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REPORT OF
SOIL VAPOR EXTRACTION
PILOT STUDIES

KENTUCKY AVENUE WELLFIELD SITE
OPERABLE UNIT NO. 3
HORSEHEADS, NEW YORK

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Prepared for:

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HORSEHEADS, NEW YORK

1 INTRODUCTION

This report describes the test methodologies and results of testing of soil vapor extraction (SVE) at two locations at the former Westinghouse Electric Corporation (Westinghouse) plant site in Horseheads, New York. The SVE tests were performed in accordance with Section 3.3 of the May 17, 1995, Revised Work Plan, Supplemental Field Investigations and Treatability Studies (Revision 3.0).

On June 13 through 16, 1995, Philip Environmental Services Corporation (Philip) personnel conducted SVE step tests and 4-hour vapor extraction tests on both shallow and deep wells in the Former Runoff Basin and Disposal Area F at the site. Test locations are shown in Figure 1. The objective of the tests was to evaluate the feasibility of SVE to remove volatile organic compounds (VOCs), especially trichloroethylene (TCE), from the soil in the Former Runoff Basin and Disposal Area F.

The following data were collected before, during, or after each test to evaluate SVE technology:

- depth to water in each well;
- static or pre-test vacuum in soil ("vacuum" is defined as the difference between measured pressure and atmospheric pressure where the measured pressure is lower than atmospheric pressure);
- volume of vapor drawn from the soil at various applied vacuums at the vapor extraction point;
- concentration of VOCs in vapors drawn from each extraction point using a field photoionization detector (PID);

- concentrations of VOCs withdrawn from each extraction well as determined by laboratory analyses conducted by GP Environmental Services, Inc. of Gaithersburg, Maryland (GPES);
- influence vacuums measured at multiple depths and distances in response to applied vacuums at the test extraction wells; and
- the volumetric flow rate of soil vapors at various applied vacuums.

The remainder of this report is divided into three sections. Section 2 describes the general test methodology and the minor variances between the planned and actually implemented methods. Section 3 presents the results of the tests. Section 4 presents an evaluation of the test results.

2 METHODOLOGY

2.1 Extraction/Monitoring Well Installation

The test well and monitoring well set-up at each test location was generally the same. In a central location for each test, a pair of 4-inch diameter Schedule 40 polyvinyl chloride (PVC) vapor extraction wells with 0.01-inch-wide slot screen width were installed within approximately 5 feet from one another (Figures 2 and 3). The well screen specifications originally called for 0.04-inch-wide slots, primarily to reduce the vapor entrance velocity through the screen and thereby reduce the potential for entraining water droplets in the air stream. Because 0.01-inch-wide slot screen was installed, the test described in Section 2.3.3 was performed to confirm that the friction loss of air flow through a well screen with 0.01-inch wide slots was not significant compared with the friction loss through a well screen with 0.04-inch-wide slots.

The locations of screened portions of the extraction wells were based on changes in lithology, depth to groundwater, or both. The shallower extraction wells were installed to test the potential for VOC removal from near-surface soils. The deeper wells extraction wells were installed to test the potential for VOC removal from soils near the water table. Well construction details and lithologic descriptions of the soil encountered are presented in Appendix A.

Two-inch-diameter Schedule 40 PVC monitoring points were installed to monitor the vacuum distribution in the soil during both static and test conditions. The screened sections of these monitoring wells were constructed of Schedule 40 PVC with a slot width of 0.01 inches. The monitoring wells were placed approximately 10 to 40 feet from the extraction wells and spaced so that the angle defined by a line connecting a monitoring well with the extraction well with another monitoring well was approximately 120 degrees (Figures 2 and 3). A pair of nested monitoring wells was completed within each borehole with the screens of each well separated from each other by a bentonite seal (Figure 4).

2.2 Equipment Set-up and Specifications

Using the installed extraction and monitoring wells, tests were performed by applying a vacuum to the extraction wells; treating vapors extracted from the subsurface; and measuring the system flows, extracted vapor concentrations, applied vacuums, and influence vacuums. A schematic of the test equipment set-up is depicted in Figure 5 and described below.

2.2.1 Extraction Equipment

Partial vacuum was applied to the extraction wells with a 2-horsepower, 230-volt, 1-phase regenerative blower capable of delivering 120 cubic feet of air per minute (CFM) at a vacuum equivalent to 60 inches of water (in. H_2O). The blower was powered by a 10-horsepower 5,000-watt portable electrical generator.

This blower system included an upstream 35-gallon moisture separator and a particulate filter. The moisture separator contained a high-water-level switch that would disable the blower if high water levels were encountered within the separator. An ambient air port was pre-plumbed between the moisture separator and the blower. Although the planned equipment set-up was to locate the ambient air port before the moisture separator, the pre-plumbed ambient air port located between the moisture separator and the blower was left unchanged. No measurable difference in system performance results from the ambient air port being located before or after the moisture separator.

The upstream side of the blower was connected to the extraction well with a 2-inch diameter reinforced flexible PVC hose with camlock ends. The seal with the extraction well was made with a ribbed rubber packer with a 2-inch threaded steel fitting in the center. An air sampling port was installed in a section of 2-inch diameter PVC pipe immediately downstream of the vapor extraction well. All fittings upstream of the air sampling port were either screw type lined with Teflon

tape or were pinned. A vacuum monitoring port was also installed near the soil vapor extraction well.

Gate valves and air velocity access ports were installed in the upstream side of the moisture separator and ambient air port. The blower effluent was connected to the activated carbon vapor treatment drums with flexible, reinforced 2-inch diameter PVC hose and camlock fittings. Vapor sampling ports were installed between and after the vapor treatment drums. An air velocity port was installed in the vapor treatment drum effluent piping.

The moisture separator, blower, and vapor treatment drums were installed inside a cargo van so that they could be readily assembled and disassembled between tests.

2.2.2 Vapor Treatment

Extracted vapor was treated with two-vapor phase activated carbon canisters (from Envirotrol, Inc.) plumbed in series. Each canister contained approximately 7.3 cubic feet (200 pounds) of activated carbon. It was expected that the combined drums could remove up to 40 pounds of VOCs before breakthrough would be observed (i.e., 1 pound of VOCs per 10 pounds of carbon). To meet the substantive requirements for vapor discharge permitting during the vapor extraction tests, a letter describing the vapor treatment methodology and monitoring was submitted to Mr. Gardiner Cross of the New York State Department of Environmental Conservation. A copy of this letter is presented in Appendix B.

2.2.3 Data Collection

Omega Model FL-540 flow rotometers were installed in-line in the ambient air line and in the piping connected to the soil vapor extraction well. As a back-up flow (and temperature) measuring system, Philip used an Alnor CompuFlow

(Model 8575) heated wire anemometer. During the first step test, it was noted that the in-line flow meters severely reduced the vacuums that could be applied to the extraction well and the vapor flows that could be drawn from the extraction well. For this reason, the in-line flow meters were removed, and the heated wire anemometer was used as the primary flow measuring device.

Vapor screening concentrations were measured with a Thermo Electron 580B PID. Air samples were collected with a Gilian GilAir-5 Sampler capable of drawing 250 cubic centimeters per minute (cm^3/min) at a vacuum equivalent to 25 in. H_2O.

Vacuums at the wells heads were measured with a set of four Dwyer Instruments, Inc., differential pressure gauges with full range pressure/vacuums of 1.0, 5.0, 20, and 100 in. H_2O. Each monitoring well was fitted with an expandable hollow-stem plug with ball valve and brass hose barb.

Water levels in the extraction and monitoring wells were measured with an electronic water level indicator.

2.3 Testing Methodology

Two types of tests were performed at each extraction well location. The first was a step test, which included extraction of vapors from the extraction well at three different vacuums. The second test was a longer-term test (approximately 4 hours) at a vacuum selected on the basis of the results of the step test. After completing a test (step or 4-hour test) at one location (either the Former Runoff Basin or the Disposal Area F), the next test was performed at the other location so that the ambient soil pressures could return to static conditions before starting another test.

2.3.1 Step Test

Before performing the step test, data were collected to establish pre-test, baseline conditions. The data collected included water levels and vapor concentrations in the vapor extraction well, static vacuum readings in all the wells, and static vapor concentrations at the vapor extraction well. Water level information was used in conjunction with well construction details to select the maximum vacuum to apply to the vapor extraction well during the tests. As described below, the maximum vacuums applied to the deeper wells were selected to avoid locally raising the groundwater level above the screen of the extraction well.

Once the pre-test data were collected, the extraction test was begun at approximately one-third of the maximum expected applied vacuum, and the time of test start-up was recorded. During the step test, vacuum was measured from shallow and deep vapor extraction wells and from all vapor monitoring wells, and the elapsed time of the measurements was recorded. Flow rates and temperatures of vapors being drawn from the well, being drawn through the ambient air port, and being exhausted from the carbon drums were also measured. The individual vacuum/flow step was terminated after approximately 20 to 30 minutes. The test was repeated at two higher vacuums/flows. A three-step test was performed at each vapor extraction well (shallow and deep) at each tested area.

2.3.2 Four-Hour Test

A 4-hour test was performed on both the shallow and deep soil vapor extraction wells at both the Former Runoff Basin and Disposal Area F.

As in the step tests, pre-test measurements were recorded for water levels and vapor concentrations in the vapor extraction well and monitoring wells, static vacuum readings in all the wells, and static vapor concentrations at the vapor extraction well.

Once the pre-test data were collected, the extraction test was begun at optimum vacuum determined from the step test. Except for the deeper well in the Former Runoff Basin, this vacuum was generally equal to or near the maximum vacuum applied in the step tests. The time of test start-up and elapsed time of the measurements were recorded. During the 4-hour test, vacuum was measured at shallow and deep vapor extraction wells and from all vapor monitoring wells. Flow rates and temperatures of vapors being drawn from the well, being drawn through the ambient air port, and being exhausted from the carbon drums was also measured. Measurements were taken approximately 30 minutes apart.

After approximately 2 hours and 4 hours from the beginning of the test, a vapor sample was collected in a Tedlar air sample bag and shipped by overnight courier to GPES for VOC analysis. The samples were collected from the vapor stream proximal to the extraction well and upstream from any glued fittings. The samples were collected by reducing the vacuum on the well to approximately 10 in. H_2O so that the air sampling pump could overcome the vacuum applied by the test equipment and withdraw vapor from the piping. A vacuum on the well was maintained so that representative vapor samples were drawn from the subsurface soil pores and so that no vapors from downstream glued pipe fittings would contaminate the sample.

2.3.3 Evaluation of Friction Loss in Well Screen

The planned well screen slot width to be used for the vapor extraction wells was 0.04-inches. This 0.04-inch slot width was specified to reduce the potential for entrained water to enter the vapor stream and travel to the moisture separator, blower, carbon drums, or low spots in the piping.

The well screen slot width actually used in the installed extraction wells was 0.01-inches. To document the expected vacuum and flow loss across well screen with 0.01-inch-wide slots versus 0.04-inch-wide slots, Philip performed a test using the same equipment used in the SVE tests.

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To perform the test, a 5-foot-long section of 4-inch diameter Schedule 40 PVC screen with 0.04-inch-wide slots was capped on one end and connected to the vapor extraction equipment. The vacuum was measured at the screen discharge end for a series of increasing flow rates.

Once the first test was completed, a second test was performed to approximate the effect of drawing similar flows through a 5-foot section of screen with 0.01-inch-wide slots. Based on information from the well screen manufacturer (Johnson Division), a section of screen with 0.04-inch-wide slots has approximately 3.5 times the open area as a equivalent length of screen with 0.01-inch-wide slots. To simulate a 5-foot-length of screen with 0.01-inch-wide slots, the amount of open area on the 5-foot section of screen was reduced by a factor of 3.5. The second test was performed at the flow rates tested during the first test and a corresponding vacuum response was recorded. These data are presented in Table 1.

The results of these tests indicated that reducing the open area of a 5-foot section of screen by a factor of 3.5 had a negligible effect on the pressure drop across the screen for the range of flows encountered during the SVE test.

3 SOIL VAPOR EXTRACTION TEST RESULTS

3.1 Lithology and Water Levels

Soil borings, including those drilled to install test wells, encountered mostly unsorted gravel and sand with significant amounts of fines, predominantly silt, in both the Former Runoff Basin and Disposal Area F. A fine-grained soil component was noticeably absent from the deeper soil (greater than 10 feet below ground surface [bgs]) encountered in Disposal Area F. Lithologic logs for the borings used to install the vapor extraction wells and vapor monitoring wells are presented in Appendix A.

Water levels in the wells were measured to calculate maximum vacuum that could be applied to the deep vapor extraction well to prevent total submergence of the screen from groundwater upwelling. A summary of well data, including screened interval depth, depth to water, and exposed length of screen, is given in Tables 2 and 3.

3.2 Test Results, Former Runoff Basin

3.2.1 Step Tests

Shallow Well

Step test results for the shallow vapor extraction well are summarized in Tables 4 and 5. Non-zero vacuum readings were encountered in VMP-1 (both shallow and deep) and in the deep vapor extraction well. Applied vacuums of 22, 40, and 55 in. H_2O produced extraction well flow rates of 17, 40, and 46 CFM, respectively. Small influence vacuums (above static vacuums) were noted at VMP-1 (shallow and deep) and the deep vapor extraction well at the highest applied

vacuum and at VMP-3 (shallow and deep) at all applied vacuums. After correcting for static vacuums, no influence vacuums exceeded 0.05 in. H_2O.

Deep Well

Step test results for the deep vapor extraction well are summarized in Tables 6 and 7. All static vacuum readings were zero. Applied vacuums of 11, 22, and 28 in. H_2O produced extraction well flow rates of 22, 34, and 30 CFM, respectively. The drop of flow rate with increasing the vacuum from 22 to 28 in. H_2O is likely due to greater restriction of flow due to groundwater upwelling with the higher vacuum. No influence vacuum response was noted in any of the vapor monitoring wells.

3.2.2 4-Hour Tests

Shallow Well

A summary of the 4-hour test data on the shallow vapor extraction well is presented in Tables 8 and 9. After field interpretation of the step tests, a vacuum of 48 to 50 in. H_2O (maximum sustainable vacuum using the test equipment specified) was applied to the shallow vapor extraction well in the Former Runoff Basin during the 4-hour test. The flow during the test ranged from 41.0 CFM near the beginning of the test to 49.6 CFM near the end of the test. The vacuum dropped during the test from 50 in. H_2O to 48 in. H_2O, possibly due to increased permeability from drying of the vadose zone. Influence vacuums were noted in VMP-1 and VMP-3 (both shallow and deep) throughout the test. No influence vacuum was noted in VMP-2 (shallow or deep) or in the deep vapor extraction well.

PID screening of the well head vapors were performed at approximately 116 and 237 minutes after the beginning of the test with results of 8 and 5.7 meter needle deflection units, respectively. Samples of the vapor stream collected at 116 and 237 minutes after the beginning of the test indicated the presence of small concentrations of 1,1,2,2-tetrachloroethane; acetone; methylene chloride; and TCE. Only TCE was found at concentrations above the detection limit. The concentrations of the remaining compounds were below the detection limit and are reported as estimated concentrations. A summary of the results is presented in Table 10; laboratory reports are presented in Appendix C.

No measurable vapor concentrations (as determined by the PID) were noted between or after the vapor treatment drums during the test.

Deep Well

A summary of the 4-hour test data on the deep vapor extraction well is presented in Tables 11 and 12. After field interpretation of the step tests, a vacuum of 28 in. H_2O was applied to the shallow vapor extraction well. The vacuum that could be applied was limited by the 36 inches of exposed screen above the water table (Table 2). The flow during the test ranged from 7.0 CFM to 9.2 CFM. This relatively low flow resulted from the limited vacuum that could safely be applied without submerging the well screen. No measurable influence vacuums were noted in any of the vapor monitoring wells.

PID screening of the well head vapors was performed at approximately 113 and 229 minutes after beginning the test with 2.4 meter needle deflection units measured at each time. Samples of the vapor stream collected at 113 and 229 minutes after the beginning of the test indicated low concentrations of 1,1,2,2-tetrachloroethane; chloromethane; methylene chloride; and toluene. Only methylene chloride was found at concentrations above the detection limit. The concentrations of the remaining compounds were below the detection limit and were reported as estimated concentrations. No TCE was detected. A summary of

the results is presented in Table 13; laboratory reports are presented in Appendix C.

No measurable vapor concentrations (as determined by the PID) were noted between or after the vapor treatment drums during the test.

3.3 Test Results, Disposal Area F

3.3.1 Step Tests

Shallow Well

Step test results for the shallow vapor extraction well are summarized in Table 14 and 15. Applied vacuums or 20, 30, and 45 in. H_2O produced extraction well flow rates of 30, 67, and 76 CFM, respectively. Small influence vacuums (0.01 in H_2O) were noted at VMP-1 (shallow and deep).

Deep Well

Step test results for the deep vapor extraction well are summarized in Tables 16 and 17. All static vacuum reading were zero. Applied vacuums of 5, 10, and 12 in. H_2O produced extraction well flow rates of 33, 86, and 110 CFM, respectively. Influence was noted at VMP-1 (shallow and deep) at all applied vacuums and at VMP-2 (shallow and deep) and the shallow vapor extraction well at 10 and 12 in. H_2O of applied vacuum. No influence vacuum response was noted in VMP-3 (shallow or deep) at any applied vacuum.

3.3.2 4-Hour Tests

Shallow Well

A summary of the 4-hour test data on the shallow vapor extraction well is presented in Tables 18 and 19. After field interpretation of the step tests, a vacuum of 40 to 42 in. H_2O (maximum sustainable vacuum using the test equipment specified) was applied to the shallow vapor extraction well in the Disposal Area F during the 4-hour test. The flow during the test ranged from 63.8 CFM near the beginning of the test to 68.0 CFM near the end of the test. The vacuum dropped during the test from 42 in. H_2O to 40 in. H_2O possibly due to increased permeability from drying of the vadose zone. Influence vacuums were noted in VMP-1 (both shallow and deep) and the deep vapor extraction well throughout the test. No influence vacuum or trace vacuums were noted in VMP-2 and VMP-3 (shallow or deep) during the test.

PID screening of the extraction well vapors was performed at approximately 120 and 235 minutes after the beginning of the test, with results 5.7 meter needle deflection units during both readings. Samples of the vapor stream collected at 120 and 235 minutes after the beginning of the test indicated low concentrations of acetone, methylene chloride, and TCE. Only TCE was found at concentrations above the detection limit. The concentrations of the remaining compounds were below the detection limit and were reported as estimated concentrations. A summary of the results is presented in Table 20; laboratory reports are presented in Appendix C.

No measurable vapor concentrations (as determined by the PID) were noted between or after the vapor treatment drums during the test.

Deep Well

A summary of the 4-hour test data on the deep vapor extraction well is presented in Tables 21 and 22. After field interpretation of the step tests, a vacuum of approximately 10 in. H_2O (maximum sustainable vacuum using the test equipment specified) was applied to the deep vapor extraction well. During the 4-hour test, the flow remained steady at 110 CFM. Influence vacuums were measured at VMP-1 (shallow and deep), VMP-2 (shallow and deep) and the shallow vapor extraction well were noted through the test. A slight but unquantifiable influence vacuum was measured in VMP-3 (shallow and deep).

PID screening of the well head vapors was performed at approximately 109 and 231 minutes after beginning the test, with 7.2 and 4.8 meter needle deflection units measured, respectively. Samples of the vapor stream collected at 109 and 231 minutes after the beginning of the test indicated low concentrations of 1,1,1-trichloroethane; 1,1,2,2-tetrachloroethane; ethylbenzene; methylene chloride; TCE; and xylenes. Only TCE and methylene chloride were found at concentrations above the detection limit. The concentrations of the remaining compounds were below the detection limit and are reported as estimated concentrations. A summary of the results is presented in Table 23; laboratory reports are presented in Appendix C.

No measurable vapor concentrations (as determined with a PID) were noted between or after the vapor treatment drums during the test.

4 ANALYSIS OF RESULTS

4.1 Flow Versus Applied Vacuum

Plots of flow versus applied vacuum were prepared using data from each step test at each location. A best-fit line was drawn through the data to show the relationship between flow and applied vacuum. The best-fit lines for each test were drawn through the origin (no vacuum and no flow). These plots are presented in Figures 6 through 9.

4.2 Radius of Vacuum Influence

Plots were prepared of influence vacuums versus distance to vapor monitoring probes for each 4-hour test, except for the 4-hour test on the deep vapor extraction well in the Former Runoff Basin (Figures 10, 11, and 12). No data were plotted for the 4-hour deep extraction well test in the Former Runoff Basin because no influence vacuums were detected during the test. Because vacuums generally decrease logarithmically with distance from the outside of the borehole of the vapor extraction well, the data are plotted on a semi-logarithmic scale so that a straight-line best fit to the data could be made. Experience indicates that the vacuum immediately outside the vapor extraction well borehole is approximately 0.3 times the applied vacuum at the vapor extraction well. This value has been plotted in Figures 10, 11, and 12 and labeled "VEW."

A best-fit line was drawn through the data points. For the shallow vapor extraction well test in the Former Runoff Basin and for the deep vapor extraction well test in Disposal Area F, best-fit lines were drawn through the data both including and excluding the corrected vacuum for the vapor extraction well. Because detectable vacuums were noted in only one vapor monitoring probe in the shallow vapor extraction well test in Disposal Area F, a best-fit line was plotted through data including a corrected value for the vapor extraction well.

The radius of vacuum influence is commonly taken as the projected distance at which the vacuum is no lower than a cutoff vacuum (commonly 0.1 to 0.01 in. H_20). Based on an 0.1 to 0.01 in. H_2O vacuum cut-off criterion and including the corrected extraction well data, the range of radii of vacuum influence for the shallow zone in the Former Runoff Basin is approximately 15 to 22 feet, for the shallow zone in Disposal Area F is approximately 8 to 12 feet, and for the deep zone in Disposal Area F is approximately 12 to 20 feet at the vacuums applied during the tests.

