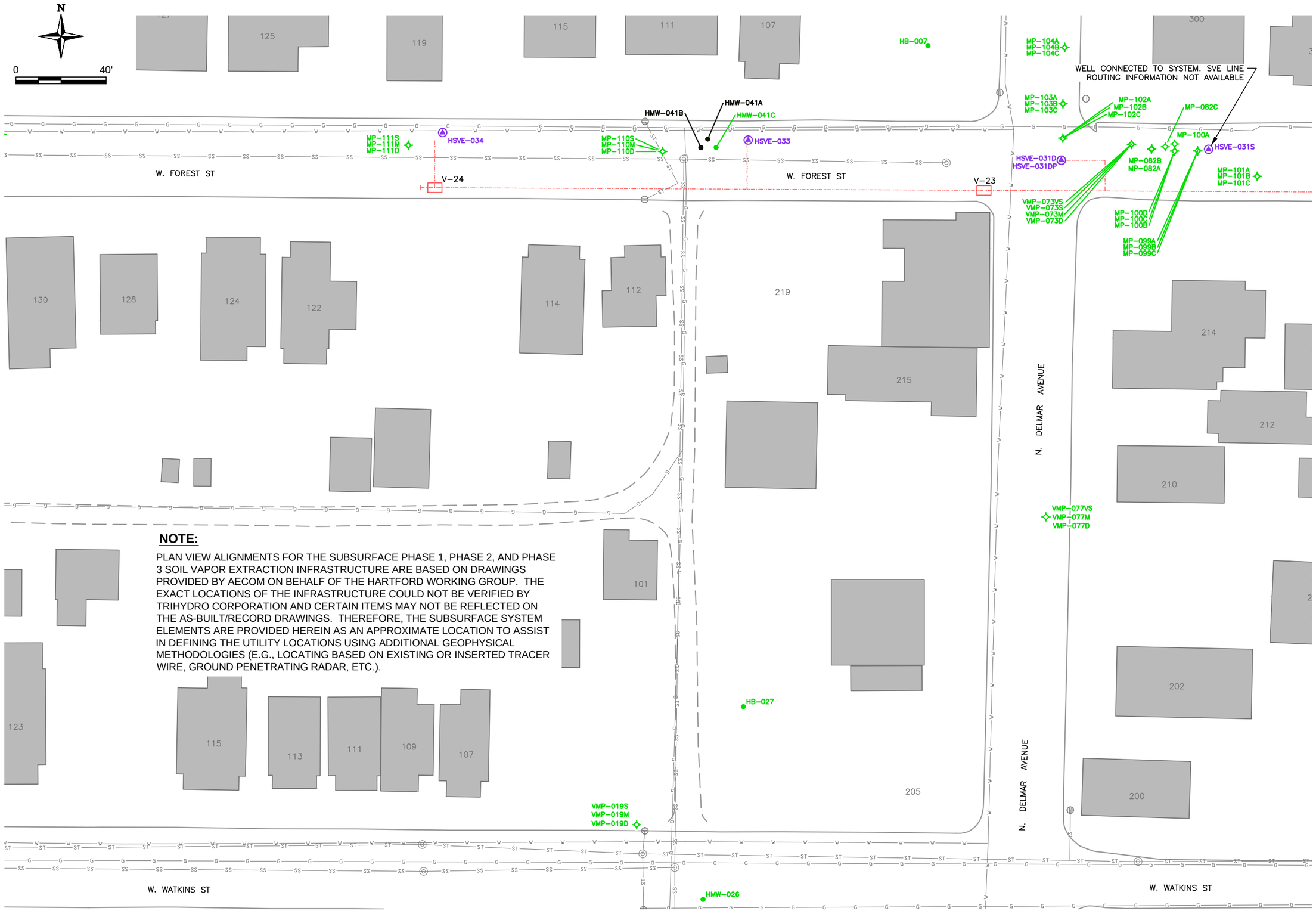

NOTE:

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SCALE: 1" = 40'

