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November 27, 1996

Mr. William C. Olson
Environmental Bureau
New Mexico Oil Conservation Division
2040 S. Pacheco St.
Santa Fe, New Mexico 87505



RE: Phase II Soil and Ground Water Assessment Report
Roswell Compressor Station
Transwestern Pipeline Company

Dear Bill,

Enclosed is one copy of the subject report. We are currently in the process of developing a Phase III Soil and Ground Water Assessment Plan to complete the delineation of affected soil and ground water at the site. In addition, we are in the process of developing a ground water monitoring plan for the site. We anticipate that both plans will be submitted to your office for review and approval no later than January 31, 1997.

If you have any questions regarding the enclosed report, please contact me at (713) 646-7644 or George Robinson at (713) 646-7327.

Sincerely,

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Manager, Projects Group

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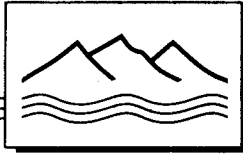
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DANIEL B. STEPHENS & ASSOCIATES, INC.

ENVIRONMENTAL SCIENTISTS AND ENGINEERS

**Phase II Soil and Ground-Water
Assessment for
Roswell Compressor Station
Surface Impoundments
Volume I: Phase II Report**

**Prepared for
ENRON Environmental Affairs
Houston, Texas**

December 2, 1996



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1. INTRODUCTION

ENRON Corp. retained Daniel B. Stephens & Associates, Inc. (DBS&A) to conduct a Phase II assessment of impacted soils and ground water underlying two former surface impoundments at Transwestern Pipeline Company's (Transwestern) Roswell Compressor Station No. 9. The site is located approximately 9 miles north of the city center of Roswell, New Mexico, along U.S. Highway 285 (Figure 1). The general layout of the area under investigation, which is located at the northeastern corner of the site, is provided in Figure 2.

The primary function of the former impoundments was to contain pipeline condensate, a hydrocarbon liquid that accumulates within natural gas pipelines. Previous environmental investigations have identified impacts to soil and the uppermost aquifer underlying the former surface impoundments (Harding Lawson Associates, 1991; Metric Corporation, 1991; Halliburton NUS Environmental Corporation, 1992; Brown & Root Environmental, 1993).

In order to complete the assessment of affected soil and ground water beneath the former surface impoundments, Transwestern has recently implemented a phased approach with clearly defined objectives (Transwestern, 1996). As part of the Phase I investigation, which DBS&A completed in August 1995, the chemical characteristics of affected soil immediately beneath the former impoundments was determined and three downgradient monitor wells (MW-7, MW-8, and MW-9) were installed in the uppermost aquifer (DBS&A, 1995a). The objectives of the Phase II investigation were to (1) evaluate two additional potential source areas, (2) further delineate the lateral and vertical extent of affected soil and ground water, and (3) assess whether soil vapor extraction (SVE) is a viable remedial technology for the site.

The Phase II investigation was completed in accordance with the *Work Plan for Phase II Soil and Ground-Water Assessment for Roswell Compressor Station No. 9 Surface Impoundments*, dated December 20, 1995 (DBS&A, 1995b). The tasks outlined in the plan were designed to ensure that the data generated from the investigation are of sufficient quality to support subsequent decisions by ENRON Corp. and state regulators. The New Mexico Oil Conservation Division (OCD) approved the Phase II work plan on July 24, 1996 contingent on additional sampling



requirements (OCD, 1996). The conditions set forth by OCD were incorporated into the work plan and implemented as requested.

The Phase II assessment was conducted during the period of September 10 through 26, 1996. In order to evaluate potential subsurface impacts, DBS&A analyzed soil and ground-water samples for numerous inorganic and organic constituents to determine if standards set by the U.S. Environmental Protection Agency (EPA) and/or the New Mexico Water Quality Control Commission (NMWQCC) were exceeded. Additional field work was conducted to determine remedial design parameters. Specifically, the DBS&A Phase II assessment included the following work:

- Five soil borings (SVE prefix) were advanced and three of the borings were converted to SVE wells near the periphery of the surface impoundment referred to as Pit 1 (Figure 2).
- Five borings (SG86-1 through SG86-4 and MW-13) were advanced, one of which was converted to a monitor well, near a suspected source area referred to as SG86.
- Five borings (Pit 3-1 through Pit 3-5) were advanced near a suspected source area referred to as Pit 3.
- Nine borings (MW-10 through MW-19, excluding MW-13) were advanced below the water table of the uppermost aquifer, and monitor wells were constructed and developed in each of these borings.
- Soil samples were collected from each of the above borings for field and laboratory analyses.
- Pneumatic bladder pumps were installed in six of the new monitor wells to be used for ground-water sampling.
- Fourteen monitor wells were sampled and analyzed for inorganic and organic constituents.



- Fluid levels were measured in all existing and newly installed wells to evaluate ground-water flow directions.
- Six SVE performance tests of various durations were conducted.
- A survey was performed to determine the locations and elevations of each new boring and well.

This report presents the methods and results of the Phase II assessment. Section 2 provides a discussion of field procedures used during drilling and sampling activities and a brief discussion of the local hydrogeologic conditions. Section 3 provides an interpretation of the soil and ground-water results. Section 4 describes the SVE performance tests. Finally, Section 5 includes a summary and the conclusions drawn from the Phase II assessment.