4.3 Permeability Calculations

The permeability of the vadose zone was calculated based on the following relationship developed by Johnson, P.C., et. al. (1990):

$$k = \frac{Qu}{H\pi P_w} \; x \; \frac{\ln(R_w/R_I)}{[1-P_{Atm}/P_w)^2]}$$

where:

k	=	soil permeability to air flow in cm^2;
u	=	viscosity of air = 1.8 x 10^{-4} g/cm-s;
P_w	=	absolute pressure at extraction well (g/cm-s^2);
P_{Atm}	=	absolute ambient pressure = 1.01 x 10^6 g/cm-s^2;
R_W	=	radius of vapor extraction well (cm);
R_I	=	estimated radius of influence of vapor extraction well (cm);
Q	=	flow rate (cm^3/sec); and
H	=	length of well screen through which air flow is being drawn (cm).

The estimated permeability for the shallow zone in the Former Runoff Basin is 4.67 x 10^{-7} cm^2 (47 darcy), for the deep zone in the Former Runoff Basin is 1.05 x 10^{-6} cm^2 (106 darcy), for the shallow zone in Disposal Area F is 4.35 x 10^{-7} cm^2 (44 darcy), and for the deep zone in Disposal Area F is 4.59 x 10^{-6} cm^2 (464 darcy). Calculations are presented in Appendix D.

4.4 TCE Mass Removal Rates

The mass removal rate of TCE was estimated for each area by multiplying the concentration of TCE by the flow rate in standard cubic feet per minute (scfm) (conversion of CFM to scfm in Appendix D). The calculated mass removal rates for the shallow well in the Former Runoff Basin ranged from 0.04 to 0.08 pounds per day, for the shallow well in Disposal Area F ranged from 0.08 to 0.18 pounds per day, and for the deep well in Disposal Area F ranged from 0.06 to 0.15 pounds per day. Because no detected or estimated concentrations of TCE were reported in air samples collected from the deep well in the Former Runoff Basin, no removal of TCE from the deeper portion of the vadose zone of the Former Runoff Basin can be predicted. Calculations of the estimated TCE mass removal rate are presented in Appendix D.

4.5 Evaluation of SVE as a Remediation Method

In both test areas, the results of the pilot-scale testing demonstrated the feasibility of SVE to induce subsurface air flows to extraction wells. Significant volumetric air flows can be developed by applying moderates vacuums, reflecting the high air permeabilities in all four test zones, and, except for the deep well in the Former Runoff Basin, reasonable zones of influence can be developed around each extraction well. In the deeper zone at the Former Runoff Basin, the applied

vacuum was limited because only 36 inches of well screen were exposed above the water table. Shallower wells would be needed in this area if larger vacuums are to be applied and air flows increased. Overall, however, there are no significant physical impediments for implementation of SVE to treat soils in the Former Runoff Basin or Disposal Area F.

The rates of TCE removal by SVE during the pilot-scale tests were generally quite low. These low mass removal rates most likely reflect the limited quantities of TCE present in the subsurface rather than the ability of this technology to extract TCE from site soils. The following sections evaluate the practicality of using SVE for TCE removal, to the extent TCE removal in these areas is shown to be required. This evaluation uses treatment areas based on sampling and analysis conducted as part of the Initial Field Investigation (IFI) phase of the remedial investigation (RI) and "model" SVE operating conditions based on the pilot-scale data.

4.5.1 Former Runoff Basin

In the Former Runoff Basin, the shallow extraction well, screened at a depth of 2.5 to 3.0 ft-bgs, withdrew 0.04 to 0.08 pounds of TCE per day. The deeper well, screened at 8.0 to 13.0 ft-bgs, did not extract a detectable quantity of TCE, most likely because the applied vacuum (and resultant air flow) had to be limited because only a relatively small section of screen (36 inches) was exposed above the water table.

IFI soil sampling and analysis detected TCE concentrations in soil above 100 micrograms per kilogram (μg/kg) at two locations located about 100 feet apart (i.e., Borings FRB-158 and FRB-163). The depths of samples ranged from 2.0 to 6.0 ft-bgs. The two "hot spots" of elevated TCE concentration are separated by soil boring FRB-160, located about 40 feet from FRB-158, in which the sample collected at a depth of 6.0 ft-bgs exhibited 6 μg/kg TCE.

To evaluate the practicality of using SVE to remove TCE from shallow soils in the area of boring FRB-158, the following treatment model was assumed:

- the overall treatment area is approximately 75 by 75 feet in plan, centered on the location of FRB-158, plus a 20 by 20 foot area centered at FRB163 with a treatment (vadose) zone thickness of 10 feet;
- the unit weight of the soil is 110 pounds per cubic foot;
- eight extraction wells would be used, each treating a nominal cylindrical volume of soil of 20-foot radius and 10 feet in depth (i.e., 12,600 cubic feet or 690 tons);
- at an assumed effective porosity of 25 percent, one pore volume for each well is 3,150 cubic feet;
- the average TCE concentration in the soil is 15,000 μg/kg, so that each extraction well needs to treat a TCE mass of approximately 20 pounds (690 tons soil x 2000 pounds/ton x 1.5×10^{-5} pound TCE/pound soil);
- the flow in each extraction well would be 50 CFM for a total air flow of 400 CFM; and
- the initial TCE removal rate is 0.06 pounds per day per extraction well.

The time required to remove 95 percent of the TCE at the initial removal rate of 0.06 pounds per day per well, would be 330 days (20 pounds x 0.95/0.06 pounds per day). Recognizing that the rate of removal decreases logarithmically, the actual treatment time could be 2 to 5 times this calculated value. This time frame would be sufficient to allow literally thousands of air exchanges through soil subject to SVE treatment. Although the treatment time appears long based on the low TCE removal rate (and possibly due to an overestimation of the total mass of TCE present), these treatment parameters are within the range of practical SVE applications.

4.5.2 Disposal Area F

In Disposal Area F, the shallow extraction well, screened at a depth of 2.5 to 3.0 ft-bgs, withdrew 0.08 to 0.18 pounds of TCE per day, and the deeper well, screened at 10.0 to 15.0 ft-bgs, withdrew 0.06 to 0.15 pounds of TCE per day. IFI soil sampling and analysis detected TCE concentrations in soil above 100 μg/kg in a test trench excavated in the northern portion of Disposal Area F. The depths of samples ranged from 1.0 to 2.5 ft-bgs; a sample from 10.0 ft-bgs showed no detectable TCE.

To evaluate the practicality of using SVE to remove TCE from soils in the area of the northern test trench in Disposal Area F, the following treatment model was assumed:

- the overall treatment area is 80 by 80 feet in plan, centered on the location of the northern test trench, with a treatment depth of 10 feet;
- the unit weight of the soil is 110 pounds per cubic foot;
- 16 extraction wells would be used, each treating a cylindrical volume of soil of 12-foot radius and 10 feet in depth (i.e., 4,520 cubic feet or 250 tons);
- at an assumed effective porosity of 25 percent, one pore volume for each well is 1,130 cubic feet;
- the average TCE concentration in the soil is 10,000 μg/kg, so that each extraction well needs to treat a TCE mass of approximately 5 pounds (250 tons soil x 2000 pounds/ton x 1.0 x 10^{-5} pound TCE/pound soil);
- the flow in each extraction well would be 100 CFM for a total air flow of 1,600 CFM; and
- the initial TCE removal rate is 0.10 pounds per day per extraction well.

The time required to remove 95 percent of the TCE at the initial removal rate of 0.10 pounds per day per well, would be 48 days (5 pounds x 0.95/0.10

pounds per day). Recognizing that the rate of removal decreases logarithmically, the actual treatment time would more likely be 2 to 5 times this calculated value or about 3 to 8 months. This treatment time is relatively short, and it may be more practical to reduce the system air flow and increase treatment time. This assessment will be performed as part of the feasibility study. In any case, these treatment parameters are within the range of practical SVE applications.

5 REFERENCES

Johnson, P.C., C. C. Stanley, M. W. Kemblowski, D. L. Byers, and J. D. Colthart. 1990. A Practical Approach to the Design, Operation, and Monitoring of In-Situ Soil Venting Systems. Groundwater Monitoring Review. Spring Issue.

TABLES

Table 1

FLOW VERSUS VACUUM IN 5-FOOT SECTION OF WELL SCREEN

REMEDIAL INVESTIGATION/FEASIBILITY STUDY
HORSEHEADS, NEW YORK

Flow (CFM)	Vacuum for 5-Foot Section of 0.04-Inch Slot Screen (in. H_2O)	Vacuum Equivalent for 5-Foot Section of 0.01-Inch Slot Screen (in. H_2O)
10.7	---	0.025
12	0.025	---
20	0.05	---
21	---	0.075
30	---	0.15
31.5	0.125	---
40	0.225	0.275
50	0.375	---
50.5	---	0.40
75	---	0.85
77	0.675	---
100	1.4	1.5

Table 2

WATER LEVELS AND EXPOSED WELL SCREEN
FORMER RUNOFF BASIN

REMEDIAL INVESTIGATION/FEASIBILITY STUDY
HORSEHEADS, NEW YORK

Well Identification	Screened Interval Below Ground Surface (feet)	Depth to Water Below Ground Surface (feet)	Exposed Screen (feet)
VEW - Shallow	2.5 - 5.0	Dry (> 5.0)	2.5
VEW - Deep	8.0 - 13.0	11.00	3.0
VMP-1 - Shallow	2.5 - 5.0	Dry (>5.0)	2.5
VMP-1 - Deep	8.0 - 13.0	10.81	2.81
VMP-2 - Shallow	4.5 - 7.0	Dry (> 7.0)	2.5
VMP-2 - Deep	10.0 - 15.0	12.25	2.25
VMP-3 - Shallow	2.5 - 5.0	Dry (> 5.0)	2.5
VMP-3 - Deep	8.0 - 13.0	10.78	2.78

Table 3

WATER LEVELS AND EXPOSED WELL SCREEN
DISPOSAL AREA F

REMEDIAL INVESTIGATION/FEASIBILITY STUDY
HORSEHEADS, NEW YORK

Well Identification	Screened Interval Below Ground Surface (feet)	Depth to Water Below Ground Surface (feet)	Exposed Screen (feet)
VEW - Shallow	2.5 - 5.0	Dry (> 5.0)	2.50
VEW - Deep	10.0 - 15.0	12.50	2.50
VMP-1 - Shallow	2.5 - 5.0	Dry (> 5.0)	2.50
VMP-1 - Deep	10.0 - 15.0	12.60	2.60
VMP-2 - Shallow	2.5 - 5.0	Dry (> 5.0)	2.50
VMP-2 - Deep	10.0 - 15.0	12.59	2.59
VMP-3 - Shallow	2.5 - 5.0	Dry (> 5.0)	2.50
VMP-3 - Deep	10.0 - 15.0	12.57	2.57

Table 4
TEST OPERATING CONDITIONS
STEP TEST - SHALLOW VAPOR EXTRATIN WELL
FORMER RUNOFF BASIN

Applied Vacuum to Extraction Well (inches H_20)	Ambient Air Flow Rate (CFM)	Extraction Well Flow Rate (CFM)	Discharge Flow Rate (CFM)	Extraction Well Vapor Concentrations (mu)	Vapor Concentrations Between Carbon Drums (mu)	Vapor Concentrations After Carbons Drums (mu)
0	0	0	0	nd	0	0
22	35	17	nd	nd	0	0
40	58	40	nd	nd	0	0
55	11.3	46	nd	nd	0	0

nd = no data CFM = cubic feet per minute mu = photoionization detector meter units

Table 5
VACUUM RESPONSE DATA
STEP TEST - SHALLOW VAPOR EXTRACTION WELL
FORMER RUNOFF BASIN

Monitoring Well Number	Relative Depth	Applied Vacuums and Corresponding Influence Vacuums (inches H_20)				Distance to Extraction Well (feet)
		Static	Step 1	Step 2	Step 3	
		0	22	40	55	
VMP-1	Shallow	0.05	0.05	0.05	0.1	11.25
VMP-1	Deep	0.05	0.05	0.05	0.1	11.25
VMP-2	Shallow	0	0	0	0	47.25
VMP-2	Deep	0	0	0	0	47.25
VMP-3	Shallow	0	0.025	0.025	0.05	20.92
VMP-3	Deep	0	0.025	0.025	0.05	20.92
Other VE Well	Deep	0.1	0.05	0.05	0.1	5
Approx. Elapsed Time (min)		0	24	28	34	

Note: Approximate Elapsed Time is time from beginning of individual step.

Table 6
TEST OPERATING CONDITIONS
STEP TEST - DEEP VAPOR EXTRACTION WELL
FORMER RUNOFF BASIN

Applied Vacuum to Extraction Well (inches H_20)	Ambient Air Flow Rate (CFM)	Extraction Well Flow Rate (CFM)	Discharge Flow Rate (CFM)	Extraction Well Vapor Concentrations (mu)	Vapor Concentrations Between Carbon Drums (mu)	Vapor Concentrations After Carbons Drums (mu)
0	0	0	0	10	nd	nd
11	116	22	102	nd	1.1	1.1
22	107	24	90	nd	1.1	1.1
28	nd	30	nd	168*	1.1	1.1

nd = no data CFM = cubic feet per minute mu = photoionization detector meter units
* = *measurement taken downstream of glued PVC fittings*

Table 7
VACUUM RESPONSE DATA
STEP TEST - DEEP VAPOR EXTRACTION WELL
FORMER RUNOFF BASIN

Monitoring Well Number	Relative Depth	Applied Vacuums and Corresponding Influence Vacuums (inches H_20)				Distance to Extraction Well (feet)
		Static	Step 1	Step 2	Step 3	
		0	11	22	28	
VMP-1	Shallow	0	0	0	0	11.5
VMP-1	Deep	0	0	0	0	11.5
VMP-2	Shallow	0	0	0	0	43.33
VMP-2	Deep	0	0	0	0	43.33
VMP-3	Shallow	0	0	0	0	21.08
VMP-3	Deep	0	0	0	0	21.08
Other VE Well	Shallow	0	0	0	0	5
Approx. Elapsed Time (min)		0	22	24	24	

Note: Approximate Elapsed Time is time from beginning of individual step.

304547

Table 8
EXTRACTION WELL TEST DATA
4-HOUR TEST - SHALLOW VAPOR EXTRACTION WELL
FORMER RUNOFF BASIN

Approximate Elapsed Time of Extraction System Measurements (min)	Vacuum at Extraction Well Head (inH_20)	Total Flow From Well (CFM)/ Temperature (°C)	Total Ambient Flow (CFM)/ Temperature (°C)	Total Discharge Flow (CFM/ Temperature (°C)	Vapor Concentration At Extraction Well Head (mu)	Vapor Concentration Between Carbon Drums (mu)	Vapor Concentration After Carbon Drums (mu)
0*	0	0 / nd	0 / nd	0 / nd	nd	nd	nd
15	50	41.0 / 23.0	21.5 / 15.6	57.6 / 17.1	nd	0	0
20	50	nd / nd	nd / nd	nd / nd	nd	0	0
59	48	43.0 / 23.0	8.0/ /19.4	48.5 / 33.0	nd	0	0
116**	48	45.0 / 26.3	9.0 / 24.5	49.0 / 36.3	8	0	0
145	48	47.5 / 26.2	10.0 / 23.4	53.3 / 36.9	nd	0	0
192	48	48.4 / 26.9	9.6 / 24.5	53.1 / 37.4	nd	0	0
220	48	47.1 / 27.1	10 / 23.7	54.0 / 37.7	nd	0	0
237**	48	49.6 / 27.6	9.9 / 25.0	54.1 / 37.5	5.7	0	0

nd = no data * = static conditions ** = approximate time of air sample collection in Tedlar bag
CFM = cubic feet per minute mu = photoionization detector meter units

Table 9
MONITORING WELL TEST DATA
4-HOUR TEST - SHALLOW VAPOR EXTRACTION WELL
FORMER RUNOFF BASIN

Vacuum VMP-1 Shallow (inH_20)	Elapsed Time (min)	Vacuum VMP-1 Deep (inH_20)	Elapsed Time (min)	Vacuum VMP-2 Shallow (inH_20)	Elapsed Time (min)	Vacuum VMP-2 Deep (inH_20)	Elapsed Time (min)	Vacuum VMP-3 Shallow (inH_20)	Elapsed Time (min)	Vacuum VMP-3 Deep (inH_20)	Elapsed Time (min)	Deep Vent Well (inH_20)
0	0	0	0	0	0	0	0	0	0	0	0	0
0.05	22.5	0.025	23	0	24.5	0	24.5	0.025	23.5	0.025	23.5	nd
0.075	51	0.025	51	0	55	0	55	0.025	54	0.025	54	nd
0.06	83	0.04	83	0	85	0	85	0.025	85	0.025	85	pressure
0.06	107	0.04	107	0	109	0	109	0.025	108	0.025	108	pressure
0.075	140	0.05	140	0	142	0	142	0.025	141	0.025	141	0
0.06	184	0.04	184	0	186	0	186	0	187	0.025	187	0
0.075	225	0.05	225	0	228	0	228	0.04	227	0.04	227	0
0.1	240	0.075	240	0	243	0	243	0.04	242	0.04	242	nd

nd = no data min = minutes inH_2O = inches of water column vacuum pressure = well at slightly higher than atmospheric pressure

Table 10

SUMMARY OF VOCS IN VAPOR SAMPLES
4-HOUR TEST - SHALLOW VAPOR EXTRACTION WELL
FORMER RUNOFF BASIN

REMEDIAL INVESTIGATION/FEASIBILITY STUDY
HORSEHEADS, NEW YORK

Parameter	Concentration After 116 Minutes (ug/L)	Concentration After 237 Minutes (ug/L)
1,1,2,2-tetrachloroethane	1.70 J	BQL
acetone	5.10 J	BQL
methylene chloride	3.60 J	6.00 J
trichloroethylene	12.7	20.6

BQL = below quantitation limit.
J = below detection limit - estimated value.
ug/L = micrograms per liter.

304549

Table 11
EXTRACTION WELL TEST DATA
4-HOUR TEST - DEEP VAPOR EXTRACTION WELL
FORMER RUNOFF BASIN

Approximate Elapsed Time of Extraction System Measurements (min)	Vacuum at Extraction Well Head (inH_20)	Total Flow From Well (CFM)/ Temperature (°C)	Total Ambient Flow (CFM)/ Temperature (°C)	Total Discharge Flow (CFM)/ Temperature (°C)	Vapor Concentration At Extraction Well Head (mu)	Vapor Concentration Between Carbon Drums (mu)	Vapor Concentration After Carbon Drums (mu)
0*	0	0 / nd	0 / nd	0 / nd	4	nd	nd
33	28	9.2 / 14.1	95.5 / 12.2	93.8 / 26.7	nd	0	0
60	28	8.4 / 16.9	92 / 14.6	94.5 / 27.5	nd	0	0
85	28	8.0 / 16.8	92.5 / 14.4	94.7 / 28.2	nd	0	0
113**	28	7.0 / 20.8	93 / 18.0	93.5 / 29.8	2.4	0	0
148	28	8.6 / 22.6	91.5 / 18.5	93 / 33.6	nd	0	0
192	28	7 / 22.7	94.0 / 20.0	89.5 / 36.8	nd	0	0
207	28	7.4 / 25.5	92.0 / 22.5	88.0 / 38.0	nd	0	0
229**	28	8.1 / 26.7	97.0 / 21.3	86.5 / 39.2	2.4	0	0

nd = no data * = static conditions ** = approximate time of air sample collection in Tedlar bag
CFM = cubic feet per minute mu = photoionization detector meter units

Table 12
MONITORING WELL TEST DATA
4-HOUR TEST - DEEP VAPOR EXTRACTION WELL
FORMER RUNOFF BASIN

Vacuum VMP-1 Shallow (inH_20)	Elapsed Time (min)	Vacuum VMP-1 Deep (inH_20)	Elapsed Time (min)	Vacuum VMP-2 Shallow (inH_20)	Elapsed Time (min)	Vacuum VMP-2 Deep (inH_20)	Elapsed Time (min)	Vacuum VMP-3 Shallow (inH_20)	Elapsed Time (min)	Vacuum VMP-3 Deep (inH_20)	Elapsed Time (min)	Shallow Vent Well (inH_20)
0	0	0	0	0	0	0	0	0	0	0	0	0
0	37	0	37	0	37.5	0	37.5	0	38	0	38	0
0	64	0	64	0	64.5	0	64.5	0	65	0	65	0
0	91	0	91	0	91.5	0	91.5	0	92	0	92	0
0	118.5	0	118.5	0	119	0	119	0	119.5	0	119.5	0
0	151.5	0	151.5	0	152	0	152	0	152.5	0	152.5	0
0	196.5	0	196.5	0	197	0	197	0	197.5	0	197.5	0
0	211	0	211	0	211.5	0	211.5	0	212	0	212	0
0	235	0	235	0	235.5	0	235.5	0	236	0	236	0

nd = no data min = minutes inH_2O = inches of water column vacuum pressure = well at slightly higher than atmospheric pressure

Table 13

SUMMARY OF VOCS IN VAPOR SAMPLES
4-HOUR TEST - DEEP VAPOR EXTRACTION WELL
FORMER RUNOFF BASIN

REMEDIAL INVESTIGATION/FEASIBILITY STUDY
HORSEHEADS, NEW YORK

Parameter	Concentration After 113 Minutes (ug/L)	Concentration After 229 Minutes (ug/L)
1,1,2,2-tetrachloroethane	BQL	1.01 J
chloromethane	0.940 J	BQL
methylene chloride	19.4	10.8
toluene	BQL	0.480 J

BQL = below quantitation limit.
J = below detection limit - estimated value.
ug/L = micrograms per liter.

304551

Table 14
TEST OPERATING CONDITIONS
STEP TEST - SHALLOW VAPOR EXTRACTION WELL
DISPOSAL AREA F

Applied Vacuum to Extraction Well (inches H_20)	Ambient Air Flow Rate (CFM)	Extraction Well Flow Rate (CFM)	Discharge Flow Rate (CFM)	Extraction Well Vapor Concentrations (mu)	Vapor Concentrations Between Carbon Drums (mu)	Vapor Concentrations After Carbons Drums (mu)
0	0	0	0	5.7	0	0
20	80	30	94	nd	3.3	1.1
30	66	67	80	nd	1.1	1.1
45	9	76	62	24*	1.1	1.1

nd = no data CFM = cubic feet per minute mu = photoionization detector meter units
* = measurement taken downstream of glued PVC fitting

Table 15
VACUUM RESPONSE DATA
STEP TEST - SHALLOW VAPOR EXTRACTION WELL
DISPOSAL AREA F

Monitoring Well Number	Relative Depth	Applied Vacuums and Corresponding Influence Vacuums (inches H_20)				Distance to Extraction Well (feet)
		Static	Step 1	Step 2	Step 3	
		0	20	35	45	
VMP-1	Shallow	0	0	0	0.01	10
VMP-1	Deep	0	0	0	0.01	10
VMP-2	Shallow	0	0	0	0	26
VMP-2	Deep	0	0	0	0	26
VMP-3	Shallow	0	0	0	0	27.11
VMP-3	Deep	0	0	0	0	27.11
Other VE Well	Deep	0	0	0	0	5
Approx. Elapsed Time (min)		0	24	22	25	

Note: Approximate Elapsed Time is time from beginning of individual step.