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DETAIL AREA J

RECORD DRAWING SET FOR UTILITY LOCATION
HARTFORD PETROLEUM RELEASE SITE
HARTFORD, ILLINOIS

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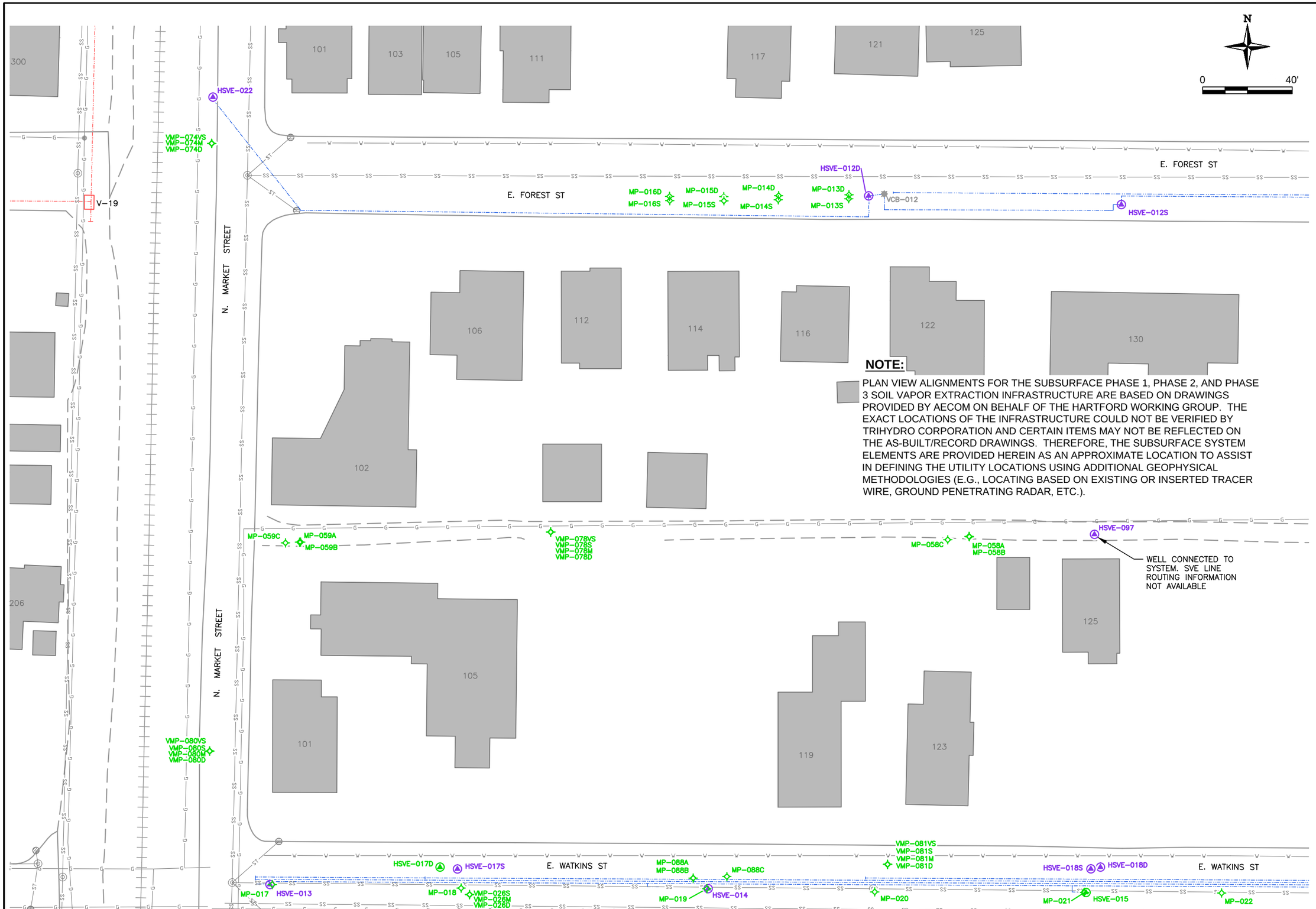

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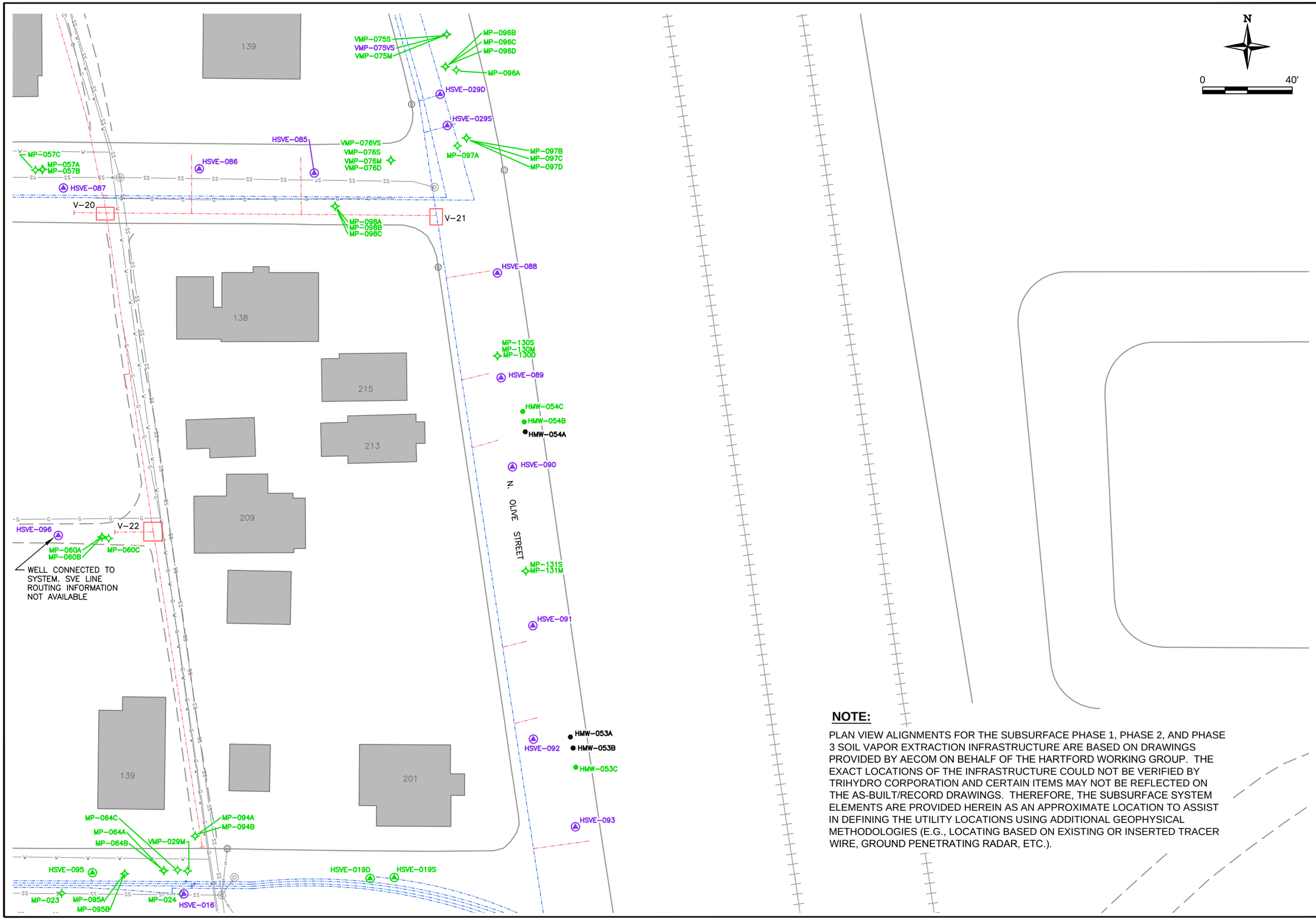
REV: 1