2. SUBSURFACE INVESTIGATION

This section describes the procedures followed during the subsurface investigation (Sections 2.1 through 2.3) and incorporates the physical data obtained from the investigation into a local hydrogeologic framework (Section 2.4). All field work was conducted in accordance with DBS&A standard operating procedures and a site-specific health and safety plan developed for the field program.

2.1 Soil Sampling and Analysis

During the Phase II investigation, DBS&A advanced 24 borings to delineate the extent of subsurface impacts. The location of soil borings and monitor wells (MW-10 through MW-19) installed during the Phase II assessment are shown on Figure 2. Drilling services were provided by Layne Environmental Services of El Paso, Texas, using a Failing F-10 hollow-stem auger rig. Prior to beginning each boring, drilling equipment and sampling devices were steam cleaned and inspected by DBS&A personnel. In addition, all sampling equipment was decontaminated prior to each use by washing with Liquinox detergent followed by rinsing with deionized water.

Soil cuttings were segregated based on field headspace screening for volatile organic compounds (VOCs) using an organic vapor analyzer equipped with a photoionization detector (PID). Potentially contaminated soil cuttings were stored in 55-gallon drums and labeled to identify the contents, date of generation, and amount of material generated. The clean cuttings were stockpiled at the site on clean plastic.

As each boring was advanced, soil samples were collected by driving 24-inch-long split-spoon samplers ahead of the lead auger flight. With the exception of borings to be completed as monitor wells, split-spoon samples were collected on 5-foot intervals to the total drilled depth of each boring. During the drilling of monitor wells, installed for the purpose of defining the extent of dissolved-phase contamination in the uppermost aquifer, split-spoon samples were collected at 10-foot intervals.



The recovered cuttings and split-spoon samples were used to develop geologic logs based on the Unified Soil Classification System. Subsamples of the recovered material were placed in resealable plastic bags for field headspace screening for VOCs using a PID. Appendix A contains the lithologic logs and PID readings for each boring advanced during the investigation.

Soil samples were selected from each boring for laboratory analysis. The samples selected included the one from the bottom of each boring and, if field screening determined that VOCs were present, the most highly impacted sample based on visual examination and the field headspace screening. Samples collected for laboratory analysis were contained in 250-mL glass jars and placed in an ice-filled cooler for shipment to Core Laboratories in Denver, Colorado, for chemical analysis using standard laboratory protocols in *Test Methods for Evaluating Solid Waste* (U.S. EPA, 1986). Analytical methods and data quality objectives for the phased investigation are discussed in detail in the Quality Assurance Project Plan (Transwestern, 1996).

Each soil sample was analyzed for total petroleum hydrocarbons (TPH) (EPA method 418.1), VOCs (EPA method 8240), semivolatile organic compounds (SVOCs) (EPA method 8270), polychlorinated biphenyls (PCBs) (EPA method 8080), and metals (EPA methods 6010 and 7471). Appendix B provides a summary of analytical results for all soil samples collected during the investigation. Copies of the Core Laboratories analytical reports and the corresponding quality assurance/quality control data are given in Volume II of this report.

Following sample collection, each boring was either plugged and abandoned with a cement/bentonite slurry or completed as a well.

2.2 Well Installation

In order to evaluate ground-water quality, borings to be completed as monitor wells were drilled to approximately 10 feet below the water table. The monitor wells installed in these borings were constructed of 2-inch-diameter schedule 40 polyvinyl chloride (PVC) pipe and included, in ascending order, a 6-inch flush-threaded silt trap (sump) at the bottom of the boring, typically 15 to 20 feet of flush-threaded 0.01-inch machine-slotted PVC screen above the sump, and blank casing from the top of the screen to ground surface.



Once the well casing was lowered to the bottom of the borehole, a sand pack consisting of #12-20 mesh silica sand was emplaced from the total well depth to approximately 2 feet above the top of the well screen. The annular space above the sand pack was filled with a minimum 2-foot-thick bentonite seal and hydrated with distilled water. The remaining annular space was filled with a cement/bentonite slurry grout to ground surface. The top of the well casing was protected by a locking expansion cap within a flush grade well vault. A concrete pad was then constructed around the well vault.

In order to evaluate SVE design parameters, three SVE wells were constructed above the water table. The three SVE borings were originally advanced to a total depth of approximately 60 feet bgs. However, VOCs were detected primarily along the water table interface in boring SVE-3, and in borings SVE-1 and SVE-2, above a clay zone present at approximately 30 feet bgs. Consequently, DBS&A abandoned borings SVE-1 and SVE-2 and drilled two nearby replacement borings to a total depth of approximately 30 feet bgs. SVE wells SVE-1A and SVE-2A were then installed in these shallow borings to evaluate hydrocarbon removal from the shallow sands and gravels. Boring SVE-3 was converted to a SVE well as originally planned to evaluate hydrocarbon removal from the deeper clays.