304552

Table 16
TEST OPERATING CONDITIONS
STEP TEST - DEEP VAPOR EXTRACTION WELL
DISPOSAL AREA F

Applied Vacuum to Extraction Well (inches H_20)	Ambient Air Flow Rate (CFM)	Extraction Well Flow Rate (CFM)	Discharge Flow Rate (CFM)	Extraction Well Vapor Concentrations (mu)	Vapor Concentrations Between Carbon Drums (mu)	Vapor Concentrations After Carbons Drums (mu)
0	0	0	0	0	0	0
5	89	33	110	nd	0	0
10	21.5	86	100	nd	0	0
12	1.5	100	100	nd	0	0

nd = no data CFM = cubic feet per minute mu = photoionization detector meter units

Table 17
VACUUM RESPONSE DATA
STEP TEST - DEEP VAPOR EXTRACTION WELL
DISPOSAL AREA F

Monitoring Well Number	Relative Depth	Applied Vacuums and Corresponding Influence Vacuums (inches H_20)				Distance to Extraction Well (feet)
		Static	Step 1	Step 2	Step 3	
		0	5	10	12	
VMP-1	Shallow	0	0.025	0.05	0.05	10.75
VMP-1	Deep	0	0.025	0.05	0.05	10.75
VMP-2	Shallow	0	0	0.025	0.025	21
VMP-2	Deep	0	0	0.025	0.025	21
VMP-3	Shallow	0	0	0	0	29.75
VMP-3	Deep	0	0	0	0	29.75
Other VE Well	Deep	0	0	0.025	0.05	5
Approx. Elapsed Time (min)		0	41	31	23	

Note: Approximate Elapsed Time is time from beginning of individual step.

Table 18
EXTRACTION WELL TEST DATA
4-HOUR TEST - SHALLOW VAPOR EXTRACTION WELL
DISPOSAL AREA F

Approximate Elapsed Time of Extraction System Measurements (min)	Vacuum at Extraction Well Head (inH_20)	Total Flow From Well (CFM)/ Temperature (°C)	Total Ambient Flow (CFM)/ Temperature (°C)	Total Discharge Flow (CFM)/ Temperature (°C)	Vapor Concentration At Extraction Well Head (mu)	Vapor Concentration Between Carbon Drums (mu)	Vapor Concentration After Carbon Drums (mu)
0*	0	0 / nd	0 / nd	0 / nd	17.1	nd	nd
13	42	63.8 / 26.3	3 / 26.9	36 / 34.8	nd	0	0
51	41	67.7 / 27.5	3 / 27.9	64 / 41.1	nd	0	0
89	40	68.5 / 26.6	3 / 28.4	62.5 / 42.1	nd	0	0
120**	40	69.2 / 26.8	4 / 27.2	64.4 / 41.6	5.7	0	0
155	40	68.5 / 28.3	3 / 28.0	63.8 / 41.8	nd	0	0
178	40	68 / 25.7	3 / 27.6	63.6 / 44.9	nd	0	0
235**	40	68 / 25.0	3 / 26.7	61.5 / 45.6	5.7	0	0

nd = no data * = static conditions ** = approximate time of air sample collection in Tedlar bag
CFM = cubic feet per minute mu = photoionization detector meter units

Table 19
MONITORING WELL TEST DATA
4-HOUR TEST - SHALLOW VAPOR EXTRACTION WELL
DISPOSAL AREA F

Vacuum VMP-1 Shallow (inH_20)	Elapsed Time (min)	Vacuum VMP-1 Deep (inH_20)	Elapsed Time (min)	Vacuum VMP-2 Shallow (inH_20)	Elapsed Time (min)	Vacuum VMP-2 Deep (inH_20)	Elapsed Time (min)	Vacuum VMP-3 Shallow (inH_20)	Elapsed Time (min)	Vacuum VMP-3 Deep (inH_20)	Elapsed Time (min)	Deep Vent Well (inH_20)
0	0	0	0	0	0	0	0	0	0	0	0	0
trace	30	trace	30	0	31	0	31	0	32	0	32	0
0.025	57	0.025	57	trace	58	trace	58	0	59	0	59	trace
0.025	96	trace	96	trace	97	trace	97	0	98	0	98	trace
0.025	135	0.025	135	0	136	0	136	0	137	0	137	0.025
0.025	162	0.025	162	0	164	0	164	0	163	0	163	0.025
0.025	184	0.025	184	0	183	0	183	0	185	0	185	0.025
0.025	232	0.025	232	0	233	0	233	0	232	0	232	0.025

nd = no data min = minutes inH_2O = inches of water column vacuum

Table 20

SUMMARY OF VOCS IN VAPOR SAMPLES
4-HOUR TEST - SHALLOW VAPOR EXTRACTION WELL
DISPOSAL AREA F

REMEDIAL INVESTIGATION/FEASIBILITY STUDY
HORSEHEADS, NEW YORK

Parameter	Concentration After 120 Minutes (ug/L)	Concentration After 235 Minutes (ug/L)
acetone	BQL	6.80 J
methylene chloride	5.10 J	6.90 J
trichloroethylene	32.0	15.6

BQL = below quantitation limit.
J = below detection limit - estimated value.
ug/L = micrograms per liter.

Table 21
EXTRACTION WELL TEST DATA
4-HOUR TEST - DEEP VAPOR EXTRACTION WELL
DISPOSAL AREA F

Approximate Elapsed Time of Extraction System Measurements (min)	Vacuum at Extraction Well Head (inH_20)	Total Flow From Well (CFM)/ Temperature (°C)	Total Ambient Flow (CFM)/ Temperature (°C)	Total Discharge Flow (CFM)/ Temperature (°C)	Vapor Concentration At Extraction Well Head (mu)	Vapor Concentration Between Carbon Drums (mu)	Vapor Concentration After Carbon Drums (mu)
0*	0	0 / nd	0 / nd	0 / nd	10	nd	nd
25	9	110 / 21	2.0 / 26	99.8 / 41.2	0	0	0
58	9	110 / 21.5	1.5 / 26.5	99.2 / 43	0	0	0
87	9	110 / 21.5	2.0 / 25	99.4 / 43.5	0	0	0
109**	9	110 / 21.6	1.7 / 26.7	99.8 / 43.2	7.2	0	0
148	10	110 / 21.6	1.8 / 27.8	97.0 / 43.6	0	0	0
177	10	110 / 21.8	1.7 / 28	97.2 / 44.3	0	0	0
206	10	110 / 21.8	1.7 / 27.7	95.3 / 45.1	0	0	0
231*	10	110 / 21.5	2.0 / 27.0	96 / 45.3	4.8	0	0

nd = no data * = static conditions ** = approximate time of air sample collection in Tedlar bag
CFM = cubic feet per minute mu = photoionization detector meter units

Table 22
MONITORING WELL TEST DATA
4-HOUR TEST - DEEP VAPOR EXTRACTION WELL
DISPOSAL AREA F

Vacuum VMP-1 Shallow (inH_20)	Elapsed Time (min)	Vacuum VMP-1 Deep (inH_20)	Elapsed Time (min)	Vacuum VMP-2 Shallow (inH_20)	Elapsed Time (min)	Vacuum VMP-2 Deep (inH_20)	Elapsed Time (min)	Vacuum VMP-3 Shallow (inH_20)	Elapsed Time (min)	Vacuum VMP-3 Deep (inH_20)	Elapsed Time (min)	Shallow Vent Well (inH_20)
0	0	0	0	0	0	0	0	0	0	0	0	0
0.05	31	0.05	31	trace	33	trace	33	trace	32	trace	32	0.05
0.05	64	0.05	64	0.025	65	0.025	65	0	66	trace	66	0.05
0.05	92	0.05	92	0.025	93	0.025	93	trace	94	trace	94	0.05
0.05	114	0.05	114	trace	115	trace	115	0	116	trace	116	0.05
0.05	153	0.05	153	trace	154	trace	154	0	155	trace	155	0.05
0.05	182	0.05	182	trace	183	trace	183	0	184	trace	184	0.05
0.05	211	0.05	211	0.025	212	0.025	212	0	213	trace	213	0.05
0.05	236	0.05	236	0.025	237	0.025	237	0	238	trace	238	0.05

nd = no data min = minutes inH_2O = inches of water column vacuum

Table 23

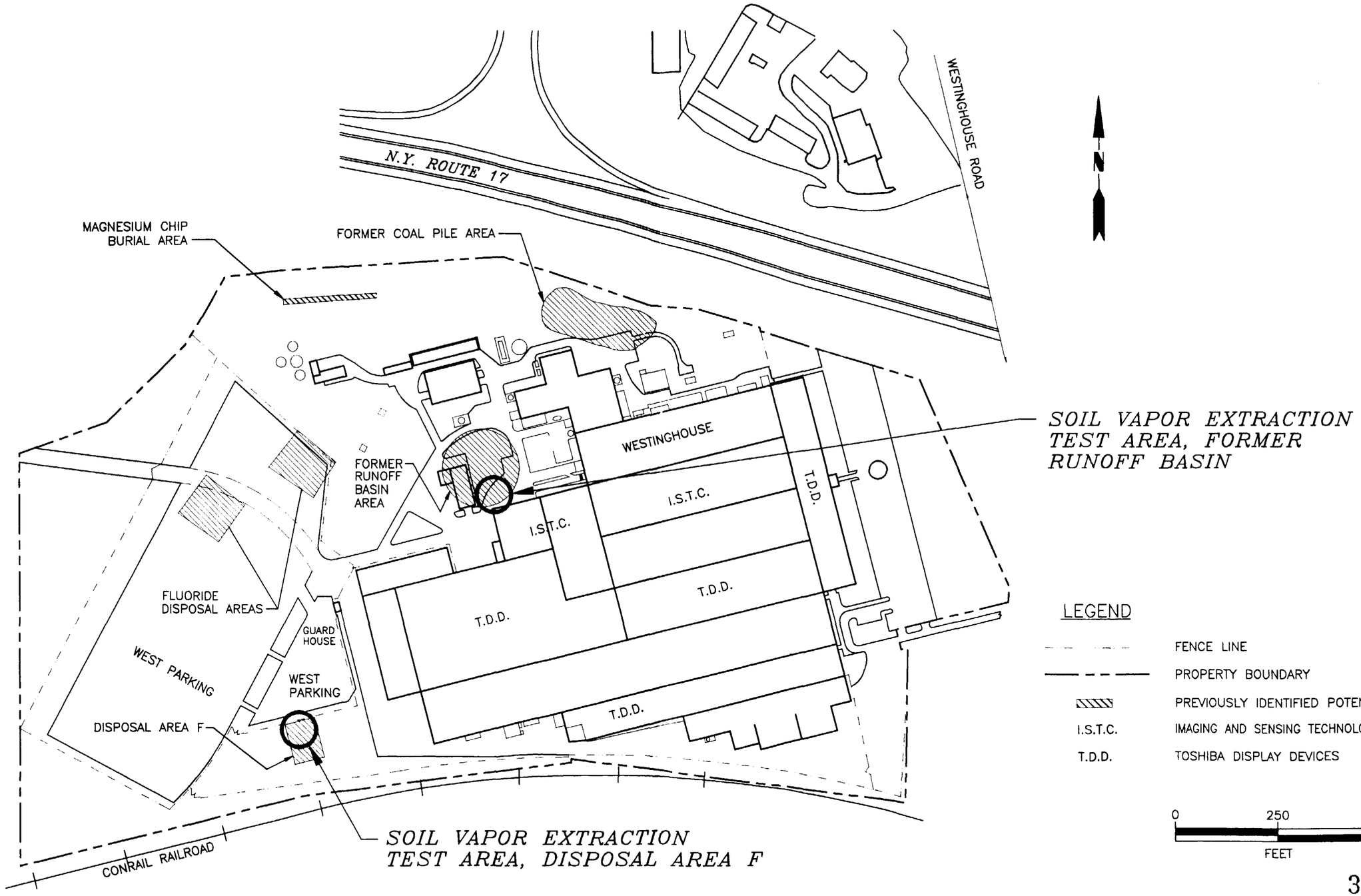
SUMMARY OF VOCS IN VAPOR SAMPLES
4-HOUR TEST - DEEP VAPOR EXTRACTION WELL
DISPOSAL AREA F

REMEDIAL INVESTIGATION/FEASIBILITY STUDY
HORSEHEADS, NEW YORK

Parameter	Concentration After 109 Minutes (ug/L)	Concentration After 231 Minutes (ug/L)
1,1,1-trichloroethene	BQL	0.500 J
1,1,2,2-tetrachloroethane	2.60 J	BQL
ethylbenzene	0.650 J	BQL
methylene chloride	11.9	11.3
trichloroethylene	5.80 J	15.2
xylenes	2.27 J	BQL

BQL = below quantitation limit.
J = below detection limit - estimated value.
ug/L = micrograms per liter.

FIGURES



304559

PHILIP ENVIRONMENTAL

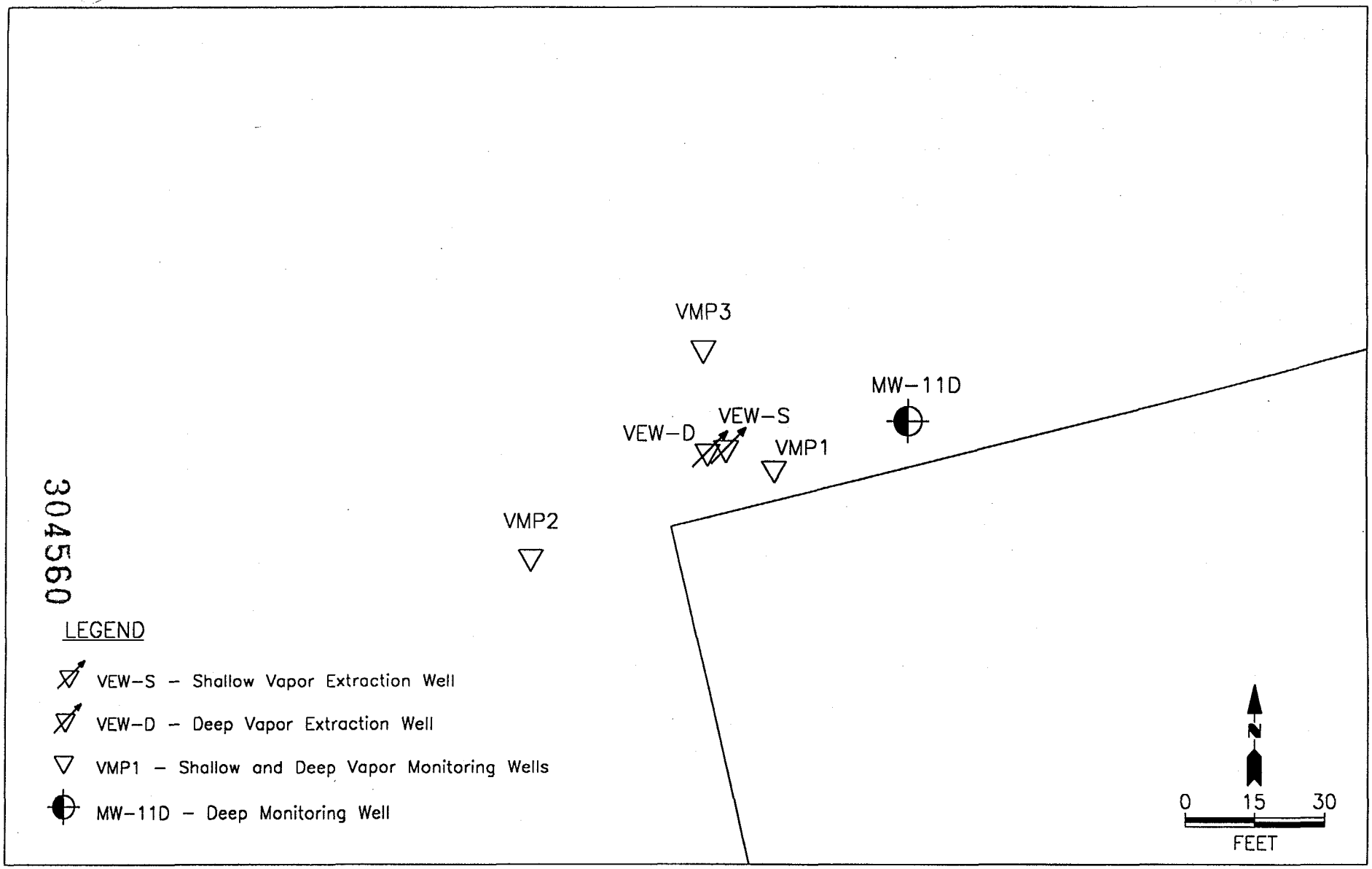
TITLE: TEST AREA LOCATION MAP

NO.	REVISION	BY	APPR.	DATE
△				

SCALE 1" = 250'-0"	DATE:		DATE:	PROJECT NO: 427100
DWN: RAZ	080295	CHKD:	8/2/95	WESTINGHOUSE HORSEHEADS, NEW YORK
DES:		APPD:	8/2/95	

FIGURE 1 REV: A

COL K:\CAD\427100\427100RR



PHILIP ENVIRONMENTAL

Vapor Extraction Well and Monitoring Well Locations in Former Runoff Basin

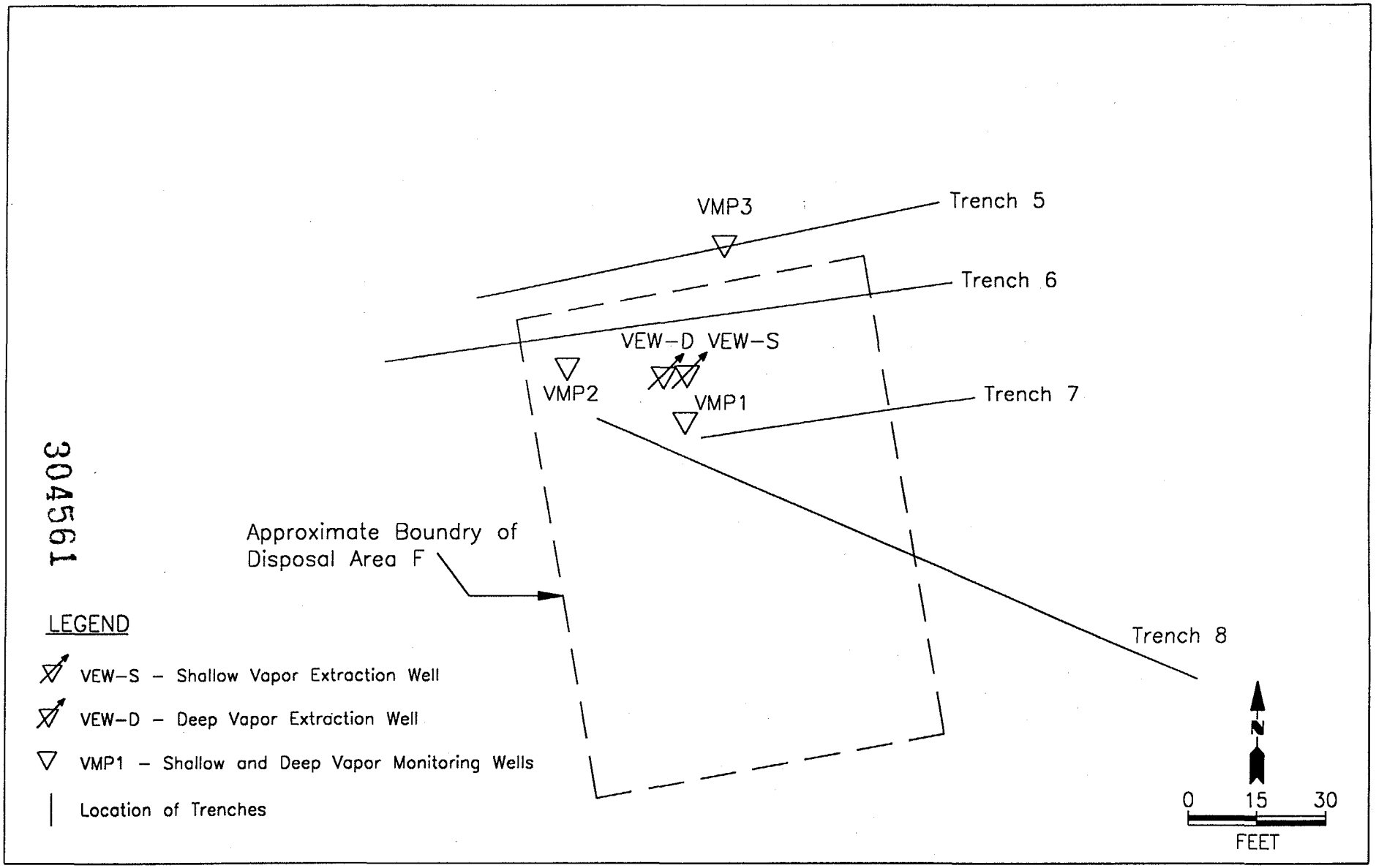
SCALE		DATE
DWN:	MFH	08/02/95
DES:		
CHKD:	SJB	8/2/95
APPD:	MBH	8/2/95

PROJECT NO: 427100
Westinghouse
Horseheads, N.Y.