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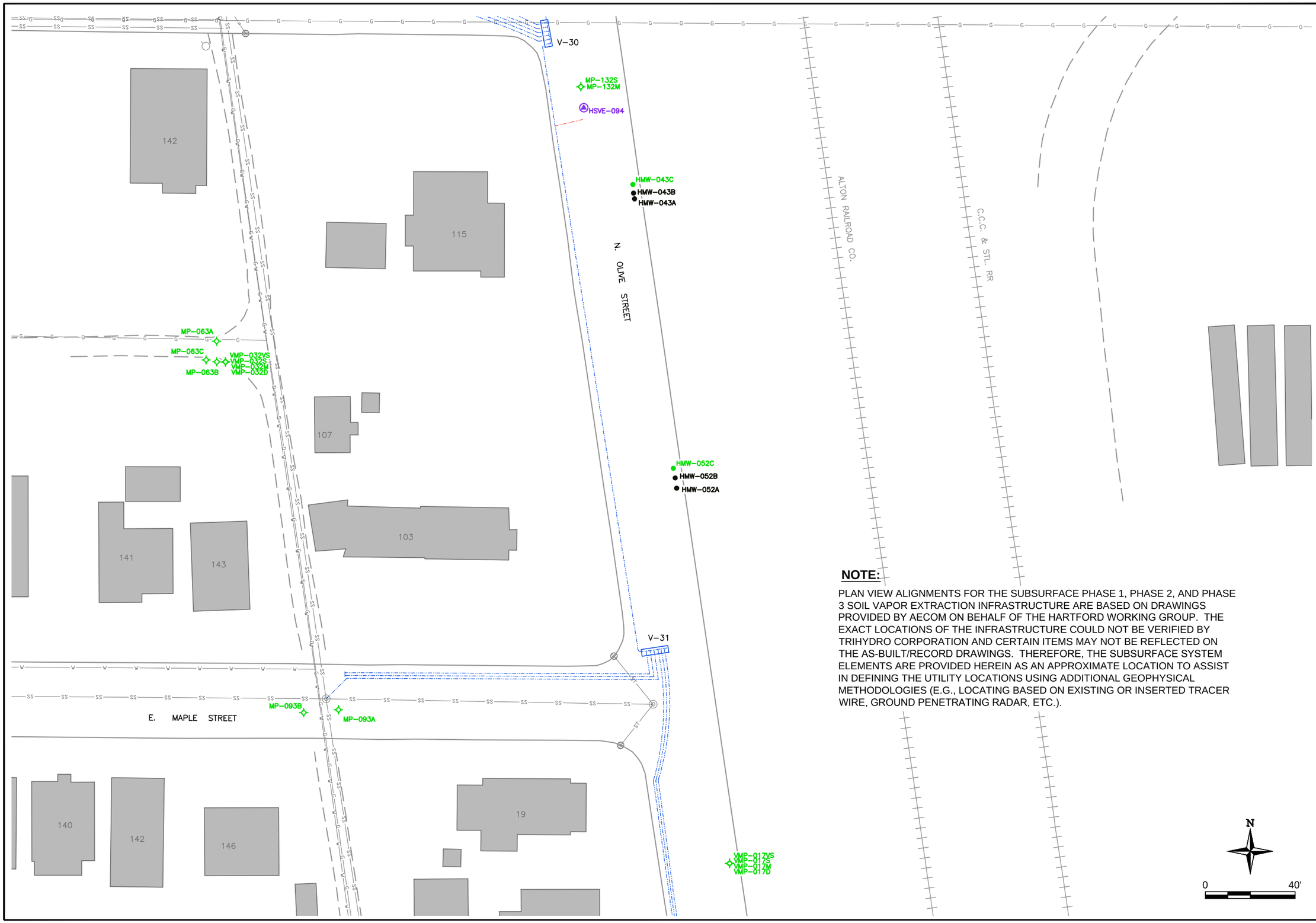

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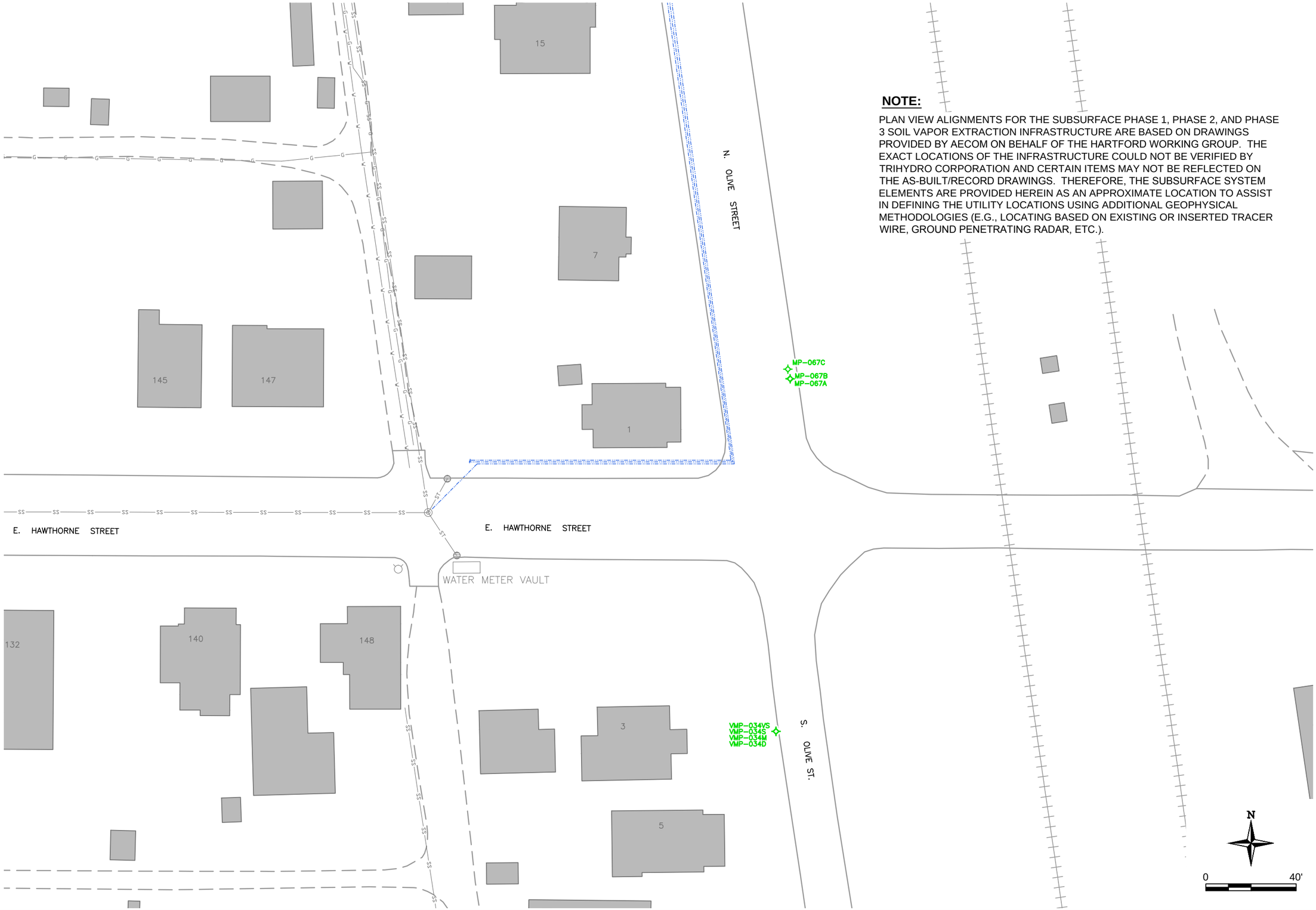