Wells SVE-1A and SVE-2A (Figure 2) were installed to a total depth of approximately 30 feet below ground surface (bgs) within the shallow soil zone, which consists primarily of sands and gravels with relatively high intrinsic permeability. Well SVE-3, installed to a total depth of approximately 62 feet bgs, was completed in the lower soil zone, which consists primarily of sandy to fat clays with relatively low permeability. Each well was completed with 2-inch-diameter, 0.020-inch machine-slotted PVC screen and flush-thread 2-inch PVC blank casing to ground surface. However, only 10 feet of screen was installed in the shallow zone as opposed to 30 feet of screen in the deeper zone. The annular seals and surface completions were similar to those of the monitor wells described above.

Construction details and September 27, 1996, water level elevations for all of the newly installed wells are provided in Table 1. Each location was surveyed relative to the facility grid and mean sea level by Wagener Engineering of Roswell, New Mexico.



2.3 Ground-Water Sampling and Analysis

The newly installed monitor wells were developed by surging with a PVC bailer in order to (1) dislodge any smeared material on the borehole wall that would otherwise inhibit ground-water flow and (2) remove fine particles near the boring. During well development, pH, temperature, specific conductance, and turbidity were monitored periodically to determine when the wells were sufficiently developed. All purged ground water was contained in 55-gallon drums to be disposed of by Transwestern.

Following well development, dedicated pneumatic bladder pumps were installed in monitor wells MW-10 through MW-14 and MW-17 to allow purging and collection of representative ground-water samples at low flow rates. Pneumatic bladder pumps were not available for installation in all monitor wells because the number of wells installed during the investigation was extended beyond the original Phase II scope in order to more accurately define the zone of impact. Instead, monitor wells MW-15 and MW-19 were sampled with dedicated, disposable polyethylene bailers. The two remaining new monitor wells were not sampled due to the presence of phase-separated hydrocarbons (PSH) in MW-16 and the absence of ground water in MW-18. In addition, ground-water samples were collected from previously installed monitor wells MW-3 and MW-5 through MW-9.

After purging three casing volumes, samples were collected in order of decreasing volatility. Samples for VOC analyses were collected in precooled, acidified, certified-clean 40-mL glass vials with septum caps supplied by the laboratory. Following collection of the VOC samples, the samples for SVOC, total metals (unfiltered), and general chemistry analyses were collected in containers with the appropriate preservative, as provided by Core Laboratories. All samples were shipped to the laboratory in an ice-filled chest using an overnight carrier.

Samples from each well were analyzed for VOCs (EPA method 8240), SVOCs (EPA method 8270), PCBs (EPA method 8080), major ions, total dissolved solids (TDS), and the metals regulated by the NMWQCC using the EPA procedures set forth in *Test Methods for Evaluating Solid Waste* (U.S. EPA, 1986). Appendix B contains a summary of the water analyses results;



the full Core Laboratories report, including the supporting quality assurance and chain-of-custody documents, is provided in Volume II of this report.

2.4 Site Hydrogeology

Hydrogeologic cross sections developed from lithologic descriptions are provided as Figures 3 and 4; the locations of the cross sections are shown on Figure 2. The alluvial sediments beneath the impoundments consist of discontinuous interbedded cobbles, gravel, sand, silt, and clay to depths of approximately 70 feet bgs. The base of the alluvium is marked by abundant gypsum beds. A detailed description of the alluvial lithology is provided in the Phase I assessment plan (DBS&A, 1995c).

Within the alluvium, ground water occurs under unconfined to possibly semiconfined conditions. The depth to water across the area of investigation ranges from approximately 50 to 65 feet bgs (although no ground water was encountered in wells MW-7ABD and MW-18). Water table elevations generated from September 27, 1996 depth to water measurements are shown on Figure 5.

As indicated on Figure 5, an accurate evaluation of the direction(s) of ground-water flow under the surface impoundments is not feasible. In the area under investigation, the uppermost aquifer flow field is complex as evidenced by (1) anomalous water level elevations, (2) significant variations in the direction and magnitude of hydraulic gradient between wells, and (3) discontinuous water-bearing zones as evidenced by dry areas near monitor well MW-18 and soil boring MW-7ABD. Consequently, no attempt was made to contour the measured water level elevations. A better indication of ground-water flow directions within the area is likely provided by the distribution of ground-water contaminants beneath the site (Section 3.2.2).



3. RESULTS OF THE PHASE II ASSESSMENT

As described in Section 2, soil and ground-water samples were collected from each boring and monitor well and analyzed for organic and inorganic constituents. Appendix A contains the results of the headspace analysis for each boring, and the analytical chemistry results are summarized in tables located in Appendix B. Laboratory reports are provided in Volume II of this report.

This section provides an interpretation of the analytical results obtained from the Phase II assessment. Sections 3.1 and 3.2 describe the soil and ground-water assessments, respectively.

3.1 Soil Assessment

The objectives of the soil assessment were to (1) more closely define the lateral extent of affected soil in the vicinity of former surface impoundment Pit 1, (2) characterize residual subsurface wastes within potential source areas SG86 and Pit 3, and (3) determine the areal extent of soil impacts. In order to meet the stated objectives, field screening methods were used to collect potentially impacted soils for analysis. Following receipt of the analytical results, DBS&A evaluated the spatial distribution of potential contaminants and compared the concentrations of each constituent with the available regulatory standards.