Figure 2

REV:

COL. g:\gis\west94sb\geo\maps\frbvmp



304561

PHILIP ENVIRONMENTAL

Vapor Extraction Well and Monitoring Well Locations in Disposal Area F

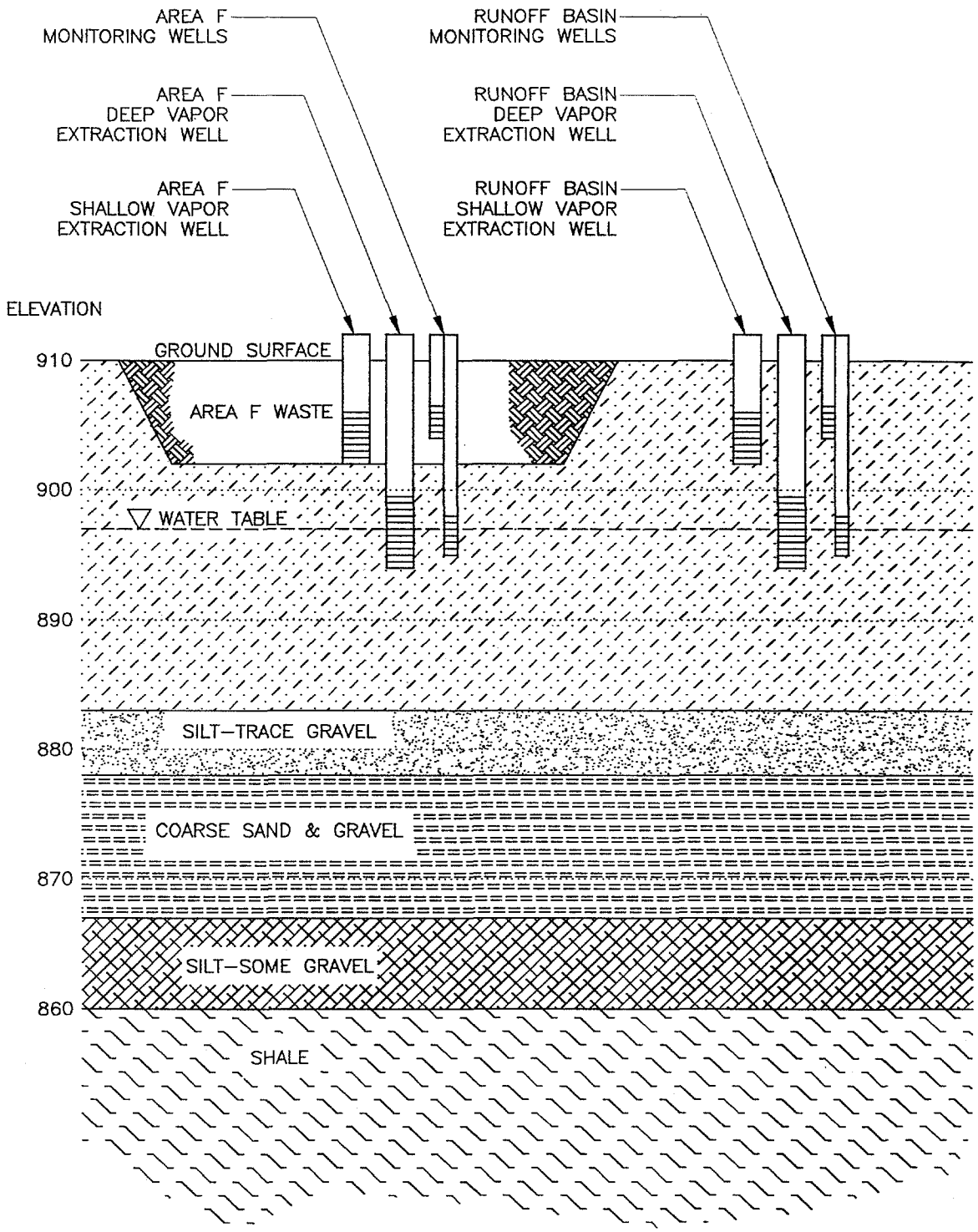
SCALE		DATE
DWN:	MFH	08/02/95
DES:		
CHKD:	AJB	8/2/95
APPD:	MBK	8/2/95

PROJECT NO: 427100
Westinghouse
Horseheads, N.Y.

Figure 3

REV:

COL. g:\gis\west94sb\geo\maps\afdvmp



PHILIP ENVIRONMENTAL

SOIL VAPOR EXTRACTION WELL AND MONITORING WELL CONSTRUCTION

SCALE	NONE	DATE
DWN:	RAZ	080295
DES:		
CHKD:		8/2/95
APPD:		8/2/95

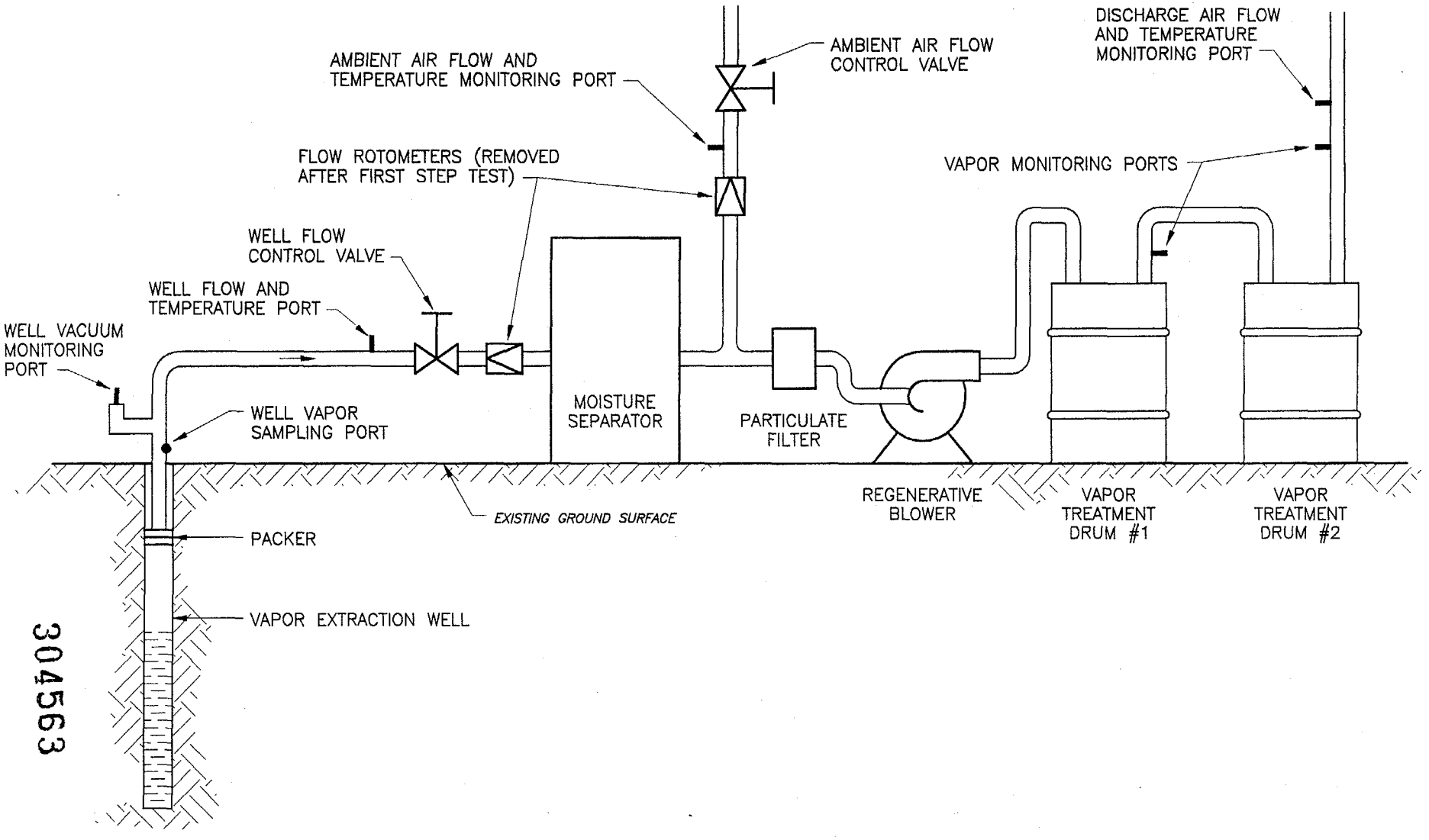
PROJECT NO: 427100
WESTINGHOUSE
HORSEHEADS, NEW YORK

FIGURE 4

REV: A

COL K:\CAD\427100\427100SS

304562



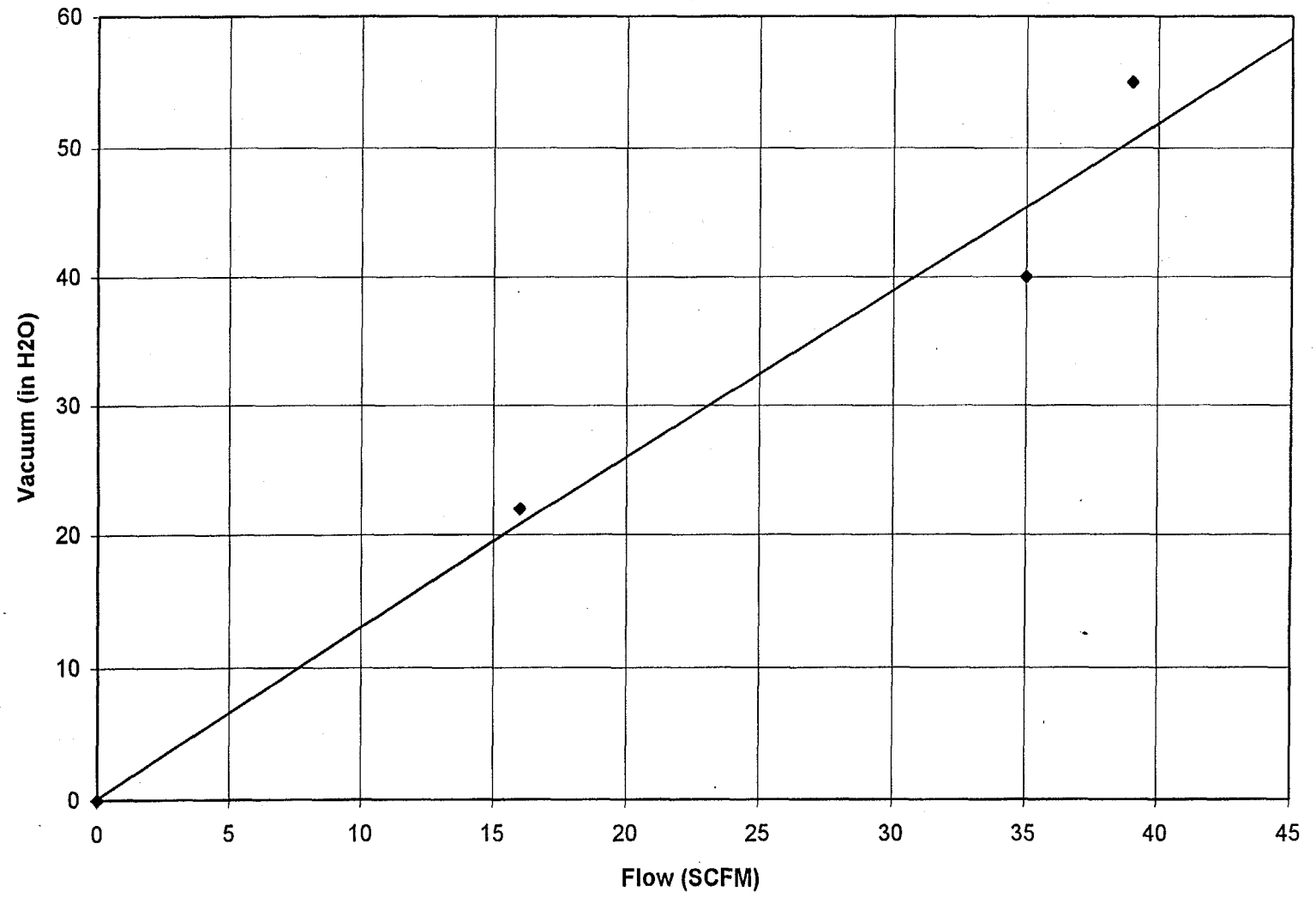
304563

PHILIP ENVIRONMENTAL

SOIL VAPOR EXTRACTION TEST
EQUIPMENT SET-UP SCHEMATIC

SCALE	SCHEMATIC	DATE	PROJECT NO: 427100
DWN:	RAZ	080295	WESTINGHOUSE HORSEHEADS, NEW YORK
DES:			
CHKD:		8/2/95	FIGURE 5 — REV: A
APPD:		8/2/95	

COL K:\CAD\427100\427100TT



304564

PHILIP ENVIRONMENTAL

FLOW VERSUS VACUUM
SHALLOW VAPOR EXTRACTION WELL
FORMER RUNOFF BASIN

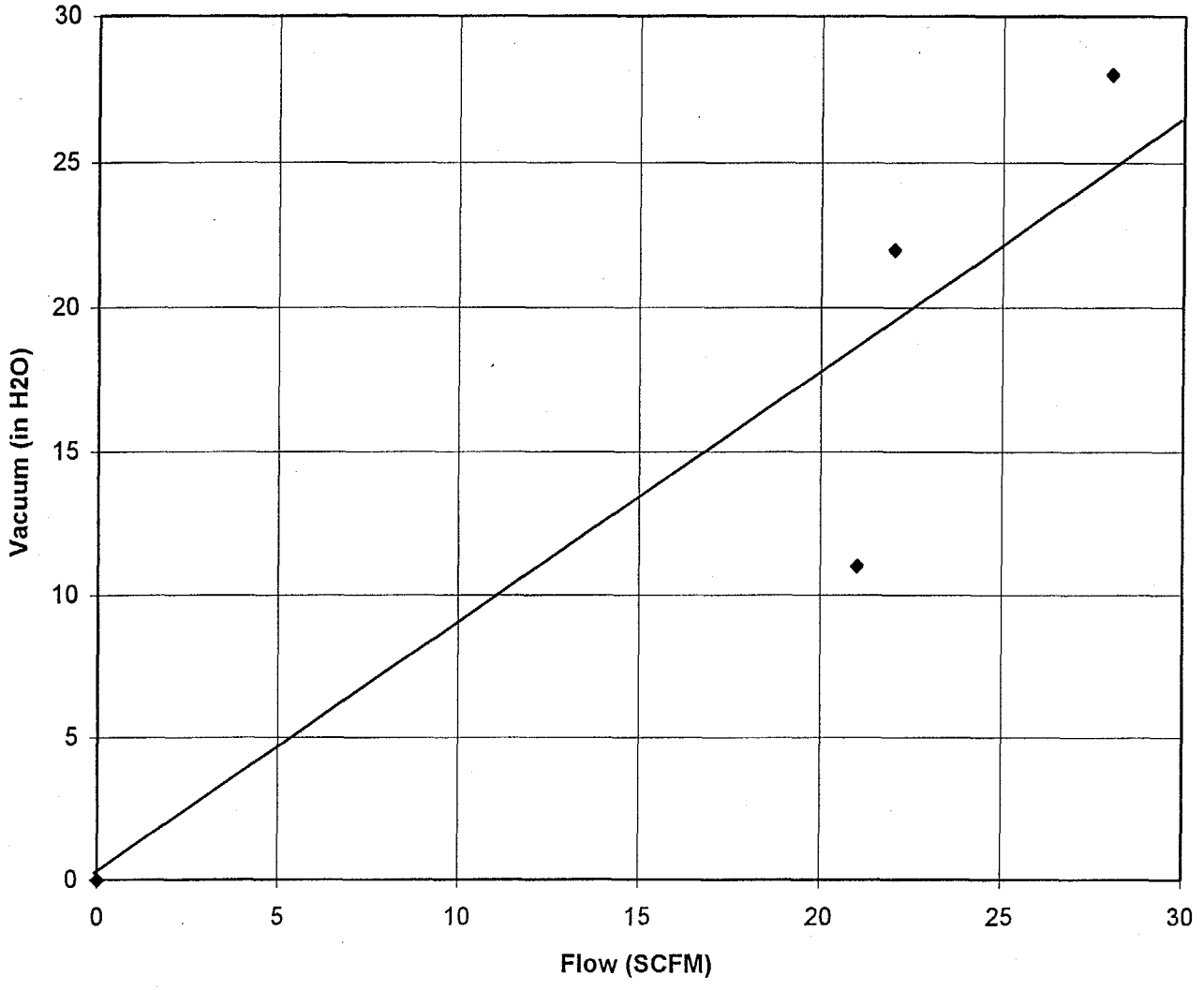
SCALE	NONE	DATE
DWN:	RAZ	080295
DES:		
CHKD:		8/2/95
APPD:		8/2/95

PROJECT NO: 427100
WESTINGHOUSE
HORSEHEADS, NEW YORK

FIGURE 6

REV: A

COL K:\CAD\427100\427100UU



3045665

PHILIP ENVIRONMENTAL

FLOW VERSUS VACUUM
DEEP VAPOR EXTRACTION WELL
FORMER RUNOFF BASIN

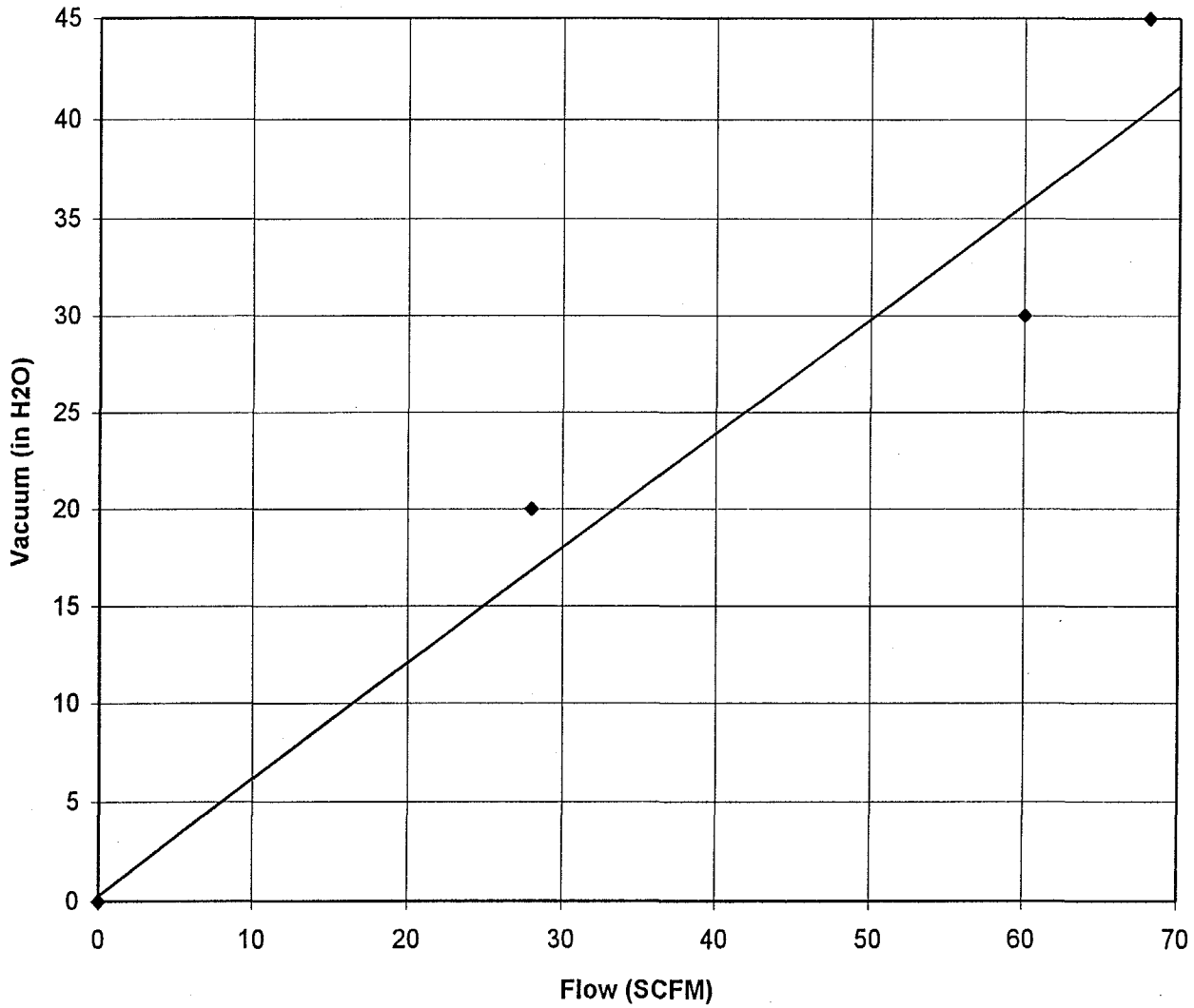
SCALE	NONE	DATE
DWN:	RAZ	080295
DES:		
CHKD:	[signature]	8/2/95
APPD:	[signature]	8/2/95