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15 OF 15

REV: 1

APPENDIX B

SUPPORTING DOCUMENTATION FOR DEVELOPMENT OF GROUNDWATER ELEVATION TRIGGERS FOR OPTIMIZATION OF SVE SYSTEM FOR MASS RECOVERY

FIGURE B-1. GROUNDWATER TRIGGER ELEVATION ANALYSIS FOR MONITORING POINT MP-029C
HARTFORD PETROLEUM RELEASE SITE, HARTFORD, ILLINOIS

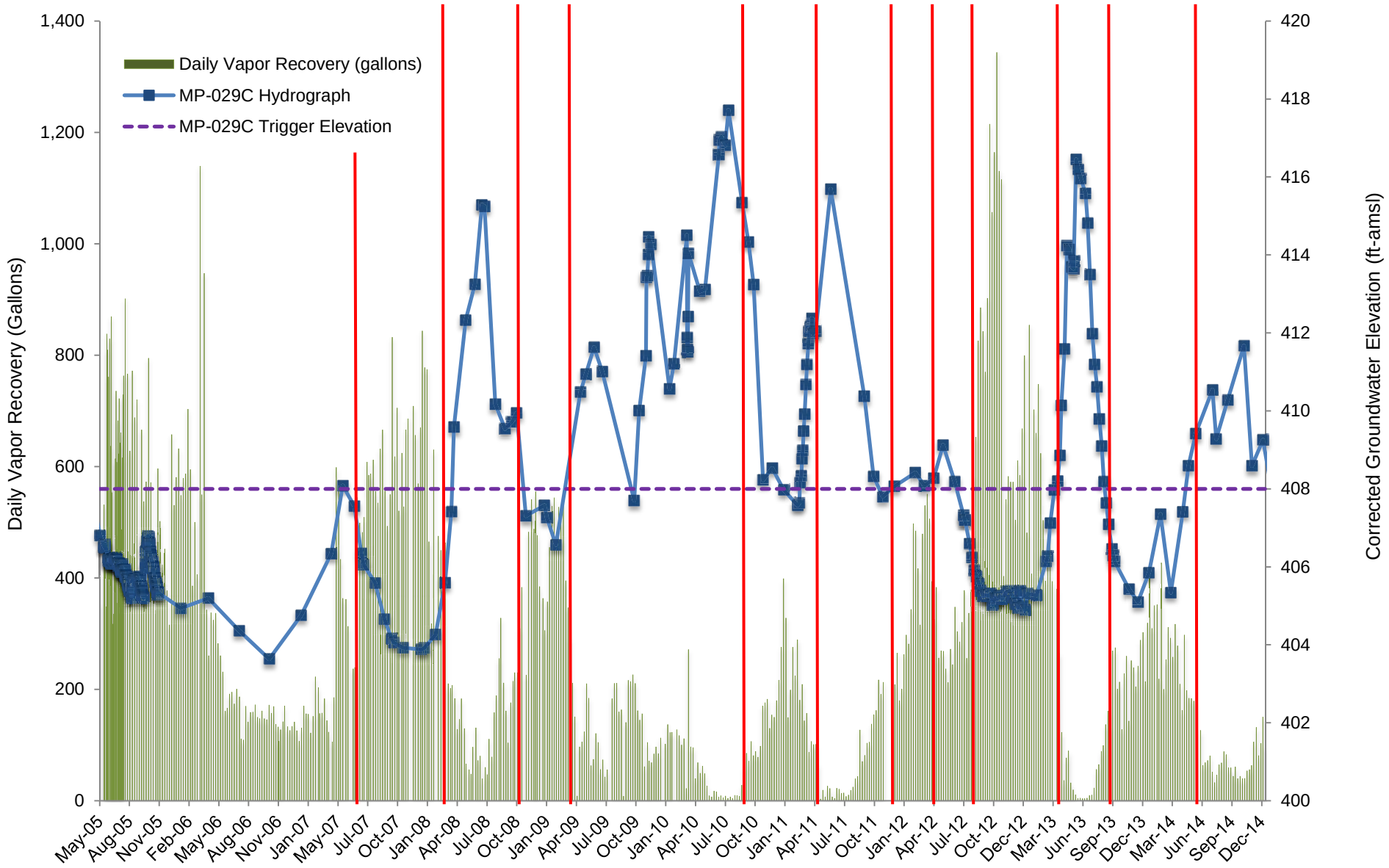


FIGURE B-2. GROUNDWATER TRIGGER ELEVATION ANALYSIS FOR MONITORING POINT MP-039B
HARTFORD PETROLEUM RELEASE SITE, HARTFORD, ILLINOIS