With the exception of the OCD regulatory guidelines for TPH, benzene, and total benzene, toluene, ethylbenzene, and xylenes (BTEX) (OCD, 1993), no regulatory standards are presently in place for the State of New Mexico. In an attempt to establish cleanup goals, Transwestern has proposed performance standards that include the OCD standards for TPH and BTEX and, for constituents other than TPH and BTEX, the Risk Reduction Standard 2 criteria established by the Texas Natural Resource Conservation Commission (TNRCC) (Transwestern, 1996). For chemical constituents for which a TNRCC Risk Reduction Standard 2 criterion is not available, Transwestern has proposed the adoption of the soil screening levels (SSLs) for transfer of contaminants from soil to ground water listed in the U.S. EPA Region III risk-based concentration table issued on October 20, 1995.



Table 2 provides a summary of the 13 organic constituents detected in at least one or more soil sample collected during the Phase II assessment. The performance standard proposed by Transwestern for each detected constituent is provided for reference. A summary of the results of all constituents analyzed for during the Phase II investigation is provided in Appendix B. Most of the analyzed metals are naturally occurring in soil and are within the range for background metal concentrations in the southwestern and western United States (Schacklette and Boerngen, 1984). Accordingly, the concentrations of metals present in soil are not discussed in greater detail.

Contaminants of concern, as defined by OCD, are those that have a potential to cause an exceedance of NMWQCC standards. Figure 6 provides the plan view distribution of the maximum concentration of the primary contaminants of concern detected in soils near the former surface impoundments. The subject contaminants of concern are discussed in greater detail in Sections 3.1.1 through 3.3.3.

3.1.1 SVE Borings

In order to evaluate the extent of soil impacts along the periphery of Pit 1, each original SVE boring was advanced to a total depth of approximately 60 feet bgs. As described in Section 2.2, field screening with a PID detected VOCs at the western and southern boundary of Pit 1 (borings SVE-1 and SVE-2, respectively) primarily above a clay zone present at approximately 30 feet bgs, whereas to the north (boring SVE-3), VOCs were detected primarily along the water table interface (approximately 50 to 60 feet bgs).

As indicated by the laboratory analyses, the residual waste surrounding Pit 1 consists primarily of petroleum hydrocarbons with minor quantities of halogenated VOCs (Figure 6). TPH concentrations ranged from 21 to 3,700 mg/kg for soil samples collected from borings SVE-1, SVE-2, and SVE-3, with the OCD regulatory guideline of 100 mg/kg for TPH exceeded in one of the six soil samples collected from these borings (Appendix B). During the Phase I assessment, a maximum TPH concentration of 26,000 mg/kg was detected within a soil sample collected directly from the residual waste present within Pit 1. The PCB Aroclor 1254 was also detected



in one sample; however, the laboratory noted matrix interferences, which made quantification of Aroclor 1254 uncertain.

3.1.2 SG86 and Pit 3 Borings

The Phase II assessment consisted of characterizing two potential source areas: (1) the area near soil boring SG86 (previously advanced by Metric Corporation [1991]) and (2) the location referred to on Figure 2 as Pit 3. At each potential source area, five borings were drilled and sampled to approximately 30 feet bgs. One of the borings located near SG86 was completed as monitor well MW-13; the others were plugged with cement-bentonite slurry and abandoned.

3.1.2.1 SG86 Borings. Field screening of soils in the SG86 area indicated that VOCs are present in the vicinity of borings SG86-1, SG86-2, and MW-13. However, with the exception of four samples collected from boring MW-13, all detected hydrocarbon concentrations were below the 100 parts per million by volume (ppmv) field screening criterion (Appendix A).

As part of the SG86 assessment, DBS&A collected nine soil samples for laboratory analyses. With the exception of acetone and methylene chloride, common laboratory contaminants that were detected in several of the samples, only two boring locations, SG86-1 and MW-13, had detectable concentrations of VOCs (Table 2). The VOCs detected in these borings include BTEX and the halogenated compounds 1,1-dichloroethane (1,1-DCA), tetrachloroethene (PCE), and 1,1,1-trichloroethane (1,1,1-TCA). Another common laboratory contaminant, the SVOC di-n-butylphthalate, was also detected in several samples as well as in the laboratory method blank.

Although the SG86 assessment determined that VOCs are present within the sands and gravels above the deeper sandy and fat clays present from 30 to 60 feet bgs, these VOC concentrations do not indicate a separate source area. Because borings SG86-1, SG86-2, and MW-13 define the area of shallow soils containing VOCs, former surface impoundment Pit 1 is the likely source (Figure 2). Based on PID readings, hydrocarbons were likely released from Pit 1, which allowed hydrocarbons to migrate laterally and downward from the Pit 1 source. Near monitor well MW-13, soils were probably impacted from two distinct sources: (1) a shallow release and (2) a deeper



source that likely leached downward through the soil column from Pit 1 or 2 and then migrated laterally along the water table toward the monitor well MW-13 area.

3.1.2.2 Pit 3 Borings. Field screening of soils in the Pit 3 area indicates that hydrocarbon concentrations are below 100 ppmv at all five boring locations (Appendix A). PID readings ranged from 0.4 to 61 ppmv for the screened soils. The highest PID readings were measured in soils near the ground surface (Pit 3-2 and Pit 3-4) and soils in contact with the lower clays (Pit 3-1 and Pit 3-5). The PID readings indicate that Pit 3 is not a likely source of ground-water contamination.