PROJECT NO: 427100
WESTINGHOUSE
HORSEHEADS, NEW YORK

FIGURE 7

REV: A

COL K:\CAD\427100\427100W



304566

PHILIP ENVIRONMENTAL

FLOW VERSUS VACUUM
SHALLOW VAPOR EXTRACTION WELL
DISPOSAL AREA F

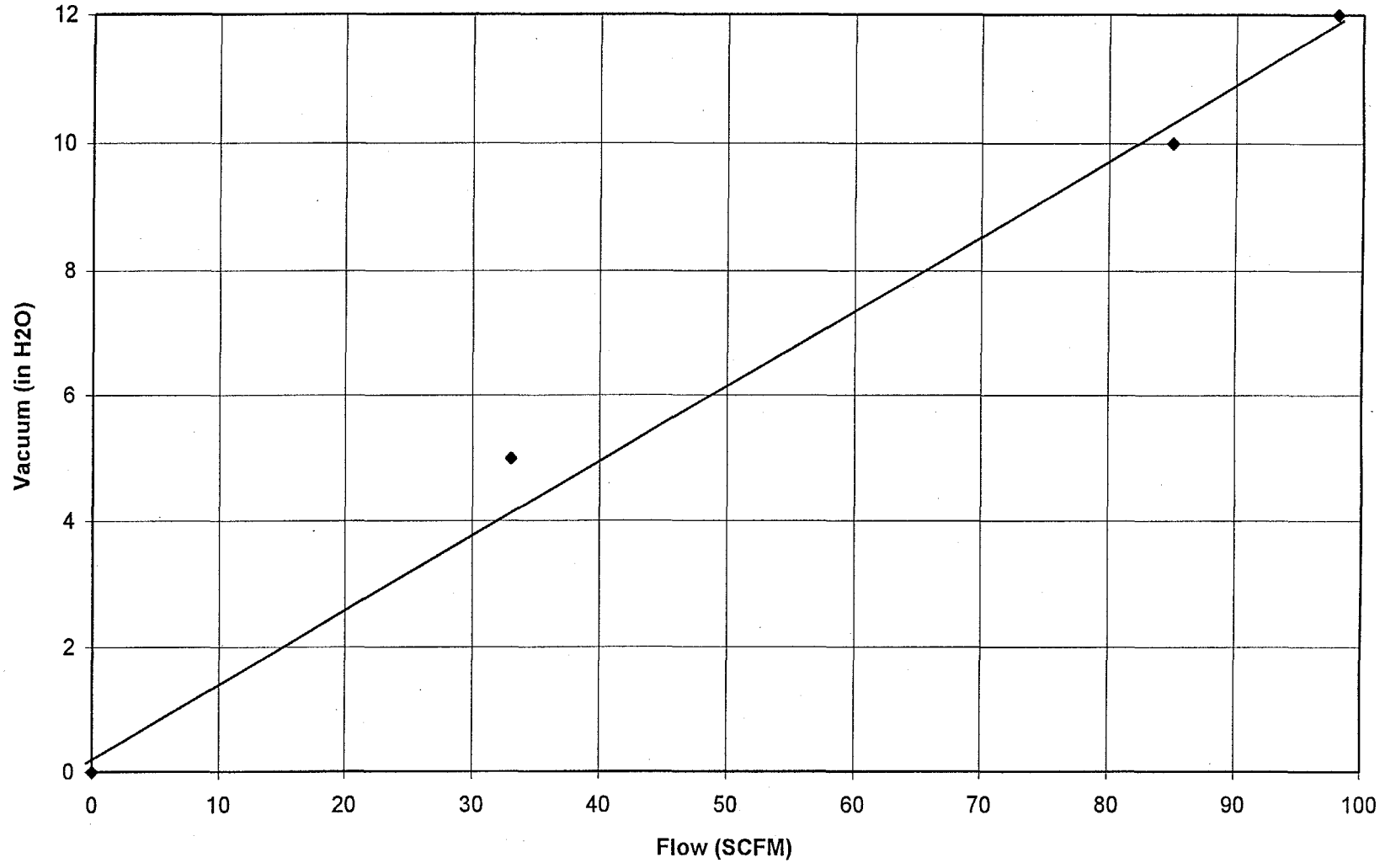
SCALE	NONE	DATE
DWN:	RAZ	080295
DES:		
CHKD:	[illegible]	8/2/95
APPD:	MBH	8/7/95

PROJECT NO: 427100
WESTINGHOUSE
HORSEHEADS, NEW YORK

FIGURE 8

REV: A

COL K:\CAD\427100\427100WW



3045967

PHILIP ENVIRONMENTAL

FLOW VERSUS VACUUM
DEEP VAPOR EXTRACTION WELL
DISPOSAL AREA F

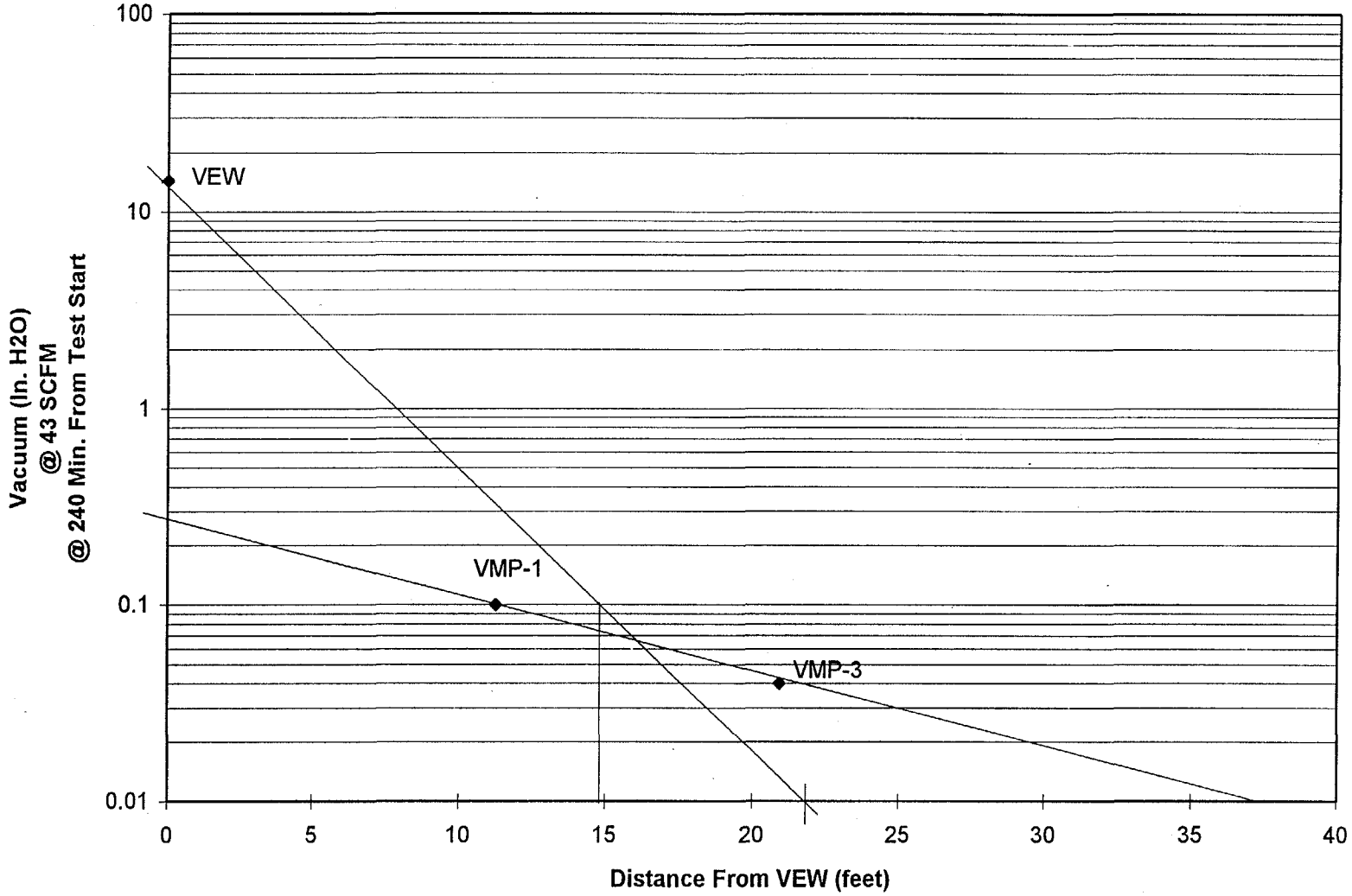
SCALE	NONE	DATE
DWN:	RAZ	080295
DES:		
CHKD:		8/2/95
APPD:		8/2/95

PROJECT NO: 427100
WESTINGHOUSE
HORSEHEADS, NEW YORK

FIGURE 9

REV: A

COL K:\CAD\427100\427100XX



304568

PHILIP ENVIRONMENTAL

VACUUM VERSUS DISTANCE
SHALLOW VAPOR EXTRACTION WELL
FORMER RUNOFF BASIN

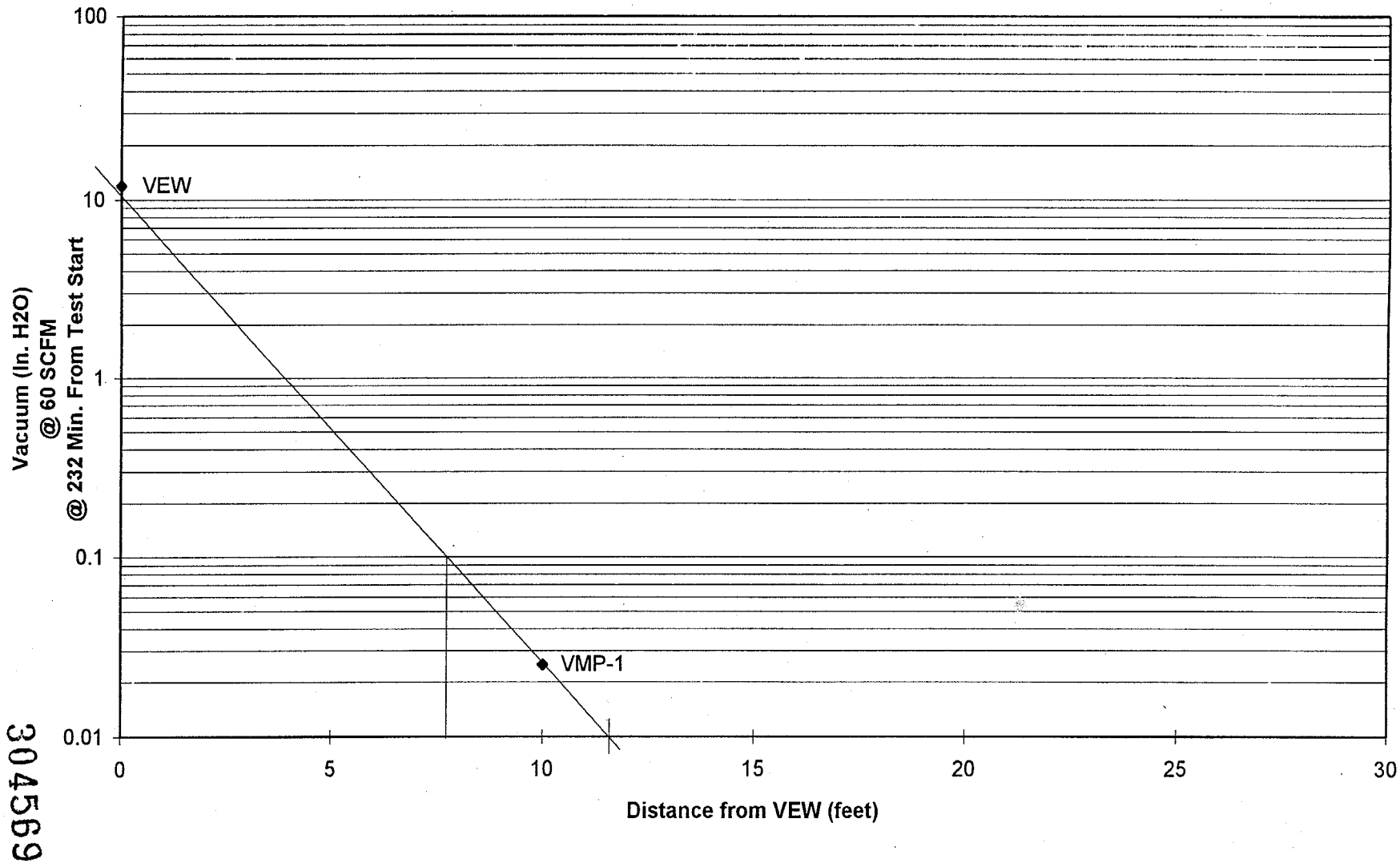
SCALE	NONE	DATE
DWN:	RAZ	080295
DES:		
CHKD:		8/6/95
APPD:		9/7/95

PROJECT NO: 427100
WESTINGHOUSE
HORSEHEADS, NEW YORK

FIGURE 10

REV: A

COL K:\CAD\427100\427100YY



3045569

PHILIP ENVIRONMENTAL

VACUUM VERSUS DISTANCE
SHALLOW VAPOR EXTRACTION WELL
DISPOSAL AREA F

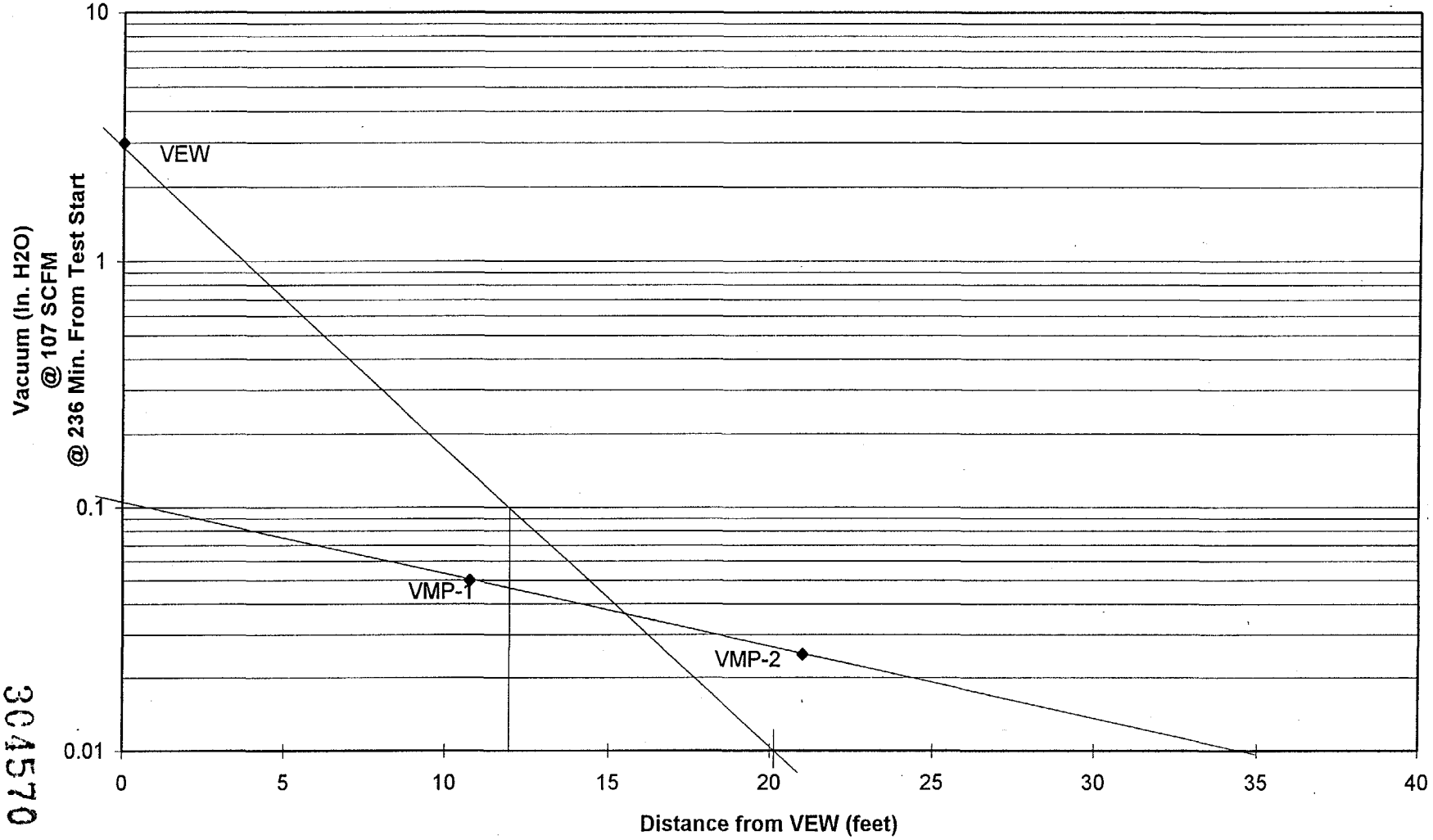
SCALE	NONE	DATE
DWN:	RAZ	080295
DES:		
CHKD:	AJB	8/2/95
APPD:	MBH	8/2/95

PROJECT NO: 427100
WESTINGHOUSE
HORSEHEADS, NEW YORK

FIGURE 11

REV: A

COL K:\CAD\427100\427100ZZ



304570

PHILIP ENVIRONMENTAL

VACUUM VERSUS DISTANCE
DEEP VAPOR EXTRACTION WELL
DISPOSAL AREA F

SCALE	NONE	DATE
DWN:	RAZ	080295
DES:		
CHKD:	GAB	8/2/95
APPD:	MBH	8/2/95

PROJECT NO: 427100
WESTINGHOUSE
HORSEHEADS, NEW YORK

FIGURE 12

REV: A

COL K:\CAD\427100\427100AB

APPENDIX A

304571

APPENDIX A

Lithologic Logs and Well Construction Details

PHILIP ENVIRONMENTAL

Project Name: Westinghouse RI/FS			Project Number: 427100
Location: Former Runoff Basin		Site Id: FRBVEW-S	Elevation: 906.99'
X: 429624.09	Y: 786799.37	Datum: Mean Sea Level	Measuring Point: 906.59'
Borehole Dia.: 4.25in		Completed Depth: 5.00'	Logged By: John LaBarbera

Date(s): 06/03/95 – 06/03/95

Remarks: Sample CA074 FRBVEW-S 0.5'-2.0'

Annular Fill:
type: Portland Cement fm: .40' to: .50'
type: Bentonite Pellets fm: .50' to: 2.00'
type: Sand Filter fm: 2.00' to: 5.00'

Drilling Method: Split Spoon/Hollow Stem Auger

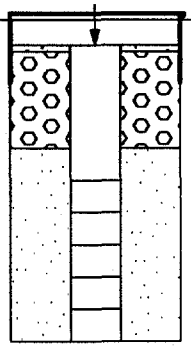
Conductor Casing:
type: dia: .00in fm: .00' to: .00'

Blank Casing:
type: PVC dia: 4.00in fm: .4' to: 2.50'

Screens:
type: Slotted size: .010in dia: 2.00in fm: 2.50' to: 5.00'

Elevation (ft MSL)	Depth (ft)	Blow Count	Recovery	Water Level	PID	USCS Code	Graphic Log	Material Description
905	2	4 7 10			0 ppm	AS GM		0'–0.5' Asphalt 0.5'–4.0' Brown to black, medium dense, silty, sandy, fine to coarse GRAVEL, moist.
		4 7 9 6			0 ppm			
	4	3 5 7 5			0 ppm			4.0'–EOB Black, wet.
	6							
900	8							
	10							
895	12							
	14							
	16							
890								

Well Construction



304573

PHILIP ENVIRONMENTAL

Project Name: Westinghouse RI/FS			Project Number: 427100
Location: Former Runoff Basin		Site Id: FRBVEW-D	Elevation: 907.04'
X: 429620.13	Y: 786798.64	Datum: Mean Sea Level	Measuring Point: 906.64'
Borehole Dia.: 4.25in		Completed Depth: 13.00'	Logged By: Tony Fabina

Date(s): 06/05/95 – 06/05/95

Remarks: Sample CA078 FRBVEW-D 10'-12'
Sample CA079 FRBVEW-D 12'-14'

Annular Fill:
type: Portland Cement fm: .50' to: 5.50'
type: Bentonite Pellets fm: 5.50' to: 7.50'
type: Sand Filter fm: 7.50' to: 13.00'

Drilling Method: Split Spoon/Hollow Stem Auger

Conductor Casing:
type: dia: .00in fm: .00' to: .00'

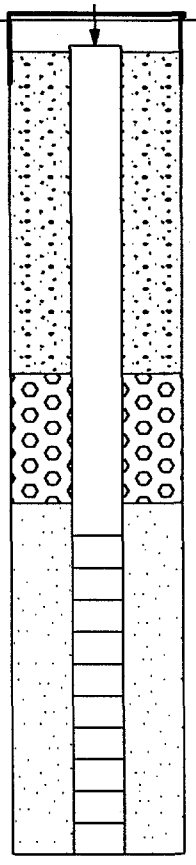
Blank Casing:
type: PVC dia: 4.00in fm: .4' to: 8.00'

Screens:
type: Slotted size: .010in dia: 2.00in fm: 8.00' to: 13.00'

Elevation (ft MSL)	Depth (ft)	Blow Count	Recovery	Water Level	PID	USCS Code	Graphic Log	Material Description
		2 8 9			0 ppm	AS		0.0'–0.5' Asphalt.
					0 ppm	GP		0.5–4.0' Black, loose to medium dense, sandy coarse GRAVEL, trace silt, dry.
905	2	8 8 7 5			0 ppm 0 ppm			
	4	4 3 2 2			0 ppm	SP		4.0'–6.0' Brown, dense, clayey, fine SAND, some gravel moist.
	6	2 2 2 2			0 ppm	GP		6.0'–12.0' Brown, medium dense, sandy, coarse, GRAVEL, trace silt at 8.0'–10.0', wet.
900	8	3 2 2 2			0 ppm			
	10	2 5 3 2			0 ppm			
895	12	9 12 9 11			0 ppm 0 ppm 0 ppm	CL		12.0'–EOB Light brown, very stiff, silty CLAY, with coarse gravel, dry to saturated below 13.0'.
	14							
	16							
890								

Well Construction

MP. EL. 906.64



304574

PHILIP ENVIRONMENTAL

Project Name: Westinghouse RI/FS			Project Number: 427100
Location: Former Runoff Basin		Site Id: FRBVMP1S/D	Elevation: 906.79'
X: 429634.38	Y: 786795.20	Datum: Mean Sea Level	Measuring Point: 906.39'
Borehole Dia.: 4.25in	Completed Depth: 13.00'		Logged By: John LaBarbera

Date(s): 05/31/95 – 05/31/95

Remarks: Sample CA033 FRBVMP-1 2'-4'
Sample CA034 FRBVMP-1 8'-10'

Annular Fill:
type: Bentonite Pellets fm: .50' to: 2.00'
type: Sand Filter fm: 2.00' to: 5.50'
type: Bentonite Pellets fm: 5.50' to: 7.50'
type: Sand Filter fm: 7.50' to: 15.00'

Drilling Method: Split Spoon/Hollow Stem Auger

Conductor Casing:
type: dia: .00in fm: .00' to: .00'

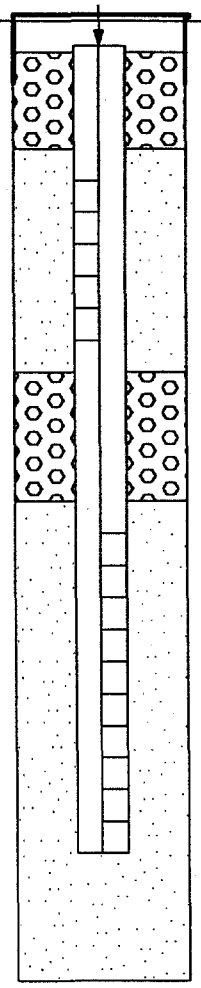
Blank Casing: dia: 2.00in fm: .4' to: 2.50'
type: PVC dia: 2.00in fm: .4' to: 8.0'