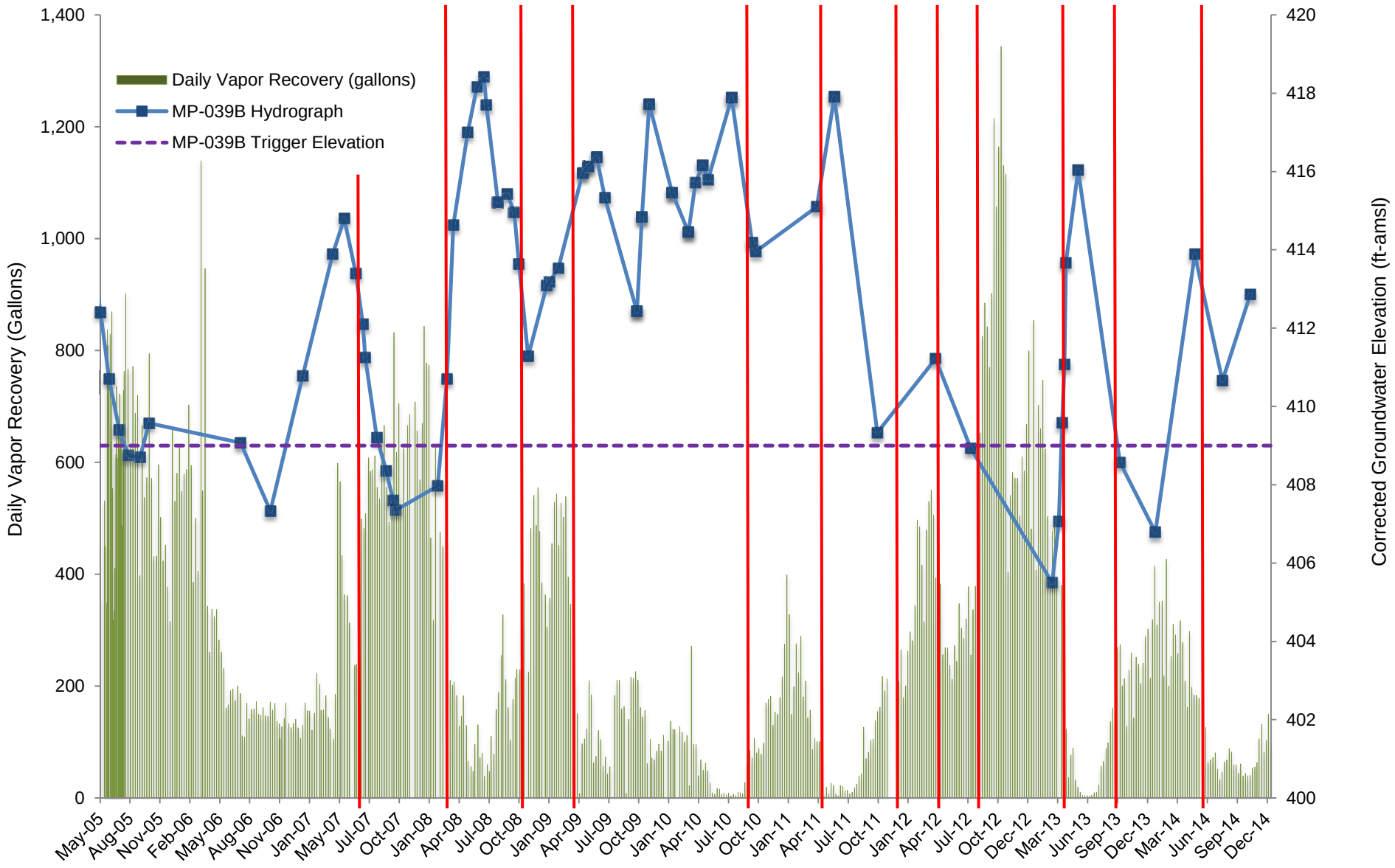


FIGURE B-3. GROUNDWATER TRIGGER ELEVATION ANALYSIS FOR MONITORING POINT MP-053B
HARTFORD PETROLEUM RELEASE SITE, HARTFORD, ILLINOIS