During the assessment, DBS&A collected seven soil samples from the Pit 3 borings for laboratory analysis. The results of these analyses (Table 2) indicate that minimal soil impacts have occurred in this area. Benzene and xylene were each detected near the method detection limit in one sample. The PCB Aroclor 1254 and methylene chloride were also detected at low concentrations within several samples. All organic constituent concentrations detected in the analyzed soils were below the proposed performance standards for remediation.

3.1.3 Monitor Well Borings

During the drilling of monitor wells, DBS&A collected 10 soil samples for the complete analysis of organic and inorganic constituents. In addition, DBS&A collected samples in each boring at 10-foot intervals to evaluate the areal distribution of TPH in soils. Appendix B contains a summary table of TPH concentrations in all analyzed soils collected during the investigation.

PID readings indicated that few soils contained detectable concentrations of VOCs. Of the 10 borings advanced for the purpose of installing monitor wells, only samples analyzed from borings MW-12, MW-13, and MW-16 had detectable concentrations of VOCs. However, several samples from these borings exceeded the 100-ppmv OCD field-screening criterion (Appendix A), and the MW-16 soil sample collected near the water table exceeded the performance standards for BTEX and TPH (Table 2). In addition, the 60-foot sample collected from MW-16 had detectable concentrations of the SVOCs 2-methyl naphthalene and naphthalene and the PCB Aroclor 1254.



Off-site soil impacts appear to be limited primarily to TPH and BTEX (i.e., no halogenated compounds were detected) (Table 2).

3.2 Ground-Water Assessment

Concurrent with the soil assessment, the Phase II ground-water assessment was conducted to determine analytes present in ground water. As proposed in the Phase II assessment plan, five monitor wells were installed in the uppermost aquifer to delineate the extent of the dissolved-phase plume near the former impoundments (monitor wells MW-10 through MW-14 [Figure 2]). Based on field observations, an additional five monitor wells were installed to delineate the extent of the plume (monitor wells MW-15 through MW-19 [Figure 2]).

Past investigations have determined that the organic constituents BTEX, 1,1,1-TCA, and 1,1-DCA are the principal threats to ground water beneath the former impoundments. However, in order to ensure that other constituents are not present, additional analyses were specified for ground-water samples (Section 2.3). Sections 3.2.1 and 3.2.2 describe the outcome of the ground-water assessment.

3.2.1 Phase-Separated Hydrocarbons

On September 23 and 27, 1996, DBS&A checked each well for the presence of phase-separated hydrocarbon (PSH). The distribution of PSH is shown on Figure 7 based on the September 23, 1996 measurements. On that date, PSH was present in three product recovery wells (MW-1, MW-1B, and MW-2) located on-site and newly installed monitor well MW-16 located approximately 120 feet east of the eastern property boundary. On September 23, 1996, the measurable thickness of PSH on top of the water table ranged from 2.9 to 7.5 feet.

The estimated extent of PSH is shown on Figure 7. The estimated area of PSH extent has a northwest to southeast orientation with a maximum and minimum axis of roughly 550 feet and 150 feet, respectively. The extent of PSH is bounded by monitor wells containing no measurable thickness.



3.2.2 Ground-Water Quality

As part of the ground-water assessment, DBS&A collected water samples from eight of the newly installed wells and the six existing wells that did not contain PSH (MW-3 and MW-5 through MW-9). Monitor wells MW-16 and MW-18 were not sampled due to the presence of PSH and lack of ground water, respectively. Tables 3 through 5 summarize the results of all past and present ground-water analyses that detected measurable concentrations of target analytes. More extensive tables that contain results for all analyzed constituent are provided in Appendix B, and the analytical laboratory reports and supporting quality assurance/quality control documentation are provided in Volume II of this report.

As shown on Table 3, only 10 organic compounds have been detected in ground water obtained from the uppermost aquifer. Based on their areal distribution, the primary contaminants of concern are BTEX. Halogenated VOCs and naphthalenes have been detected in ground water only in the vicinity of recovery well MW-1, located in the northeast corner of the site.

Based on September 1996 benzene concentrations, the estimated extent of actionable ground-water impacts is shown on Figure 8. Actionable impacts cover an area having dimensions of roughly 600 feet by 350 feet. The distribution of contaminants suggests that ground water flows to the north and east of the former surface impoundments. To date, the extent of actionable ground-water impacts north of monitor well MW-12 and due south of MW-16 have not been fully defined.

During the Phase I ground-water assessment, DBS&A analyzed ground-water samples from 6 wells for 18 metals. Based on the Phase I analysis, the analyte list was reduced to 10 specific metals based on previous detections and/or the presence of a NMWQCC standard for the metal. Phase II chemical analysis of ground-water samples indicates that all metals detected in water samples from the 14 monitor wells sampled are below the NMWQCC standards (Table 4). Repeat sampling of MW-1 was not conducted due to the presence of PSH.

Inorganic analyses for major ions indicate that ground-water samples from each well, including upgradient monitor wells MW-6 and MW-10, exceed the NMWQCC ground-water standards for



TDS, chloride, and sulfate. The generally poor inorganic water quality in the vicinity of the site is natural and is likely due primarily to the presence of gypsum beds within the alluvium and underlying Artesia Group.