Screens:
type: Slotted size: .010in dia: 2.00in fm: 2.50' to: 5.00'
type: Slotted size: .010in dia: 2.00in fm: 8.00' to: 13.00'

Elevation (ft MSL)	Depth (ft)	Blow Count	Recovery	Water Level	PID	USCS Code	Graphic Log	Material Description
						AS		0'–0.5' Asphalt.
		4			0 ppm	ML		0.5'–2.0' Dark gray, loose, sandy, gravelly, SILT, trace clay, moist.
905	2	3 5 6						
		7 3 4			0.7 ppm	SM		2.0'–9.75' Black, medium dense to loose, silty, gravely, SAND, trace coal fragments, moist.
	4	1 2 3 2			0.3 ppm			
	6	4 3 3 4			0.5 ppm			
900	8	3 3 8 10			0.3 ppm			
		6				CL GW		9.75'–10.0' Olive, stiff, silty, sandy, CLAY, some gravel, moist.
	10	16 26 18			0.1 ppm			10.0'–12.0' Brown, dense, silty, sandy, fine to coarse, GRAVEL, saturated below 11.0'.
895	12	5 10 10 13			0.1 ppm	CL ML		12.0'–12.5' Brown and gray, very stiff, silty, CLAY, moist. 12.5'–14.75' Gray, clayey, SILT, trace fine gravel, saturated.
	14	5 16 35 36			0.1 ppm	GM		14.75–EOB Yellow/gray, very dense, silty, sandy, GRAVEL, saturated.
890	16							

Well Construction

MP. EL. 906.39



304575

PHILIP ENVIRONMENTAL

Project Name: Westinghouse RI/FS			Project Number: 427100
Location: Former Runoff Basin		Site Id: FRBVMP2S/D	Elevation: 908.79'
X: 429582.53	Y: 786776.75	Datum: Mean Sea Level	Measuring Point: 908.39'
Borehole Dia.: 4.25in	Completed Depth: 15.00'		Logged By: John LaBarbera

Date(s): 06/02/95 - 06/02/95

Remarks: Sample CA059 FRBVMP-2 2'-4'
Sample CA060 FRBVMP-2 2'-4' Dup
Took second spoon to get volume
for Sample 2
Sample CA061 FRBVMP-2 8'-10'

Annular Fill:

type: Portland Cement	fm: .50'	to: 3.00'
type: Bentonite Pellets	fm: 3.00'	to: 4.00'
type: Sand Filter	fm: 4.00'	to: 7.50'
type: Bentonite Pellets	fm: 7.50'	to: 9.50'
type: Sand Filter	fm: 9.50'	to: 15.00'

Drilling Method: Split Spoon/Hollow Stem Auger

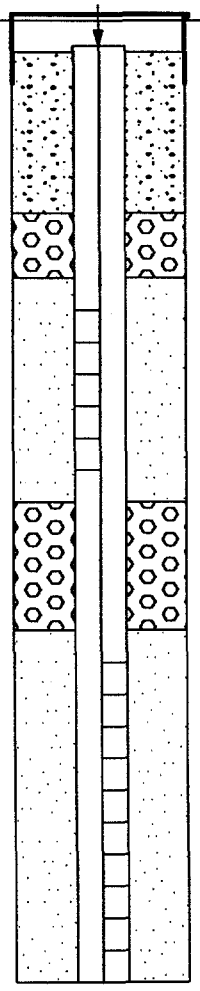
Conductor Casing:
type: dia: .00in fm: .00' to: .00'

Blank Casing: dia: 2.00in fm: .4' to: 4.50'
type: PVC dia: 2.00in fm: .4' to: 10.0'

Screens:
type: Slotted size: .010in dia: 2.00in fm: 4.50' to: 7.00'
type: Slotted size: .010in dia: 2.00in fm: 10.00' to: 15.00'

Elevation (ft MSL)	Depth (ft)	Blow Count	Recovery	Water Level	PID	USCS Code	Graphic Log	Material Description
		3 7 8			0 ppm	AS GM		0'-0.5' Asphalt. 0.5'-2.0' Black, loose, silty, sandy, GRAVEL, (fill), moist.
	2	6 7 4 4			0 ppm			2.0'-10.0' Black, loose to medium dense, silty, sandy, GRAVEL, moist to wet.
905	4	5 2 3 2			0 ppm			
	6	3 3 5 6			0 ppm			
	8	4 4 3 6			0 ppm			
900	10	11 19 19 20			0 ppm			10.0'-EOB Brown to yellow, dense, silty, sandy GRAVEL, trace clay, wet to saturated below 13.0'.
	12	13 10 20 20			0 ppm			
895	14				0 ppm			
	16							

Well Construction



304576

PHILIP ENVIRONMENTAL

Project Name: Westinghouse RI/FS		Project Number: 427100	
Location: Former Runoff Basin		Site Id: FRBVMP3S/D	Elevation: 906.80'
X: 429619.09	Y: 786819.71	Datum: Mean Sea Level	Measuring Point: 906.40'
Borehole Dia.: 4.25in	Completed Depth: 13.00'		Logged By: Tony Fabina

Date(s): 06/05/95 - 06/05/95

Remarks: Sample CA080 FRBVMP-3 10'-12'

Annular Fill:

type: Portland Cement	fm: .50'	to: 1.00'
type: Bentonite Pellets	fm: 1.00'	to: 2.00'
type: Sand Filter	fm: 2.00'	to: 5.50'
type: Bentonite Pellets	fm: 5.50'	to: 7.50'
type: Sand Filter	fm: 7.50'	to: 13.00'

Drilling Method: Split Spoon/Hollow Stem Auger

Conductor Casing: type: dia: .00in fm: .00' to: .00'

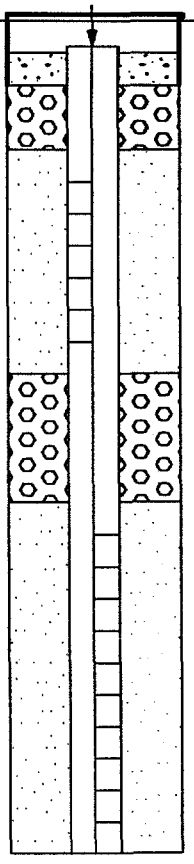
Blank Casing: dia: 2.00in fm: .4' to: 2.50'
type: PVC dia: 2.00in fm: .4' to: 8.0'

Screens:
type: Slotted size: .010in dia: 2.00in fm: 2.50' to: 5.00'
type: Slotted size: .010in dia: 2.00in fm: 8.00' to: 13.00'

Elevation (ft MSL)	Depth (ft)	Blow Count	Recovery	Water Level	PID	USCS Code	Graphic Log	Material Description
						AS		0.0'-0.5' Asphalt.
		3			0 ppm	GM		0.5'-1.0' Black, very dense, sandy, fine to coarse GRAVEL, with fines, dry.
		5			0 ppm	GP		
		15						
905	2	9			0 ppm			1.0'-2.0' Brown, medium dense, GRAVEL, trace silt, dry.
		11						2.0'-4.0' Black, medium dense to dense, sandy, fine to coarse GRAVEL, dry.
		9						
		7						
	4	3			0 ppm			
		4						
		4						
		3						
	6	3			0 ppm			
900		4						
		2						
		3						
	8							
	10							
		24			0 ppm	GM		10.5'-12.0' Brown, very dense, sandy, fine GRAVEL, with silt, wet.
		20						
		12						
895	12	7			0 ppm	CL		12.0'-EOB Brown to green, hard, silty, CLAY and coarse gravel, saturated.
		7			0 ppm			
		17						
		37			0 ppm			
	14							
	16							
890								

Well Construction

MP. EL. 906.40



304577

PHILIP ENVIRONMENTAL

Project Name: Westinghouse RI/FS			Project Number: 427100
Location: Area F		Site Id: AFDVEW-S	Elevation: 910.26'
X: 429047.86	Y: 786235.22	Datum: Mean Sea Level	Measuring Point: 914.26'
Borehole Dia.: 4.25in	Completed Depth: 5.00'		Logged By: Tony Fabina

Date(s): 06/08/95 - 06/08/95

Remarks: CA049 AFD-TB-VEW-S 2.0'-4.0'

Annular Fill:
type: Portland Cement fm: .00' to: 1.00'
type: Bentonite Pellets fm: 1.00' to: 2.00'
type: Sand Filter fm: 2.00' to: 5.00'

Drilling Method: Split Spoon/Hollow Stem Auger

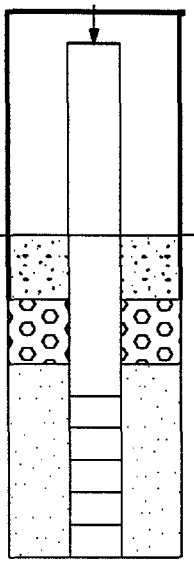
Conductor Casing:
type: dia: .00in fm: .00' to: .00'

Blank Casing:
type: PVC dia: 4.00in fm: -3.0' to: 2.50'

Screens:
type: Slotted size: .010in dia: 4.00in fm: 2.50' to: 5.00'

Elevation (ft MSL)	Depth (ft)	Blow Count	Recovery	Water Level	PID	USCS Code	Graphic Log	Material Description
910		11			0 ppm	GM		0'-EOB Light brown to brown to black, dense to very dense, GRAVEL some silt and trace sand.
		5			0 ppm			
		7						
		9						
	2	13			0 ppm			
		15						
		11						
		11						
	4	7			0 ppm			
		11						
905		7						
		3						
	6							
	8							
900	10							
	12							
	14							
895								
	16							

Well Construction
MP. EL. 914.26



304578

PHILIP ENVIRONMENTAL

Project Name: Westinghouse RI/FS			Project Number: 427100
Location: Area F		Site Id: AFDVEW-D	Elevation: 909.89'
X: 429042.86	Y: 786234.93	Datum: Mean Sea Level	Measuring Point: 914.07'
Borehole Dia.: 4.25in	Completed Depth: 15.00'		Logged By: Tony Fabina

Date(s): 06/08/95 - 06/08/95

Remarks: CA045 AFD-TB-VEW-D 3.0'-4.0'
CA046 AFD-TB-VEW-D 6.0'-8.0'
CA047 AFD-TB-VEW-D 12.0'-13.0'
CA048 AFD-TB-VEW-D 14.0'-16.0'

Annular Fill:
type: Portland Cement fm: .00' to: .50'
type: Bentonite Grout fm: .50' to: 7.50'
type: Bentonite Pellets fm: 7.50' to: 9.50'
type: Sand Filter fm: 9.50' to: 15.00'

Drilling Method: Split Spoon/Hollow Stem Auger

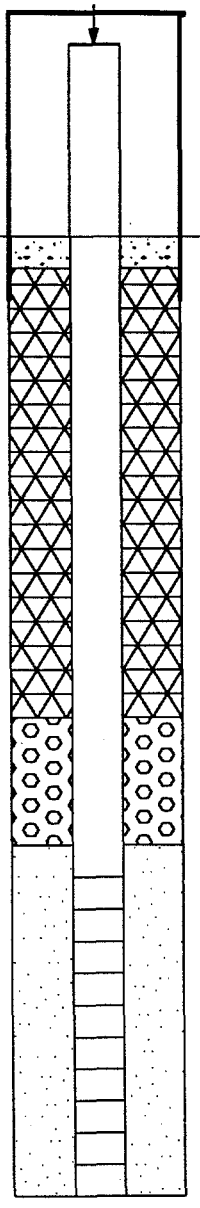
Conductor Casing:
type: dia: .00in fm: .00' to: .00'

Blank Casing:
type: PVC dia: 4.00in fm: -3.0' to: 10.00'

Screens:
type: Slotted size: .010in dia: 4.00in fm: 10.00' to: 15.00'

Elevation (ft MSL)	Depth (ft)	Blow Count	Recovery	Water Level	PID	USCS Code	Graphic Log	Material Description
905	2	3 40			0 ppm	GM		0'-10.0 Light brown to brown to black, medium dense to very dense, GRAVEL, some silt and trace sand, dry.
		8 16 16 16			0 ppm 0 ppm			
	4	9 11 17 5			0 ppm			
	6				0 ppm			
	8	3 5 5 4			0 ppm			
900	10	5 6 9 7			0 ppm	GP		10.0'-EOB Black, medium dense, fine to coarse sandy GRAVEL, trace silt and clay, dry to saturated below 13.0 ft.
	12	1 2 2 2			0 ppm			
895	14	2 4 5 10			0 ppm			
	16							

Well Construction
MP. EL. 914.07



304579

PHILIP ENVIRONMENTAL

Project Name: Westinghouse RI/FS			Project Number: 427100
Location: Area F		Site Id: AFDVMP1S/D	Elevation: 910.01'
X: 429047.46	Y: 786225.39	Datum: Mean Sea Level	Measuring Point: 913.98'
Borehole Dia.: 4.25in	Completed Depth: 15.00'		Logged By: Tony Fabina

Date(s): 06/08/95 - 06/08/95

Remarks:

Annular Fill:

type: Portland Cement	fm: .00'	to: 1.00'
type: Bentonite Pellets	fm: 1.00'	to: 2.00'
type: Sand Filter	fm: 2.00'	to: 5.50'
type: Portland Cement	fm: 5.50'	to: 7.50'
type: Bentonite Pellets	fm: 7.50'	to: 9.50'
type: Sand Filter	fm: 9.50'	to: 15.00'

Drilling Method: Split Spoon/Hollow Stem Auger

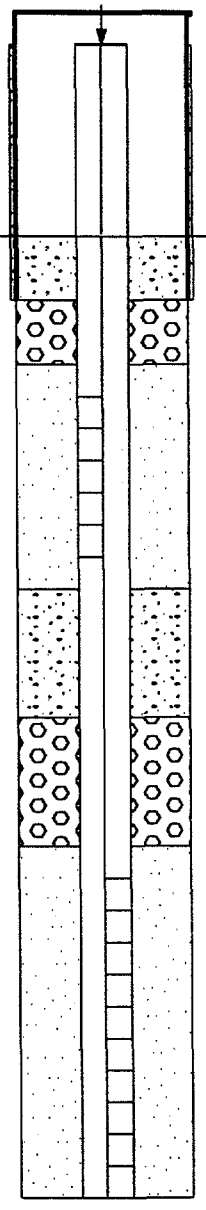
Conductor Casing:
type: Carbon Steel dia: 6.00in fm: -3.00' to: 1.00'

Blank Casing:
type: PVC dia: 2.00in fm: -3.0' to: 2.50'
type: PVC dia: 2.00in fm: -3.0' to: 10.0'

Screens:
type: Slotted size: .010in dia: 2.00in fm: 2.50' to: 5.00'
type: Slotted size: .010in dia: 2.00in fm: 10.00' to: 15.00'

Elevation (ft MSL)	Depth (ft)	Blow Count	Recovery	Water Level	PID	USCS Code	Graphic Log	Material Description
910	0	4 5 6 7			0 ppm	GM		0'-4.0' Gray, medium dense, sandy GRAVEL some silt, dry.
	2	3 11 2 2			0 ppm			
	4	1 2 9 7			0 ppm			
905								
	6	3 3 2 4			0 ppm			6.0'-10.0' Gray, medium dense, fine to coarse sandy GRAVEL some silt, dry.
	8	3 3 4 8			0 ppm			
900	10	8 6 6 6			0 ppm			10.0'-EOB Light brown, medium dense to dense, sandy, fine to coarse, GRAVEL some silt, moist to saturated below 13.0'
	12	2 1 2 2		▽	0 ppm			
	14	3 16 16 30			0 ppm			
895								
	16							

Well Construction
MP. EL. 913.98



304580

PHILIP ENVIRONMENTAL

Project Name: Westinghouse RI/FS		Project Number: 427100	
Location: Area F		Site Id: AFDVMP2S/D	Elevation: 910.03'
X: 429022.43	Y: 786236.70	Datum: Mean Sea Level	Measuring Point: 914.08'
Borehole Dia.: 4.25in	Completed Depth: 15.00'		Logged By: Tony Fabina

Date(s): 06/08/95 - 06/08/95

Remarks:

Annular Fill:

type: Portland Cement	fm: .00'	to: 1.00'
type: Bentonite Pellets	fm: 1.00'	to: 2.00'
type: Sand Filter	fm: 2.00'	to: 5.50'
type: Portland Cement	fm: 5.50'	to: 7.50'
type: Bentonite Pellets	fm: 7.50'	to: 9.50'
type: Sand Filter	fm: 9.50'	to: 15.00'

Drilling Method: Split Spoon/Hollow Stem Auger

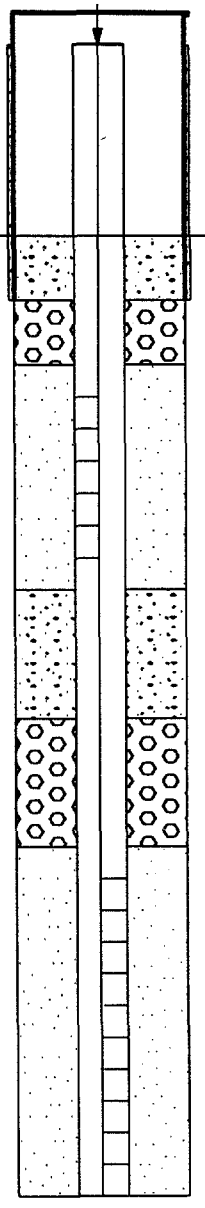
Conductor Casing:
type: dia: 6.00in fm: -3.00' to: 1.00'

Blank Casing:
type: PVC dia: 2.00in fm: -3.0' to: 2.50'
dia: 2.00in fm: -3.0' to: 10.0'

Screens:
type: Slotted size: .010in dia: 2.00in fm: 2.50' to: 5.00'
type: Slotted size: .010in dia: 2.00in fm: 10.00' to: 15.00'

Elevation (ft MSL)	Depth (ft)	Blow Count	Recovery	Water Level	PID	USCS Code	Graphic Log	Material Description
910		4 7 5 4			0 ppm	GM		0'-EOB Dark brown, medium dense, sandy, fine to coarse GRAVEL some silt, (pebbles at 10.0' to 13.0') dry to saturated below 13.0'.
	2	3 3 4 3			0 ppm			
	4	3 2 3 7			0 ppm			
905								
	6	3 2 2 3			0 ppm			
	8	8 16 13 19			0 ppm			
900	10	14 7 8 6			0 ppm			
	12	4 4 4 6			0 ppm			
	14	3 3 6 8			0 ppm			
895								
	16							

Well Construction
MP. EL. 914.08



304581

PHILIP ENVIRONMENTAL

Project Name: Westinghouse RI/FS		Project Number: 427100	
Location: Area F		Site Id: AFDVMP3S/D	Elevation: 909.87'
X: 429055.67	Y: 786261.94	Datum: Mean Sea Level	Measuring Point: 913.67'
Borehole Dia.: 4.25in	Completed Depth: 15.00'		Logged By: Tony Fabina

Date(s): 06/09/95 – 06/09/95

Remarks:

Annular Fill:

type: Portland Cement	fm: .00'	to: 1.00'
type: Bentonite Pellets	fm: 1.00'	to: 2.00'
type: Sand Filter	fm: 2.00'	to: 5.50'
type: Portland Cement	fm: 5.50'	to: 7.50'
type: Bentonite Pellets	fm: 7.50'	to: 9.50'
type: Sand Filter	fm: 9.50'	to: 15.00'

Drilling Method: Split Spoon/Hollow Stem Auger

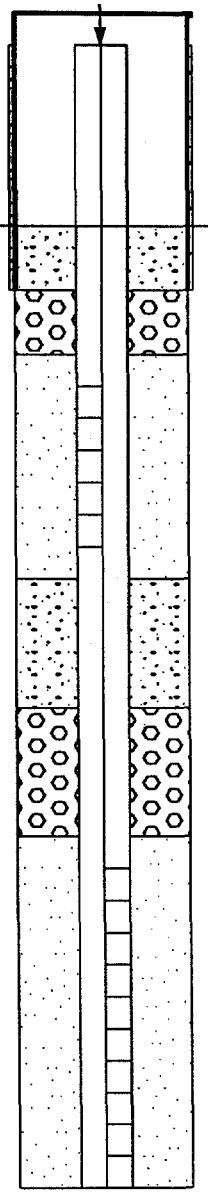
Conductor Casing:
type: dia: 6.00in fm: -2.80' to: 1.00'

Blank Casing:
type: PVC dia: 2.00in fm: -2.8' to: 2.50'
type: PVC dia: 2.00in fm: -2.8' to: 10.0'

Screens:
type: Slotted size: .010in dia: 2.00in fm: 2.50' to: 5.00'
type: Slotted size: .010in dia: 2.00in fm: 10.00' to: 15.00'

Elevation (ft MSL)	Depth (ft)	Blow Count	Recovery	Water Level	PID	USCS Code	Graphic Log	Material Description
		2 3 3 5			0 ppm	GM		0'–12.0' Gray and brown, medium dense, sandy, fine to coarse GRAVEL, some silt, dry to moist below 10.0'.
	2	3 5 2 3			0 ppm			
	4	3 1 2 2			0 ppm			
905								
	6	6 4 7 4			0 ppm			
	8	1 3 4 4			0 ppm			
900	10	4 2 8 10			0 ppm			
	12	8 25 14 4		▽	0 ppm	GP		12.0'– EOB Light brown, very dense, sandy GRAVEL, trace fine to coarse silt, saturated below 13.0'.
	14	3 9 13 11			0 ppm			
895								
	16							

Well Construction



304582

APPENDIX
B

304583

APPENDIX B

May 8, 1995, Letter of NYDEC Regarding Substantive Requirements for Vapor Discharge Permitting During Vapor Extraction Test

PHILIP ENVIRONMENTAL

May 8, 1995
Project 427100

Mr. Gardner Cross
Kentucky Avenue Site Project Manager
New York State Department
of Environmental Conservation
50 Wolf Road
Albany, New York 12233-7010

Dear Mr. Cross:

Subject: Substantive Requirements for Vapor Discharge Permitting During Vapor Extraction Test, Remedial Investigation/Feasibility Study, Westinghouse Electric Corporation, Horseheads, New York

As you are aware, Philip Environmental Services Corporation (Philip) is preparing to perform vapor extraction pilot tests at two areas of the Westinghouse Electric Corporation's (Westinghouse) former property. These tests will be performed in the vicinity of Disposal Area F and in the vicinity of the former runoff basin. Mr. Jim Harrington (Chief of Technology Section, Bureau of Program Management, Division of Hazardous Waste Remediation) indicated that, to fulfill the substantive requirements for approval of vapor discharge during the performance of the vapor extraction tests, we must prepare a description of proposed activities for his review. Mr. Harrington indicated that we should submit the description of the proposed vapor extraction test to you and that you would forward this description to him for his review and approval.