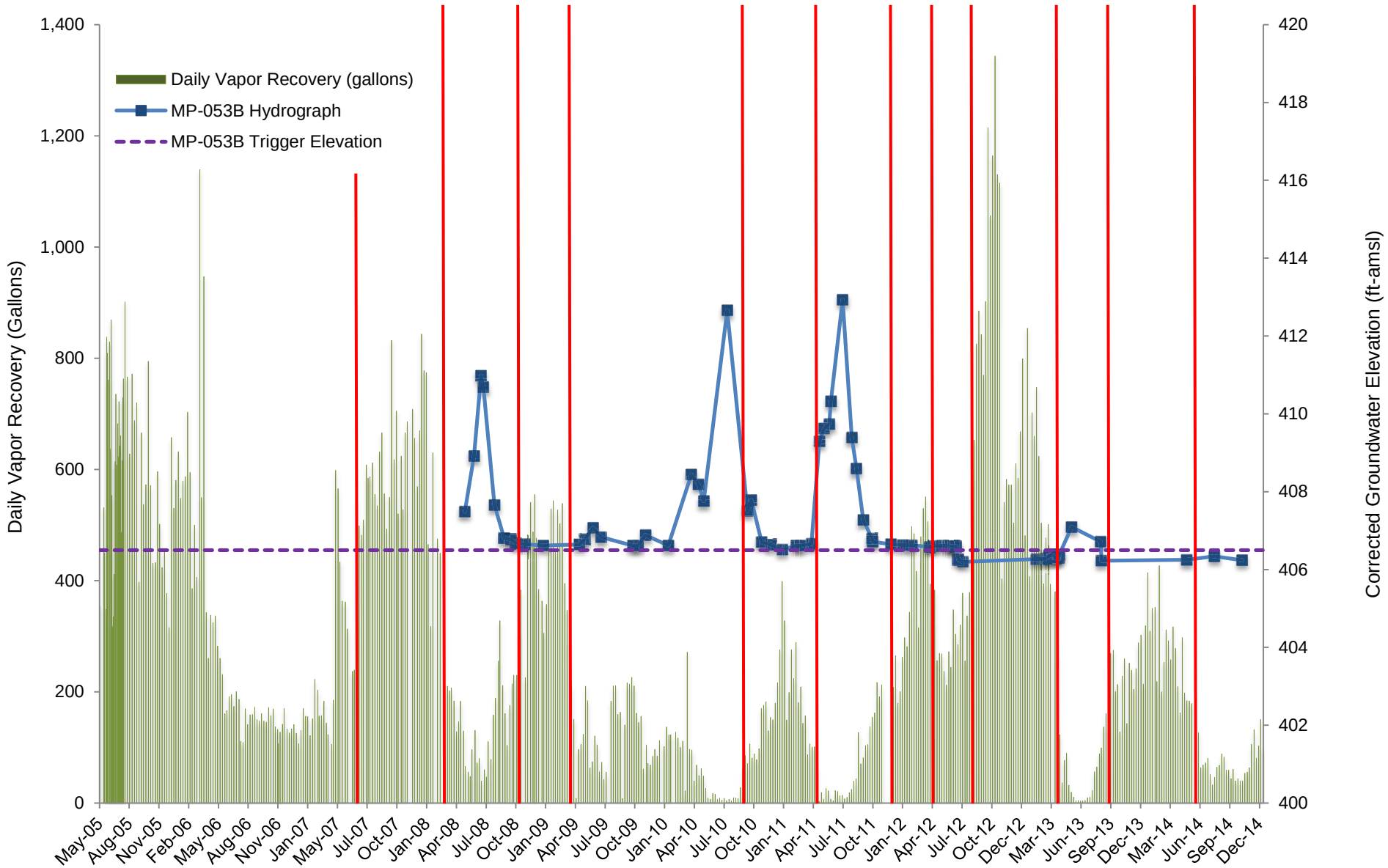


FIGURE B-4. GROUNDWATER TRIGGER ELEVATION ANALYSIS FOR MONITORING POINT MP-079B
HARTFORD PETROLEUM RELEASE SITE, HARTFORD, ILLINOIS