4. SVE PERFORMANCE TESTS

On September 24 and 25, 1996, DBS&A conducted several short-term SVE performance tests. The tests were conducted with the assistance of AcuVac Remediation (AcuVac) of Houston, Texas. AcuVac transported a mobile internal combustion engine (ICE) vapor extraction unit to the site and operated the unit under DBS&A's direction. The ICE draws a vacuum on the wells and at the same time achieves nearly complete oxidation of well vapors. The AcuVac pilot testing report is provided in Appendix C.

The tests were conducted in order to assess whether SVE is a viable technology at this site for the removal of PSH and hydrocarbons adsorbed on soils. The specific objectives of the SVE tests were to:

- Evaluate the effective radius of influence for SVE wells
- Determine operational flow rates and vacuums
- Estimate hydrocarbon mass removal rates

4.1 Performance Tests

The SVE tests consisted of (1) a 6.9-hour test on well SVE-3, completed in the deep zone of impacts (30 to 60 feet bgs) within sandy to fat clays, (2) a 5.7-hour test on recovery well MW-1, also completed in the deep zone, (3) a 2.8-hour test on well SVE-2, completed in the shallow zone of impacts (20 to 30 feet bgs) within sands and gravels, and (4) three 15- to 30-minute tests on wells SVE-1, MW-15, and MW-16. The location of each test well is shown on Figure 2.

Tests were conducted at air flow rates ranging from approximately 15 to 40 cubic feet per minute (cfm) and vacuums of 25 to 160 inches of water. The performance tests indicated that approximately 2 to 3 cfm per linear foot of screen could be obtained from a 2-inch-diameter SVE well completed in the upper zone at vacuums of 25 to 40 inches of water. In the lower zone, approximately 1 to 1.5 cfm per linear foot of screen could be obtained from a 2-inch-diameter



SVE well completed in the lower zone at vacuums of 50 to 160 inches of water. AcuVac estimated that the effective radii of influence ranged from 80 feet to 90 feet in the lower zone.

4.2 Vapor Sampling

During the pilot testing of wells SVE-3 and MW-1, soil vapor samples were collected to evaluate hydrocarbon mass removal rates. Samples were collected in stainless steel canisters and shipped to Core Laboratories in Houston, Texas for analysis of BTEX, extended refinery gases (aliphatics and branched paraffins), and fixed gases ($O_2/N_2/CO_2$). The analytical results from samples collected during the pilot tests are provided in Appendix C. In addition to the collection of samples for laboratory analyses, soil vapor concentrations were measured in the field with a Horiba auto emissions analyzer provided by AcuVac. Non-methane hydrocarbon concentrations measured by Core Laboratories (12,800 ppmv in well MW-10) compared favorably with the Horiba measurement made by AcuVac.

Table 6 summarizes the results of vapor analyses performed on samples collected during the SVE performance testing. The highest concentrations of total hydrocarbon vapors, approximately 15,590 ppmv as measured by AcuVac, were extracted from SVE well SVE-3 during the 6.9-hour SVE test. Fixed gas concentrations indicate that natural in-situ biodegradation of hydrocarbons is occurring, as evidenced by elevated CO_2 and reduced O_2 concentrations (Appendix C).

The test results indicate that an SVE system can be used to remove hydrocarbon contamination at the site by vapor means and that such a system will be effective in the area surrounding the former impoundments, where contaminants are primarily low-molecular-weight pipeline distillates and where sustainable flow rates were recorded during the pilot test periods.



5. SUMMARY AND RECOMMENDATIONS

This report summarizes the Phase II soil and ground-water assessment undertaken by DBS&A on September 10 through 26, 1996, at Transwestern Pipeline Company's Roswell Compressor Station No. 9. The objectives of this Phase II investigation were to (1) evaluate two additional potential source areas (Pit 3 and SG86 [Figure 2]), (2) further delineate the extent of affected soil and ground water, and (3) assess whether SVE is a viable remedial technology for the site. Based on the data gathered to date, the following conclusions can be made regarding hydrogeologic characteristics and the extent of subsurface contamination near the former surface impoundments:

- Ground water beneath the investigated area is generally present near the base of the alluvium at approximately 50 to 65 feet bgs. The base of the alluvium is characterized by abundant gypsum beds. Ground-water flow directions are complex, as shown by the anomalous water level elevations, variable hydraulic gradients, and discontinuous water-bearing zones.
- The SVE borings advanced along the periphery of Pit 1 indicate that soil impacts are limited primarily to the area above the clays present at approximately 30 feet bgs. Based on the Phase I and II assessments, TPH concentrations within the area surrounding Pit 1 range from 21 to 3,700 mg/kg, and the residual waste has a maximum concentration of 26,000 mg/kg. The residual waste within Pit 1 consists primarily of petroleum hydrocarbons with minimal concentrations of halogenated VOCs.
- Assessment of soils in the SG86 and Pit 3 areas indicates that these two areas are not likely sources of ground-water contamination. In general, the soil impacts in these areas are minimal.
- Soil samples collected during the drilling of Phase II monitor wells indicate that off-site soil impacts are limited to TPH and BTEX. Only one soil sample, collected from boring MW-16, exceeded the regulatory standard for TPH and BTEX.