The activities proposed are described in Section 3.3 of the Revised Work Plan, Supplemental Field Investigations and Treatability Studies for the Remedial Investigation/Feasibility Study, Horseheads, New York (Revision 2.0 dated April 17, 1995). Section 3.3 of the Revised Work Plan is reproduced, with minor modifications, in Attachment A to this letter. The difference between the proposed activities in Attachment A and those originally described in Section 3.3 of the April 17, 1995, Revised Work Plan are based upon Philip's May 4, 1995, discussions with Mr. Harrington. Mr. Harrington indicated that he expects us to use two canisters (plumbed in series) containing vapor-phase activated carbon during pilot tests. Mr. Harrington also indicated that we should monitor, with a photoionization detector, the vapor concentrations before, between, and after the carbon canisters to evaluate for organic vapor break-through.

304585

PHILIP ENVIRONMENTAL SERVICES CORPORATION
10 Duff Road • Suite 500 • Pittsburgh, PA 15235-3205
(412) 244-9000 • Fax (412) 244-9100

Please forward this information to Mr. Harrington for his review and approval. We anticipate the tests will be conducted during the first week in June 1995. If you or Mr. Harrington have any questions or comments, please do not hesitate to call me or Jim Pinta at (412) 244-9000.

Very truly yours,

PHILIP ENVIRONMENTAL
SERVICES CORPORATION

Mark B. Hanish
Senior Hydrogeologist

MBH/dld/331G-word-letters

Enclosures

cc: L. M. Brausch
J. Pinta, Jr.

304586

Attachment A

Modified Section 3.3 from
Revised Work Plan
Supplemental Field Investigation
and Treatability Studies

Remedial Investigation/Feasibility Study
Horseheads, New York

3.3 Evaluation of Vapor Extraction at the Disposal Area F and the Former Runoff Basin

Philip proposes to perform in situ SVE testing at Disposal Area F and the Former Runoff Basin to assess design and operational parameters for this remedial technology for use in the alternatives evaluation in the FS. Prior to performing any field activities related to this task, Philip will determine the need to apply for permits to perform the test.

3.3.1 Vapor Extraction Wells and Monitoring Point Installation

Prior to drilling, Philip will consult with Westinghouse facility personnel to locate any utilities and clear well locations in the area where drilling will be performed. Philip will also contact the state utility location services to locate all public utilities in the areas to be drilled. All drilling and sampling equipment will be decontaminated according to the approved Field Sampling and Analysis Plan (FSP). Waste soil produced during drilling will be contained and stored according to the approved FSP. Westinghouse will properly dispose of the drummed waste soil in accordance with all applicable state and federal regulations. Sample handling, custody, and documentation procedures to be followed are outlined in the FSP.

3.3.1.1 Vapor Extraction Wells

A pair of nested vapor extraction wells will be installed in Disposal Area F (Figure 3) and the Former Runoff Basin (Figure 4) and completed as depicted in Figure 5. The vapor extraction wells will be installed through hollow-stem augers. Boreholes used for well construction will be advanced using continuous split-spoon sampling followed by hollow-stem augering. All split-spoon samples will be screened with an HNu.

One soil sample will be retained for laboratory analysis for those locations where drilling extends through the waste. An additional two soil samples will be retained for laboratory analysis from those locations where drilling extends into the water table. One sample will be collected from above the water table and one sample will be collected from below the water table. All samples will be analyzed for TCL VOCs. These samples will be used in conjunction with samples from the IFI trenching to estimate the mass of TCL VOCs in Area F.

A deeper vapor extraction well will be installed with the screened portion of the extraction well extending from a few feet into the water table through the native material beneath the Area F disposal horizon. A second shallower well will be installed with the screened interval placed within the disposal horizon at Area F.

A pair of nested wells will be installed in a similar fashion in the Former Runoff Basin. Wells will be screened at two intervals because of potential soil permeability contrasts (such as in Area F) and because of large water table fluctuations (observed at both locations).

The vapor extraction wells will be constructed using 4-inch diameter 0.04-inch slot polyvinyl chloride (PVC) screens and PVC risers. Flush-mounted well protectors will be used in the Former Runoff Basin area and stick-up well protectors will be used in Disposal Area F.

Washed and graded sand will be placed in the borehole annulus across the entire screened interval of each vapor extraction well and up to 2 feet above the screened interval. A 2-foot thick bentonite seal will be installed above the sand pack and a 5 percent bentonite grout will be placed in the well annulus to the ground surface.

3.3.1.2 Monitoring Points

Monitoring points will be installed through hollow-stem augers at three locations surrounding each pair of vapor extraction wells. Boreholes used for well construction will be advanced using continuous split-spoon sampling followed by hollow-stem

augering. All split-spoon samples will be screened with an HNu. The monitoring points will be used to monitor the changes in pressure and changes in concentration of organic vapors induced by the vapor extraction tests.

The monitoring points will be installed at the locations shown on Figures 3 and 4 and completed as depicted in Figure 5. The monitoring points will be constructed of 2-inch PVC screens and risers.

3.3.2 Treatability (Pilot) Tests

3.3.2.1 Equipment Set-Up and Installation

A regenerative blower equipped with a 2 horsepower (hp), 230-volt, single-phase motor will be used for the pilot tests. The blower will produce approximately 50 standard cubic feet per minute (scfm) at 60 inches of water (in H_2O) vacuum and 100 scfm at 35 inches H_2O vacuum.

Mr. Jim Harrington (Chief of Technology Section, Bureau of Program Management, Division of Hazardous Waste Remediation, New York State Department of Environmental Conservation) indicated that treatment of vapor effluent using two activated carbon adsorption canisters (plumbed in series) and monitoring the discharge between and after each drum with a photoionization detector would be sufficient for him to grant approval to perform the tests. Philip proposes to use two canisters containing approximately 140 to 200 pounds of activated carbon. Sample ports will be located before, between, and after the two canisters containing activated carbon. An in-line valve in the exhaust stack will be used to create pressure in the pipe for sample collection.

The blower will be equipped with a dilution valve in the influent side to control the vacuum applied to the well. A rotameter flow meter will be connected to the dilution valve to monitor the flow of atmospheric air introduced into the blower. A moisture separator will be located between the dilution valve and the blower. Vacuum

gauges will be located between the dilution valve and the well, and between the moisture separator and the blower to monitor pressure drop through the separator and vacuum applied to the well.

3.3.2.2 Vapor Extraction Tests

Two in situ SVE tests will be performed at each location. Prior to performing any of the tests, static conditions will be measured in each monitoring probe, including organic vapor concentrations, water levels, and pressure.

A step vacuum test will be performed at each location prior to each vapor extraction test to evaluate the appropriate vacuum and flow to operate the system for the longer term tests. During the step test system, system flow and effluent vapor concentrations will be measured after each step. Each vacuum step will be approximately 10 minutes long and the vacuum for each step will increase in increments of 10 inches H_2O. The site manager will evaluate the step test and establish the appropriate vacuum and flow to operate the system during the longer term tests.

The first test at each location will include extraction of vapors from the shallow vapor extraction well. This test on the shallow vapor extraction well will be run for a maximum of 4 hours during which measurements of system vacuum, system flow, concentrations of organic vapors (before, between and after the two canisters of activated carbon), monitoring point vacuum, and water levels will be monitored at least once every hour.

The second test at each location will include extraction of vapors from the deep vapor extraction well. This test will also run for a maximum of 4 hours with measurement of the same parameters monitored during the extraction test performed on the shallow vapor extraction well.

Two sets of air samples will be collected from the system effluent vapor stream during each of the two vapor extraction tests at each location. These samples will be collected two hours after test startup, and immediately prior to terminating each test.

The samples will be collected within Tedlar air sample bags and shipped to an appropriate laboratory (Philip is currently evaluating laboratories) where they will be analyzed for VOCs.

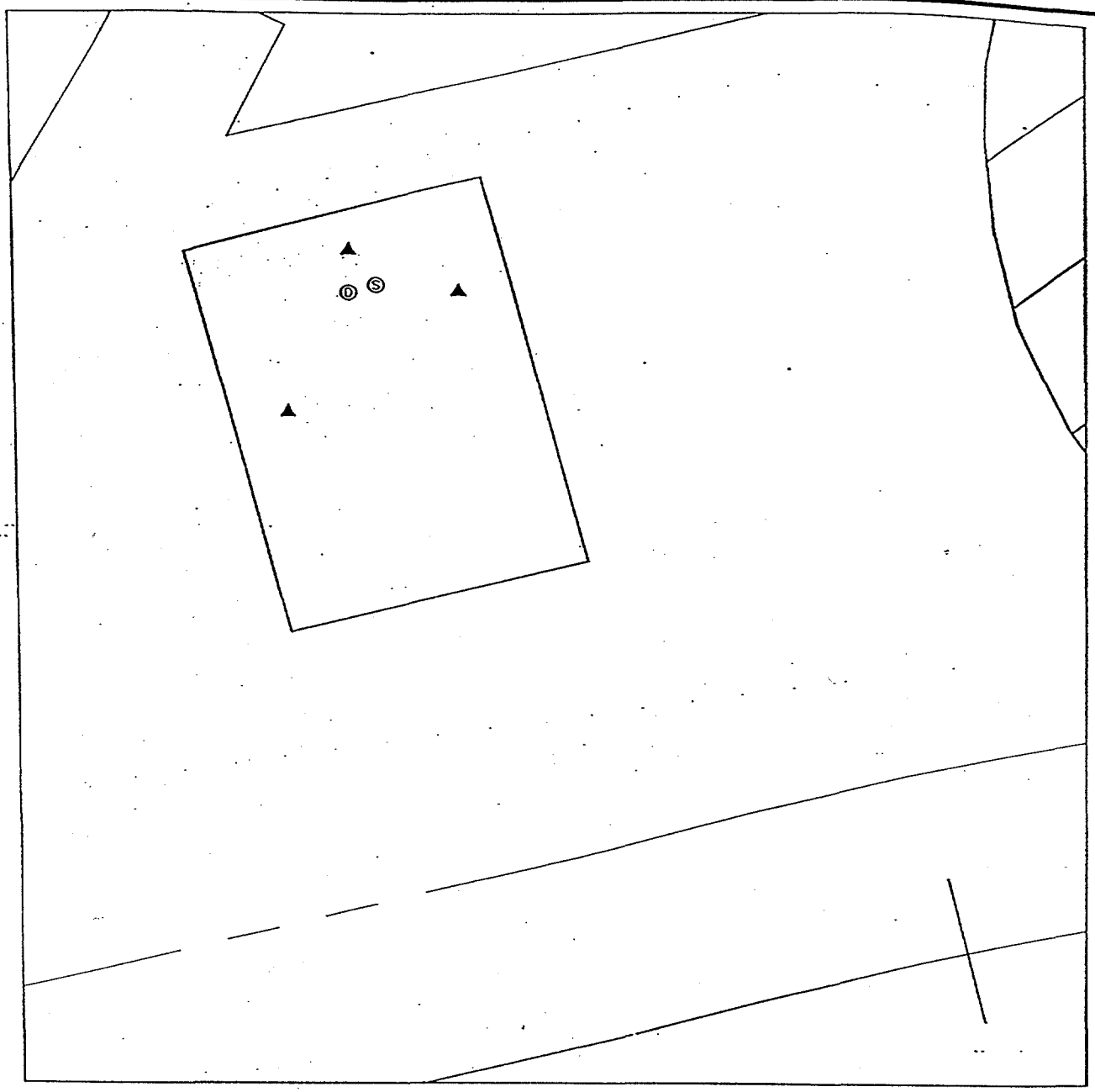
3.3.3 Data Evaluation

Data collected during drilling and pilot-testing activities will be used to evaluate the following:

- the radius of influence of the pilot tested vapor extraction systems; and
- the concentration and mass removal rate of VOCs from the subsurface during testing.

3.3.4 Reporting

As part of the RI report, a section describing the treatability pilot testing will be prepared which will include a description of all field activities and the results of all tests. The evaluation of in situ SVE as a remediation technology will be provided in the FS.



LEGEND:

Ⓓ DEEP VAPOR EXTRACTION WELL

Ⓢ SHALLOW VAPOR EXTRACTION WELL

▲ NESTED MONITORING POINTS

304593

0 40 80

SCALE IN FEET

N

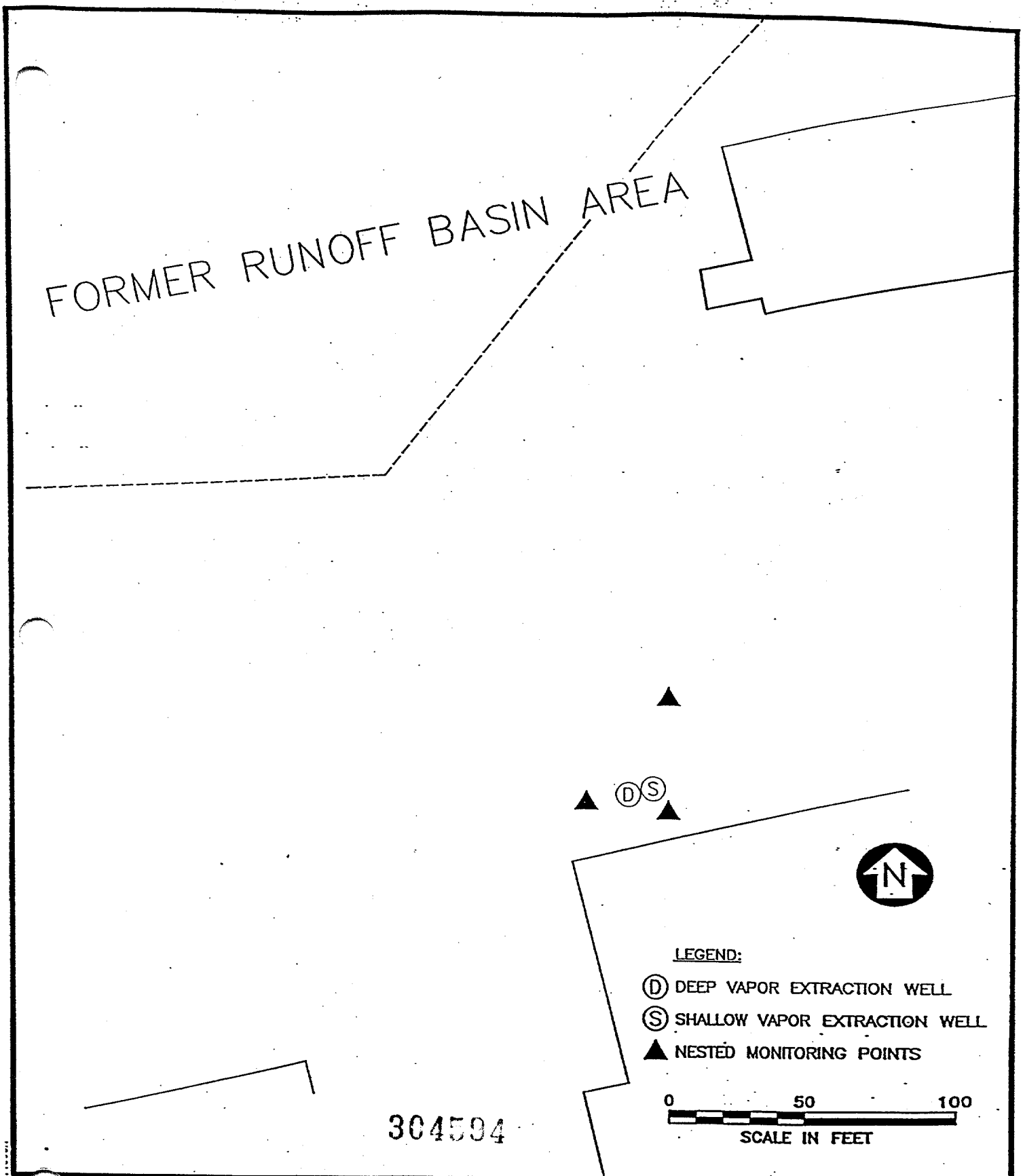
BURLINGTON ENVIRONMENTAL
– A Philip Environmental Company –

TITLE:
VAPOR EXTRACTION WELL AND MONITORING POINT INSTALLATION LOCATIONS
DISPOSAL AREA F

DWN: CAM	DES.:
CHK'D:	APP'D:
DATE: 10/28/94	REV.: A

PROJECT NO.: 427100
WESTINGHOUSE
HORSEHEADS, N.Y.

FIGURE 3



304594

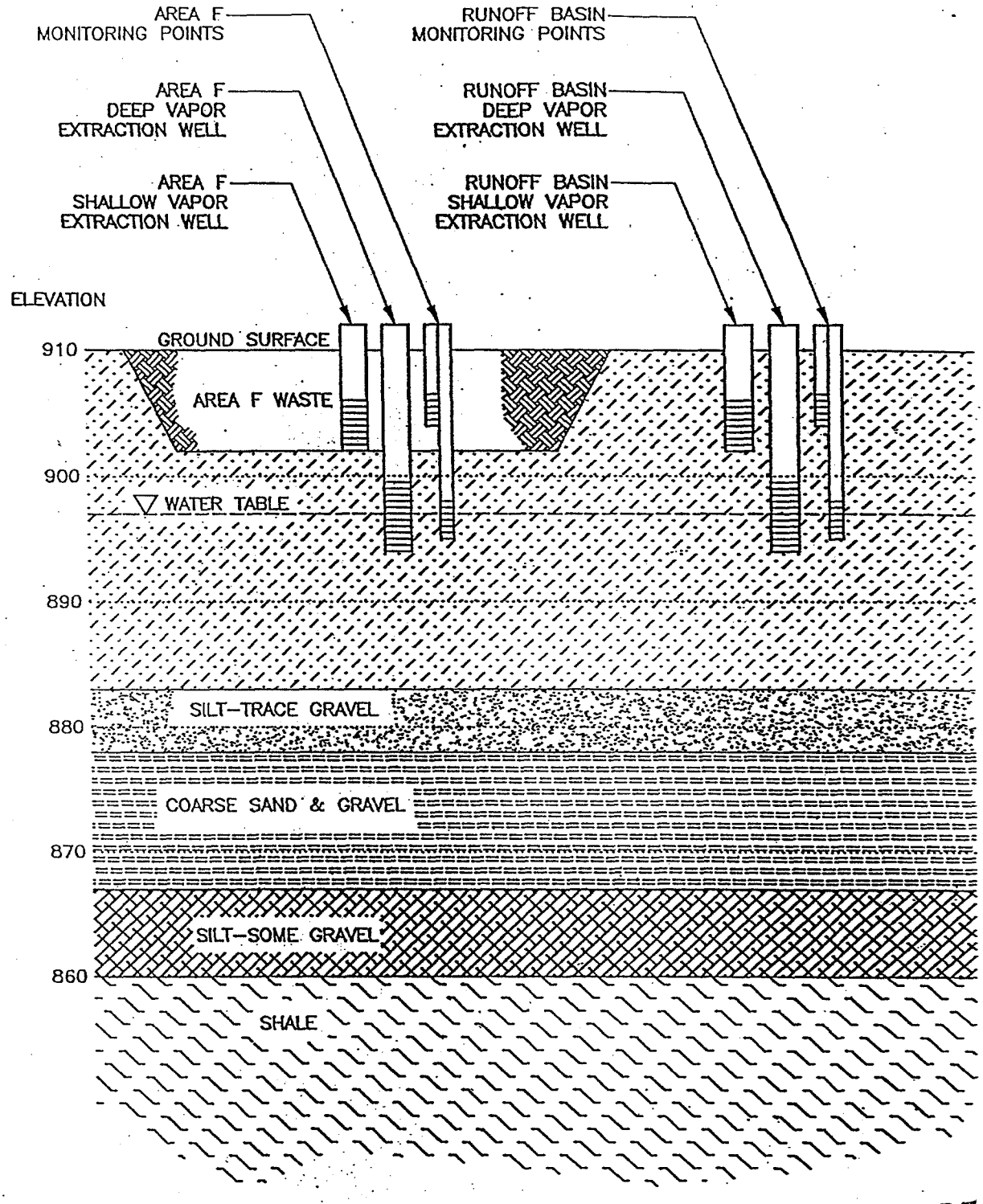
BURLINGTON ENVIRONMENTAL
— A Philip Environmental Company —

TITLE:
VAPOR EXTRACTION WELL AND MONITORING POINT INSTALLATION LOCATIONS FORMER RUNOFF BASIN AREA

DWN: CAM
DES.:
CHKD:
APP'D:
DATE: 10/28/94
REV: A

PROJECT NO.: 427100
WESTINGHOUSE HORSEHEADS, N.Y.