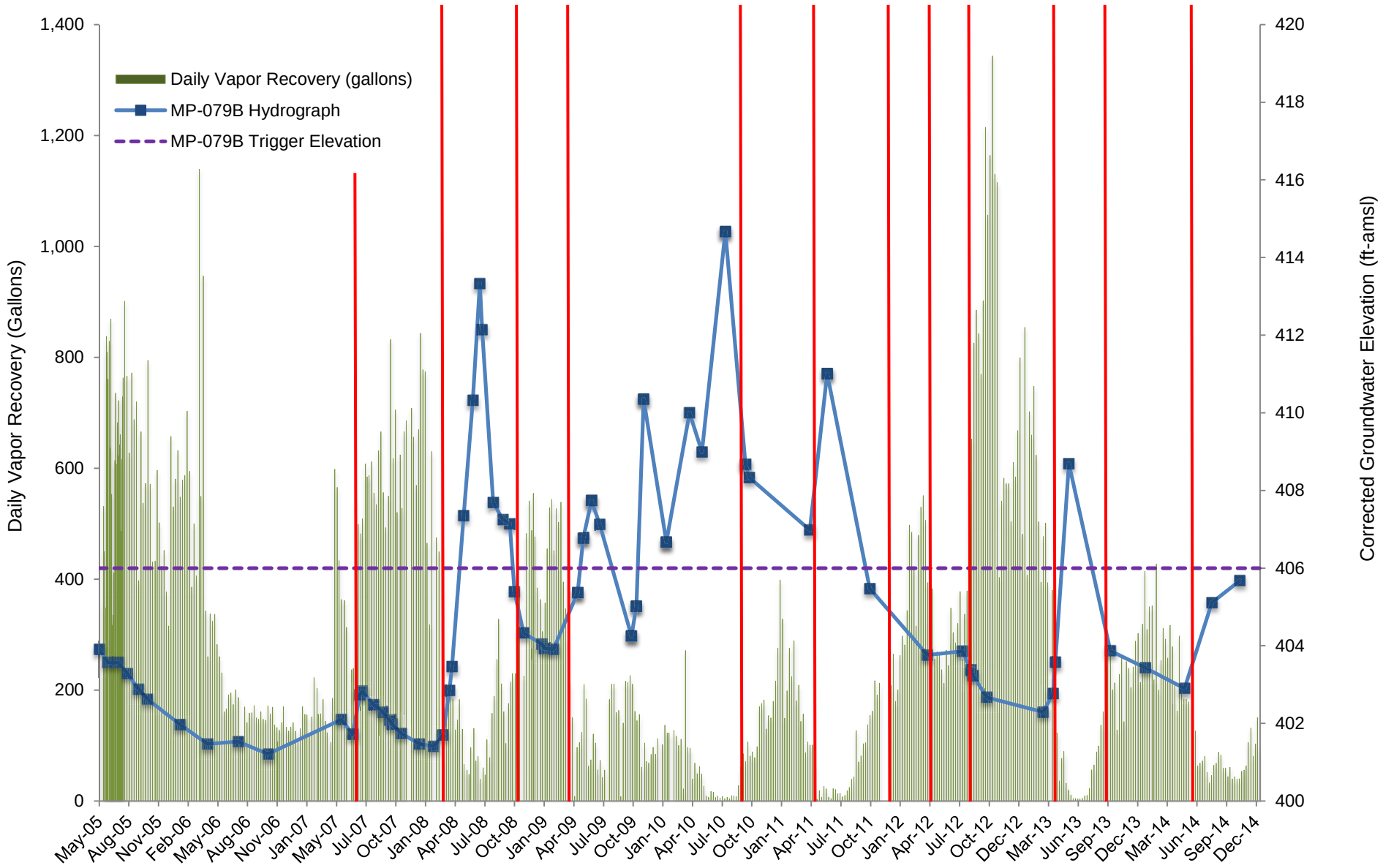
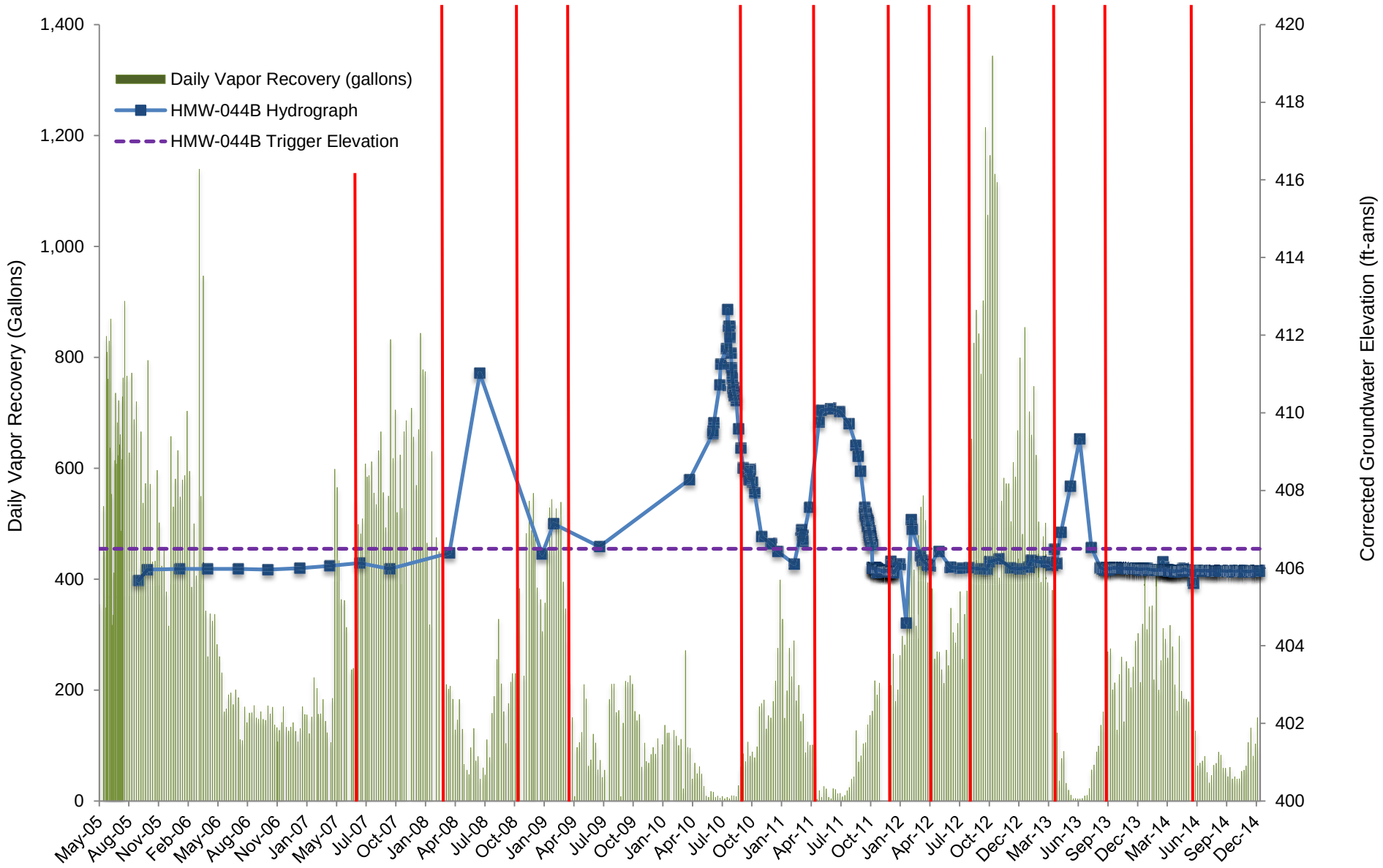


FIGURE B-5. GROUNDWATER TRIGGER ELEVATION ANALYSIS FOR MONITORING WELL HMW-044B
HARTFORD PETROLEUM RELEASE SITE, HARTFORD, ILLINOIS