- Laboratory identification of PCBs is based on a "best fit" analysis of chromatographic peak patterns and retention times. Due to chemical weathering and matrix interferences, the identification process can be rather subjective. Prior to the Phase II investigation, PCBs had not been detected in the residual waste or soils surrounding Pits 1 and 2. However, during this investigation the PCB Aroclor 1254 was detected in several otherwise clean samples. A mechanism for transport of PCBs to depths of 60 feet bgs has not been determined. Additional analysis will be completed in the future to determine the presence or absence of PCBs.
- During the Phase II investigation, 10 additional monitor wells were installed to assess ground-water impacts. The analyses of samples from these wells indicates that BTEX constituents, 1,1,1-TCA and 1,1-DCA, are the primary constituents of concern. Based on benzene concentrations, the estimated extent of ground-water impacts covers an area of approximately 600 feet by 350 feet. At this point, the extent of actionable ground-water impacts north of monitor well MW-12 and south of MW-16 have not been fully defined.
- Measurable thicknesses of PSH present in four wells indicate that the estimated extent of PSH covers roughly a 550-foot by 150-foot area (roughly 2 acres).
- The SVE performance test determined that an SVE remedial system can be used to remove hydrocarbon contamination from the soils present at the site. Tests were conducted at air flow rates ranging from approximately 15 to 40 cfm and vacuums of 25 to 160 inches of water. AcuVac estimated that the effective radii of influence ranged from 80 feet to 90 feet in both the lower clayey soils and in the upper zone.



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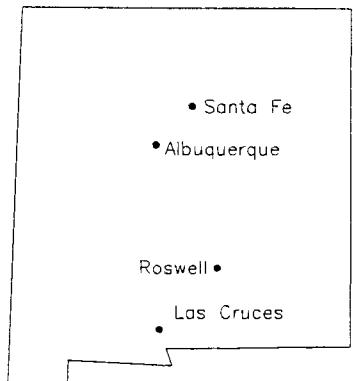
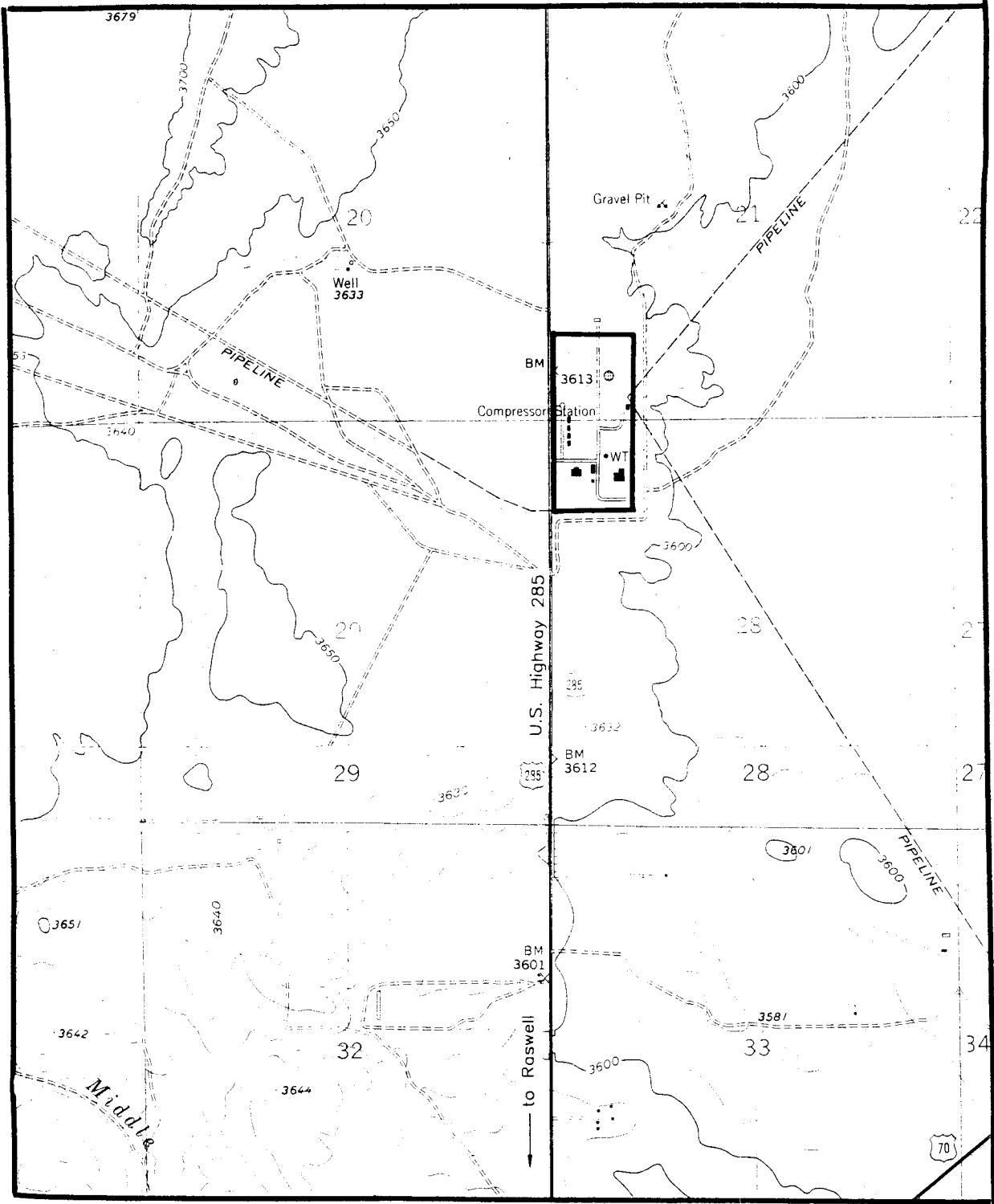
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FIGURES