FIGURE 4



304595

BURLINGTON ENVIRONMENTAL	TITLE: VAPOR EXTRACTION WELL AND MONITORING POINT CONSTRUCTION	DWN: CAM / DES.:	PROJECT NO.: 427100	WESTINGHOUSE HORSEHEADS, N.Y.
		CHKD: / APPD:		
		DATE: 10/28/94 / REV.: A		FIGURE 5

APPENDIX
C

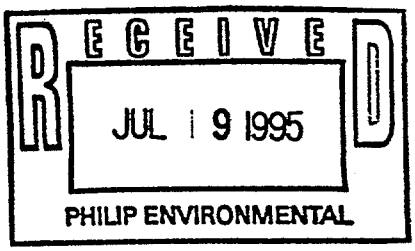
APPENDIX C

Results of Soil Vapor Analysis
Laboratory Reports

SDG # 6

GP Work Order # 9506112

SAMPLE ANALYSIS REPORT



Prepared For:

Philip Environmental
10 Duff Road Suite 500
Pittsburgh, PA 15235-3205

427100 WESTINGHOUSE RIFS

Prepared By:

GP Environmental Services, Inc.
202 Perry Parkway
Gaithersburg, MD 20877

July 18, 1995

for Albert Ellis, Laboratory Director

304598

GP ENVIRONMENTAL SERVICES
ANALYTICAL RESULTS

Project: 427100 WESTINGHOUSE RIFS

Philip Environmental
10 Duff Road Suite 500
Pittsburgh, PA 15235-3205
Atten: James Pinta

GP ENVIRONMENTAL SERVICES
202 Perry Parkway
Gaithersburg, MD 20877

Atten: Client Services
Phone: (301) 926-6802

Certified by: 

SAMPLE IDENTIFICATION

GP ID	Client ID
9506112-01A	CA082 FRBTBMW11D
9506112-01B	
9506112-02A	CA083 FRBTBMW11D 48-50'
9506112-02B	
9506112-03A	CA084 FRBTBMW11D TRIP BLAN
9506112-04A	CA080 FRBTBVMP3 10-12'
9506112-05A	CA046 AFDTBVWD 6-8'
9506112-06A	HOLDING BLANK
9506112-06B	

GP ENVIRONMENTAL SERVICES
ORGANIC ANALYSIS RESULTS

GP ID: 9506112-01A
Client ID: CA082 FRBTBMW11D
Collected: 06/09/95
Dilution: 1

Matrix: WATER
Method: CLP SOW 390
Units: ug/L

Analyst: AD
Analyzed: 06/16/95
Prepared:

VOLATILE TARGET COMPOUNDS

Parameter	Result	Det.Lim.	Qualifier
Chloromethane	BQL	10.0	
Bromomethane	BQL	10.0	
Vinyl chloride	BQL	10.0	
Chloroethane	BQL	10.0	
Methylene chloride	4.00	5.00	BJ
Acetone	6.00	10.0	J
Carbon Disulfide	2.00	5.00	J
1,1-Dichloroethene	BQL	5.00	
1,1-Dichloroethane	BQL	5.00	
cis-1,2-Dichloroethene	BQL	5.00	
trans-1,2-Dichloroethene	BQL	5.00	
Chloroform	BQL	5.00	
1,2-Dichloroethane	BQL	5.00	
2-Butanone	BQL	10.0	
Bromochloromethane	BQL	5.00	
1,1,1-Trichloroethane	BQL	5.00	
Carbon tetrachloride	BQL	5.00	
Bromodichloromethane	BQL	5.00	
1,2-Dichloropropane	BQL	5.00	
cis-1,3-Dichloropropene	BQL	5.00	
Trichloroethene	BQL	5.00	
Dibromochloromethane	BQL	5.00	
1,1,2-Trichloroethane	BQL	5.00	
Benzene	BQL	5.00	
trans-1,3-Dichloropropene	BQL	5.00	
Bromoform	BQL	5.00	
4-Methyl-2-pentanone	BQL	10.0	
2-Hexanone	BQL	10.0	
Tetrachloroethene	BQL	5.00	
1,1,2,2-Tetrachloroethane	BQL	5.00	
Toluene	2.00	5.00	BJ
Chlorobenzene	BQL	5.00	
Ethylbenzene	BQL	5.00	
Styrene	BQL	5.00	
Xylenes (total)	BQL	5.00	

GP ENVIRONMENTAL SERVICES
ORGANIC ANALYSIS RESULTS

GP ID: 9506112-02A
Client ID: CA083 FRBTBMW11D 48-50'
Collected: 06/10/95
Dilution: 1

Matrix: SOIL
Method: CLP SOW 390
Units: ug/Kg

Analyst: NH
Analyzed: 06/13/95
Prepared:

VOLATILE TARGET COMPOUNDS

Parameter	Result	Det.Lim.	Qualifier
Chloromethane	BQL	11.2	
Bromomethane	BQL	11.2	
Vinyl chloride	BQL	11.2	
Chloroethane	BQL	11.2	
Methylene chloride	7.00	11.2	BJ
Acetone	BQL	11.2	
Carbon Disulfide	BQL	11.2	
1,1-Dichloroethene	BQL	11.2	
1,1-Dichloroethane	BQL	11.2	
cis-1,2-Dichloroethene	BQL	11.2	
trans-1,2-Dichloroethene	BQL	11.2	
Chloroform	BQL	11.2	
1,2-Dichloroethane	BQL	11.2	
2-Butanone	BQL	11.2	
Bromochloromethane	BQL	11.2	
1,1,1-Trichloroethane	BQL	11.2	
Carbon tetrachloride	BQL	11.2	
Bromodichloromethane	BQL	11.2	
1,2-Dichloropropane	BQL	11.2	
cis-1,3-Dichloropropene	BQL	11.2	
Trichloroethene	4.00	11.2	J
Dibromochloromethane	BQL	11.2	
1,1,2-Trichloroethane	BQL	11.2	
Benzene	BQL	11.2	
trans-1,3-Dichloropropene	BQL	11.2	
Bromoform	BQL	11.2	
4-Methyl-2-pentanone	BQL	11.2	
2-Hexanone	BQL	11.2	
Tetrachloroethene	BQL	11.2	
1,1,2,2-Tetrachloroethane	BQL	11.2	
Toluene	2.00	11.2	J
Chlorobenzene	BQL	11.2	
Ethylbenzene	BQL	11.2	
Styrene	BQL	11.2	
Xylenes (total)	BQL	11.2	

GP ENVIRONMENTAL SERVICES
ORGANIC ANALYSIS RESULTS

GP ID: 9506112-03A
Client ID: CA084 FRBTBMW11D TRIP BLAN
Collected: 06/10/95
Dilution: 1

Matrix: WATER
Method: CLP SOW 390
Units: ug/L

Analyst: AD
Analyzed: 06/16/95
Prepared:

VOLATILE TARGET COMPOUNDS

Parameter	Result	Det.Lim.	Qualifier
Chloromethane	BQL	10.0	
Bromomethane	BQL	10.0	
Vinyl chloride	BQL	10.0	
Chloroethane	BQL	10.0	
Methylene chloride	4.00	5.00	BJ
Acetone	3.00	10.0	J
Carbon Disulfide	2.00	5.00	J
1,1-Dichloroethene	BQL	5.00	
1,1-Dichloroethane	BQL	5.00	
cis-1,2-Dichloroethene	BQL	5.00	
trans-1,2-Dichloroethene	BQL	5.00	
Chloroform	BQL	5.00	
1,2-Dichloroethane	BQL	5.00	
2-Butanone	BQL	10.0	
Bromochloromethane	BQL	5.00	
1,1,1-Trichloroethane	BQL	5.00	
Carbon tetrachloride	BQL	5.00	
Bromodichloromethane	BQL	5.00	
1,2-Dichloropropane	BQL	5.00	
cis-1,3-Dichloropropene	BQL	5.00	
Trichloroethene	BQL	5.00	
Dibromochloromethane	BQL	5.00	
1,1,2-Trichloroethane	BQL	5.00	
Benzene	BQL	5.00	
trans-1,3-Dichloropropene	BQL	5.00	
Bromoform	BQL	5.00	
4-Methyl-2-pentanone	BQL	10.0	
2-Hexanone	BQL	10.0	
Tetrachloroethene	BQL	5.00	
1,1,2,2-Tetrachloroethane	BQL	5.00	
Toluene	BQL	5.00	
Chlorobenzene	BQL	5.00	
Ethylbenzene	BQL	5.00	
Styrene	BQL	5.00	
Xylenes (total)	BQL	5.00	

GP ENVIRONMENTAL SERVICES
ORGANIC ANALYSIS RESULTS

GP ID: 9506112-06A
Client ID: HOLDING BLANK
Collected: 06/12/95
Dilution: 1

Matrix: WATER
Method: CLP SOW 390
Units: ug/L

Analyst: AD
Analyzed: 06/17/95
Prepared:

VOLATILE TARGET COMPOUNDS

Parameter	Result	Det.Lim.	Qualifier
Chloromethane	BQL	10.0	
Bromomethane	BQL	10.0	
Vinyl chloride	BQL	10.0	
Chloroethane	BQL	10.0	
Methylene chloride	BQL	5.00	
Acetone	BQL	10.0	
Carbon Disulfide	2.00	5.00	J
1,1-Dichloroethene	BQL	5.00	
1,1-Dichloroethane	BQL	5.00	
cis-1,2-Dichloroethene	BQL	5.00	
trans-1,2-Dichloroethene	BQL	5.00	
Chloroform	BQL	5.00	
1,2-Dichloroethane	BQL	5.00	
2-Butanone	BQL	10.0	
Bromochloromethane	BQL	5.00	
1,1,1-Trichloroethane	BQL	5.00	
Carbon tetrachloride	BQL	5.00	
Bromodichloromethane	BQL	5.00	
1,2-Dichloropropane	BQL	5.00	
cis-1,3-Dichloropropene	BQL	5.00	
Trichloroethene	BQL	5.00	
Dibromochloromethane	BQL	5.00	
1,1,2-Trichloroethane	BQL	5.00	
Benzene	BQL	5.00	
trans-1,3-Dichloropropene	BQL	5.00	
Bromoform	BQL	5.00	
4-Methyl-2-pentanone	BQL	10.0	
2-Hexanone	BQL	10.0	
Tetrachloroethene	BQL	5.00	
1,1,2,2-Tetrachloroethane	BQL	5.00	
Toluene	BQL	5.00	
Chlorobenzene	BQL	5.00	
Ethylbenzene	BQL	5.00	
Styrene	BQL	5.00	
Xylenes (total)	BQL	5.00	

GP ENVIRONMENTAL SERVICES
WET CHEMISTRY ANALYSIS RESULTS

GP ID: 9506112-02
Client ID: CA083 FRBTBMW11D 48-50'

Matrix: SOIL
Collected: 06/10/95

Parameter	Method	Result	Det.Lim.	Units	Dil.	Prepared	Analyzed By
Percent Solids	MCAWW 160.3	88.4		%			06/28/95 SCT

GP ENVIRONMENTAL SERVICES
ANALYSIS RESULTS

GP ID: 9506112-04
Client ID: CA080 FRBTBVMP3 10-12'

Matrix: SOIL
Collected: 06/05/95

Parameter	Method	Result	Det.Lim.	Units	Dil.	Prepared	Analyzed By
Permeability	ASTM D 5084	9.10 E-5		cm/second			06/21/95 SC
Porosity	Calculation	29.6		%			06/21/95 SC

GP ID: 9506112-05
Client ID: CA046 AFDTBVWD 6-8'

Matrix: SOIL
Collected: 06/08/95

Parameter	Method	Result	Det.Lim.	Units	Dil.	Prepared	Analyzed By
Permeability	ASTM D 5084	3.90 E-6		cm/second			06/21/95 SC
Porosity	Calculation	29.2		%			06/21/95 SC

GP ENVIRONMENTAL SERVICES

Possible notes and definitions for this report:

BQL	= Below Quantitation Limit
J	= An estimated value, below method detection limit
B	= Indicates that the compound was found in the associated blank
E	= Indicates that the concentration exceeded the calibration range of the instrument
U	= Indicates that the compound was analyzed for but not detected, number indicates the detection limit
D	= Indicates that the compound was found in a analysis at a secondary dilution factor
*	= Value obtained from a 1:5 dilution
+	= Value obtained from a 1:10 dilution
#	= Value obtained from a 1:20 dilution
^	= Value obtained from a 1:50 dilution
~	= Value obtained from a 1:100 dilution
!	= Value obtained from a 1:250 dilution
@	= Value obtained from a 1:125 dilution (Medium Level)
$	= Value obtained from a 1:1000 dilution
&	= Value obtained from a 1:10000 dilution
N	= Flashpoint not observed; heated to specified limit
R	= Flammable at room temperature
TNTC	= Too numerous to count
B.P.	= Detection limit taken from boiling point
F.F.	= Sample gave off flammable fumes

Chain of Custody Record

PHILIP ENVIRONMENTAL

10 Duff Road
Suite 500
Pittsburgh, PA 15235-3201

(412) -9000 Phone
(412) 244-9100 FAX

COC Serial No. E 2220

Project Name Westinghouse RI/FS
Project Number 422100 Phase . Task 7760 . 77
Samplers T. LoBarbara / A. Fabiano
Laboratory Name GP Environmental Svcs
Location Gaithersburg, MD

Sample Number (and depth)	Date	Time	Matrix	Total Number of Bottles	Type of Analysis and Bottle: VOC's - 40ml VOA's	24" Shelby Tube Grain	TCL VOC's (40 ml	Comments
CA082FRBTBMW11A	6/9/95	1340	Water	2	2			
CA083FRBTBMW11D 48-50'	6/10/95	0815	Soil	2			2	
CA084FRBTBMW11D TRIP BLANK	6/10	1530	~~Soil~~ WATER	1			1	
CA080FRBTBVMP3 10-12'	6/5	1410	Soil	1		1		
CA046AFDTBVWD 6-8'	6/8	0900	Soil	1		1		

Relinquished by:

Signature	Date	Time
A. D Fabiano	6/10/95	1615

Received By:

Signature	Date	Time
C. Lyon	6/12/95	9:50 AM

Samples Iced: ☒ Yes ☐ No

Preservatives (ONLY for Water Samples)
- ☐ Cyanide ..... Sodium hyroxide (NaOH)
- ☐ Volatile Organic Analysis ..... Hydrochloric acid (HCl)
- ☐ Metals ..... Nitric acid (HNO_3)
- ☐ TPH (418.1) ..... Sulfuric acid (H_2SO_4)
- ☐ Other (Specify) _____
- ☐ Other (Specify) _____

Carrier:

Airbill No.

Shipping and Lab Notes: Cooler Temp 4.2

C4007

ENVIRONMENTAL SERVICES

SAMPLE RECEIPT CHECKLIST

.O. No.	95.06.112	Carrier Name	Fed Ex
ient Name	Westinghouse	Prepared (Logged In) By	CL 6/12/96 (Initials / Date)
ate Received	6/12/96	Project	R1/E5
me Received	9:50AM	Site	
eceived By	Lynn S	VOA Holding Blank I.D. No.	

	YES	NO		YES	NO
irbill/Manifest Present? No. 153970 7741	✓	—	Trip Blanks Received? No. of Sets 1 set	✓	—
ipping Container in Good Condition?	✓	—	VOA Vials Have Zero Headspace?	✓	—
istody Seals Present on Shipping Container? Condition: Good ____ Broken ____	—	✗	Preservatives Added to Sample?	—	✗
ain-of-Custody Present?	✓	—	pH Check Required? Performed By? ____	—	✓
ain-of-Custody Agrees with Sample Labels?	✓	—	Ice Present in Shipping Container?	✓	—
ain-of-Custody Signed?	✓	—			
icking Present in Shipping Container? Type of Packing Packing Wool	✓	—			
istody Seals on Sample Bottles? Condition: Good ✓ Broken ____	✓	—			
otal Number of Sample Bottles 7					
otal Number of Samples 5					
mples Intact?	✓	—			
fficient Sample Volume for Indicated Test?	✓	—			

Container#	Temperature
1	4.2

Project Manager Contacted?
Name: [illegible]
Date Contacted: 6/12/96

ny NO response must be detailed in the comments section below. If items are not applicable to particular samples or contracts, ey should be marked N/A.

OMMENTS: _____

Checklist Completed by CL

Date 6/12/96

304608

APPENDIX
D

304609

APPENDIX D

Calculations

Vapor Extraction Mass Removal Rates of Trichloroethene

Where:
Concentration x Mass = Mass Removal Rate

Test Identification	Concentration (ug/L)	Flow Rate (SCFM)	Flow Rate (L/Min)	Mass Removal Rate (ug/min)	Mass Removal Rate (ug/day)	Mass Removal Rate (ug/year)	Mass Removal Rate (lb/day)	Mass Removal Rate (lb/year)
Former Runoff Basin	12.7	39	1104	1.40E+04	2.02E+07	7.37E+09	0.04	16
Shallow Well	20.6	43	1218	2.51E+04	3.61E+07	1.32E+10	0.08	29
Former Runoff Basin	0	7	198	0.00E+00	0.00E+00	0.00E+00	0.00	0
Deep Well	0	7	198	0.00E+00	0.00E+00	0.00E+00	0.00	0
Disposal Area F	32	61	1728	5.53E+04	7.96E+07	2.91E+10	0.18	64
Shallow Well	15.6	60	1699	2.65E+04	3.82E+07	1.39E+10	0.08	31
Disposal Area F	5.8	107	3030	1.76E+04	2.53E+07	9.24E+09	0.06	20
Deep Well	15.2	107	3030	4.61E+04	6.63E+07	2.42E+10	0.15	53

Example Calculation

12.7 ug/L x 39 standard cubic feet per minute x 28.32 liters/cubic foot = 1.40E+04 ug/min
1.40E+04 ug/min x 1440 min/day = 2.02E+07 ug/day
2.02E+07 ug/day x 365 day/year = 7.37E+09 ug/year
7.37E+09 ug/year / 453590000 ug/lb = 0.04 lb/day
0.04 lb/day x 365 day/year = 14.6 lb / year

Standard Volume Calculation

$V_1 = (P_2V_2T_1)/(P_1T_2)$

Where:
V_1 = Volume (cubic feet) at standard temperatures and pressures
P_1 = Standard pressure (1 atmosphere = 406.8 inches of water column)
T_1 = 20 °C = 293 °K
V_2 = measured volume in cubic feet
P_2 = measured pressure in inches of water column
T_2 = measured temperature in °K

Test Location	Flow at Well Head (CFM) V_2	Gauge Pressure at Well Head (inH_2O)	Absolute Pressure at Well Head (inH_2O) P_2	Vapor Temperature at Well Head (°C)	Absolute Temperature at Well Head (°K) T_2	Standard Temperature (°K) T_1	Standard Pressure (inH_2O) P_1	Flow at Standard Conditions (SCFM) V_1
FRB	17	-22	384.8	22	295	293	406.8	16
Step Test	40	-40	366.8	26	299	293	406.8	35
Shallow Well	46	-55	351.8	27	300	293	406.8	39
FRB	22	-11	395.8	26	299	293	406.8	21
Step Test	24	-22	384.8	23.6	296.6	293	406.8	22
Deep Well	30	-28	378.8	23.6	296.6	293	406.8	28
DAF	30	-20	386.8	28.7	301.7	293	406.8	28
Step Test	67	-30	376.8	30	303	293	406.8	60
Shallow Well	76	-45	361.8	25	298	293	406.8	66
DAF	33	-5	401.8	20.5	293.5	293	406.8	33
Step Test	86	-10	396.8	16	289	293	406.8	85
Deep Well	100	-12	394.8	16.3	289.3	293	406.8	98
FRB - 4-Hour Test	45	-48	358.8	26.3	299.3	293	406.8	39
Shallow Well	49.6	-48	358.8	27.6	300.6	293	406.8	43
FRB - 4 Hour Test	7	-28	378.8	20.8	293.8	293	406.8	7
Deep Well	8.1	-28	378.8	26.7	299.7	293	406.8	7
DAF - 4-Hour Test	69.2	-40	366.8	26.8	299.8	293	406.8	61
Shallow Well	68	-40	366.8	25	298	293	406.8	60
DAF - 4 Hour Test	110	-9	397.8	21.6	294.6	293	406.8	107
Deep Well	110	-10	396.8	21.5	294.5	293	406.8	107
			406.8		273	293	406.8	0
			406.8		273	293	406.8	0

Example Calculation V_1 = (384.8 inH_2O x 17 Cubic Feet x 293 °K) / (406.8 inH_2O x 295 °K) = 15.97 Cubic Feet

PERMEABILITY OF SOIL DETERMINED FROM FLOW RATES AND CORRESPONDING VACUUMS

$k = (Qu/Hpip_w) \times \ln(R_W/R_I)/(1-(P_{Atm}/P_w)^2)$

Where:

k = soil permeability to air flow (cm^2)
Q = flow in cm^3/sec
u = viscosity of air = 1.8×10^{-4} g/cm-s
H = length of screened interval (cm)
pi = 3.14
R_w = radius of vapor extraction well (cm)
R_I = Radius of influence of vapor extraction well
P_{Atm} = absolute ambient pressure = 1.01×10^6 g/cm-s^2 (= 1 atm)
P_w = absolute pressure at extraction well (g/cm-s^2)

Given the following information collected during testing:

Location	VEW Flow (CFM)	Screened Interval (Feet)	Well Vacuum (In. H2O)	Radius of Well (inches)	Radius of Influence (feet)
Shallow FRB	55	2.5	39	2	22
Deep FRB	28	0.67	28	2	10
Shallow DAF	68	2.5	45	2	12
Deep DAF	98	1.5	12	2	20

and the following conversions:

Q (ft^3/min) to Q (cm^3/sec): Q(ft^3/min) x (1 min/60 sec) x (28317 cm^3/ft^3) = Q (cm^3/sec)

H (feet) to H (cm): H (feet) x (12 inches/foot) x (2.54 cm/inch) = H (cm)

Well Vacuum (in. H_2O) to P_w (g/cm-s^2): (1 atm x 406.8 in. H_2O/1 atm) - (well vacuum (in. H_2O)) = P_w (in. H_2O)
P_w (in H_2O) x (1 atm/406.8 in.H_2O) x (1.01×10^6 g/cm-s^2/ 1 atm) = P_w (g/cm-s^2)

R_W (in.) to R_W (cm): R_W (in) x (2.54 cm/inch) = R_W (cm)

R_I (feet) to R_W (cm): R_I (feet) x (12 inches/foot) x (2.54 cm/inch) = R_I (cm)

Location	Parameter						
	k (cm^2)	Q (cm^3/sec)	H (cm)	P_w (g/cm-s^2)	R_w (cm)	R_I (cm)	P_{Atm} (g/cm-s^2)
Shallow FRB	4.67E-07	25957	76	913171	5.08	671	1.01E+06
Deep FRB	1.05E-06	13215	20	940482	5.08	305	1.01E+06
Shallow DAF	4.35E-07	32093	76	898274	5.08	366	1.01E+06
Deep DAF	4.59E-06	46251	46	980206	5.08	610	1.01E+06

Example Calculation:

$k = ((25{,}957\ cm^3/sec \times 1.8 \times 10^{-4}\ g/cm\text{-}s)/(76\ cm \times 3.14 \times 913171\ g/cm\text{-}s^2)) \times$
$(\ln(5.08\ cm/671\ cm)/(1-(1.01 \times 10^6\ g/cm\text{-}s^2/913171\ g/cm\text{-}s^2)^2)) = 4.67 \times 10^{-7}\ cm^2$