APPENDIX C

FIELD DIRECT® ELECTRONIC FIELD FORMS

FIGURE C-1. SCREEN SHOT OF FIELD DIRECT SYSTEM MONITORING FIELD FORM

HARTFORD PETROLEUM RELEASE SITE

HARTFORD , ILLINOIS

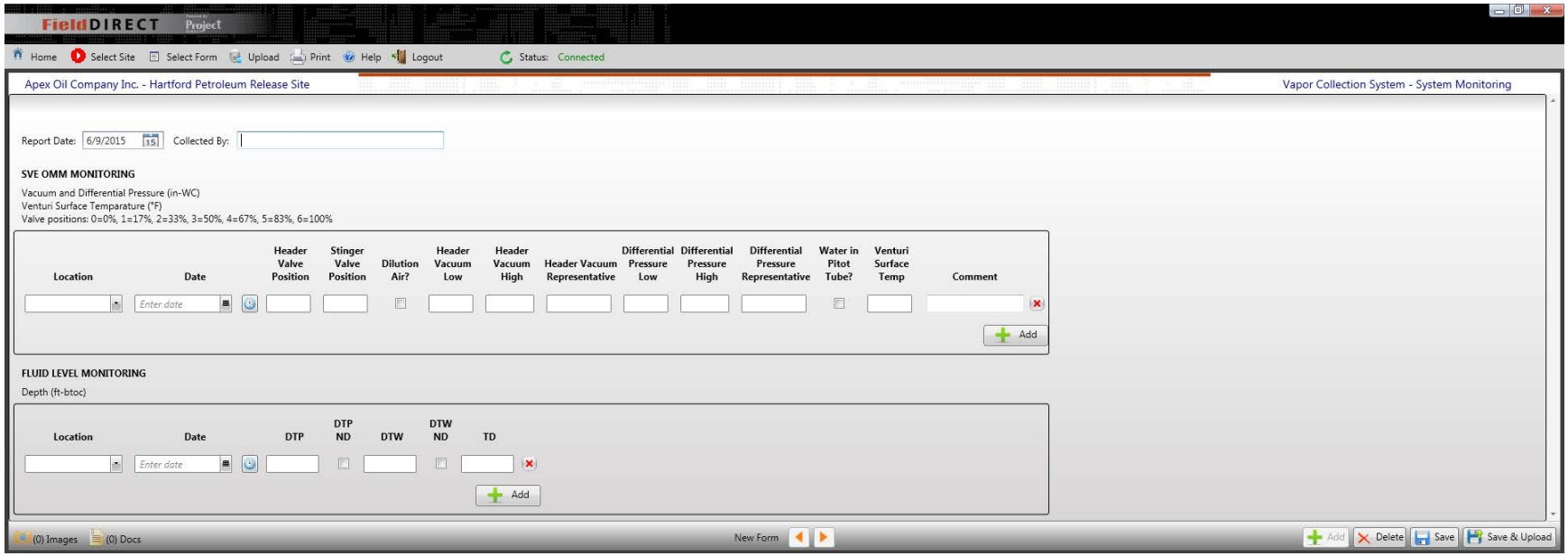
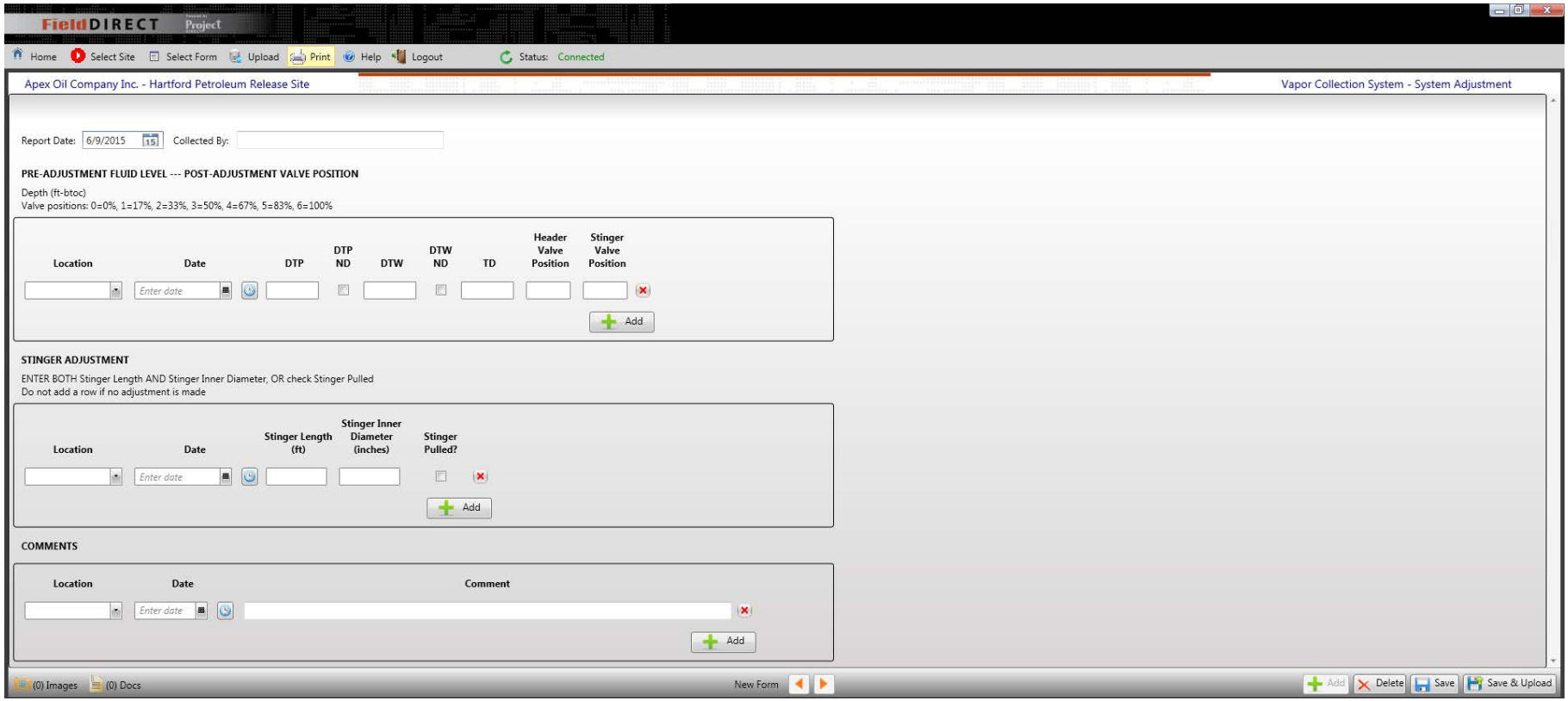


FIGURE C-2. SCREEN SHOT OF FIELD DIRECT SYSTEM ADJUSTMENT FIELD FORM

HARTFORD PETROLEUM RELEASE SITE

HARTFORD , ILLINOIS