Source: U.S. Geological Survey, 1982
 Panther Hill, Roswell North
 7 1/2 Minute Topographic
 Quadrangle Map.

**ROSWELL COMPRESSOR STATION
 Location Map**

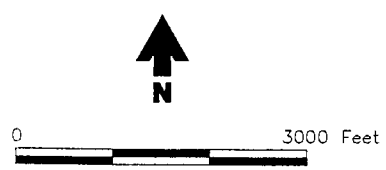
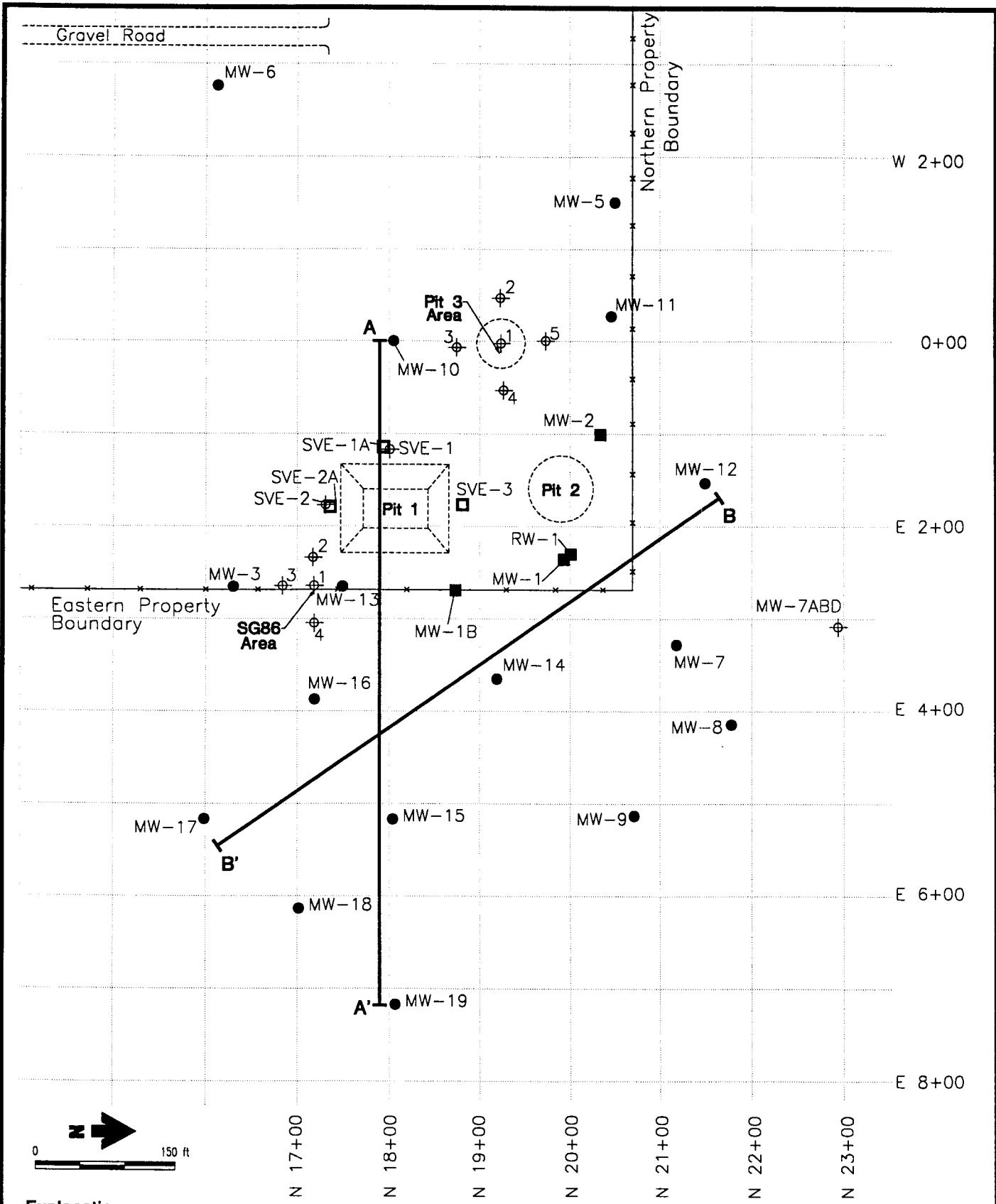


Figure 1



Explanation

	Monitor well		Cross section
	Recovery well		Soil boring
	SVE well		Fence

**ROSWELL COMPRESSOR STATION
Monitor Well and Soil Boring Locations**

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Figure 2