SPARTON

SPARTON TECHNOLOGY

December 12, 1991

Mr. Keith N. Phillips, Chief
Technical Section (6H-CX)
RCRA Enforcement Branch
U.S. EPA, Region 6
1445 Ross Avenue, Suite 1200
Dallas, Texas 75202-2733

Re: Draft Final RFI Report
Sparton Technology, Inc.
Coors Road Facility
Albuquerque, New Mexico

Dear Mr. Phillips:

In accordance with the provisions of the Consent Order, as amended, enclosed are six copies of the revised text and six copies of new/revised figures for the final RFI report. Revisions and/or additions to the draft final RFI report, dated August 1, 1991, are printed in italics, bordered, and indicated by the revised date, December 1, 1991, at the bottom of each page. These revisions are in general conformance to EPA comments dated October 15, 1991. The revisions should consolidate the RFI report into two volumes. Our consultants have prepared an accompanying set of instructions for revising the RFI report into final form. The draft Bench Scale Report is also enclosed.

Sincerely,

SPARTON TECHNOLOGY, INC.

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Enclosure

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Sparton Technology , Inc.
Coors Road Facility
Albuquerque, New Mexico

INSTRUCTION CHECKLIST FOR REVISING DRAFT FINAL RFI REPORT INTO FINAL FORM, DECEMBER 1991.

Existing Volume I of III

- ☐ Remove existing RFI text and figures. Retain Figures 1, 2, 4, 6-37, and 39. Discard remaining Figures 3, 5, 38, and 40-72 and old text. Retain plastic map pockets.
- ☐ Insert new RFI text into Volume I. Integrate existing Figures 1, 2, 4, 6-37, and 39 into new text using the table of contents and/or figure spacer sheets to determine location.
- ☐ Insert new figures at indicated locations utilizing the previously retained map pockets for the folded figures.
- ☐ Remove existing Volume I of III notebook cover and spine inserts and replace with new Volume I of II inserts dated December 1991.
- ☐ Volume I is now complete.

Existing Volume II of III

- ☐ Remove the entire contents of existing Attachment 5 (Report on the Areal Extent of Zones of Relatively Lower Permeability) and discard.
- ☐ Relocate the contents of existing Attachment 6 into new Attachment 5. Include new cover sheet.
- ☐ Remove the text of the report in existing Attachment 7 (Soil Investigation of the Unsaturated and Upper Saturated Zones) and discard. Retain all figures and appendices and transfer these into new Attachment 6. Include new cover sheet.
- ☐ Transfer the entire contents of existing Attachment 8 to new Attachment 7. Include new cover sheet.
- ☐ Remove the entire contents of existing Attachment 9 (Effectiveness of the Groundwater Recovery Well System) and discard.

- ☐ Remove existing Volume II of III cover and spine and replace with new Volume II of II inserts dated December 1991.

Existing Volume III of III

- ☐ Relocate contents of existing Attachment 10 to new Attachment 8 in Volume II. Include new cover sheet.
- ☐ Remove the entire contents of existing Attachment 11 (Environmental Assessment of Properties Surrounding Facility) and discard.
- ☐ Relocate contents of existing Attachment 12 to new Attachment 9 of Volume II. Include new cover sheet. Replace existing Tracer Research Corporation Soil-Gas Report with December 1991 Revision.
- ☐ Discard attachment tab dividers 10, 11, and 12.
- ☐ Discard Volume III notebook.
- ☐ Volume II is now revised.

A Report Prepared for:

Sparton Technology, Inc.
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RCRA FACILITY INVESTIGATION
Sparton Technology, Inc.
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5. Groundwater Flow
6. *Unsaturated Zone Boring Logs and Analytical Data*
7. Off-Site Investigation
8. Description of Vicinity Wells
9. June 1991 Sampling and Analysis

I INTRODUCTION

This report presents the findings of a RCRA Facility Investigation (RFI) conducted at the Sparton Technology, Inc. (Sparton) facility located at 9621 Coors Road, NW, in Albuquerque, New Mexico.

This RFI was conducted under the conditions of an Administrative Order on Consent entered into by Sparton and the U.S. Environmental Protection Agency (EPA) which became effective October 1, 1988. This report is being submitted in accordance with the provisions of that Consent Order.

II BACKGROUND

The Sparton facility is sited on an approximate 12-acre parcel of land located on the northwest side of Albuquerque, on State Highway 448, known locally as Coors Road, approximately 0.75 miles north of the intersection of Coors Road and Paseo del Norte (See Figure 1).

The Sparton facility began operation in 1961, and since that time has been engaged in the manufacture of electronic components, including printed circuit boards. The manufacturing process generates two waste streams which are managed as hazardous wastes: an aqueous metal plating waste, and a solvent waste stream. The plating wastes were stored in an in-ground concrete basin until approximately 1975. This basin was replaced by a lined surface impoundment in 1975, termed the "West Pond". A second lined surface impoundment was installed circa 1977. This pond was termed the "East Pond". Accumulated wastewater was periodically removed from the ponds via vacuum truck for off-site disposal at a permitted facility. Figure 2 shows the facility layout.

After the installation of the East Pond, the West Pond was not used again until January 1981. At that time, the West Pond was refurbished by providing a new liner and by constructing concrete sidewalls for liner support. From 1981 through August 1983, use of the two ponds was alternated so that each pond could be regularly inspected. No significant liner damage was identified during any of these inspections. In August 1983,

FIGURE 1

SITE LOCATION MAP

FIGURE 2

FACILITY LAYOUT

Sparton ceased discharging to either pond and removed the plating wastes which were in the ponds at that time. The ponds have not been used since that time. Plating wastes are currently stored in drums in an on-site "less than 90 day" storage facility prior to shipment to a permitted off-site disposal facility.

Waste solvents were accumulated in an on-site concrete sump and allowed to evaporate. Use of this sump was discontinued in 1980, at which time Sparton began to store the waste solvents in drums prior to off-site disposal at a permitted facility.

In 1983, several groundwater monitoring wells were installed around the pond and sump area to determine whether there had been a release of hazardous constituents from the ponds or the sump. Analytical results from groundwater samples taken from these wells indicated concentrations of several constituents above state standards.

Since this initial finding in 1983, investigation of the nature and extent of the contamination continued through 1987. During this period, Sparton worked closely with the New Mexico Environmental Improvement Division (EID). Also during this period, the ponds were closed, and the entire pond and sump area was capped under a state-approved closure plan. In 1987, when it became apparent that contaminants had migrated beyond facility boundaries, the EPA commenced negotiations with Sparton to develop an Administrative Order on Consent. This Order was signed and became effective on October 1, 1988. Under the provisions of this order, in early 1989 Sparton completed the installation and start-up of an interim groundwater recovery well system to begin removal

of contaminants from the more concentrated areas of the contaminant plume in the upper flow zone.

Since 1983, the results of the ongoing investigation have been published in a number of reports, copies of which have been previously furnished to EPA and EID. A list of these reports is included in Figure 3.

The remainder of this RFI report will summarize the findings of the RCRA Facility Investigation, drawing on information from previous reports where appropriate for needed detail. The purpose of the RCRA Facility Investigation is to develop the information needed to support a Corrective Measures Study.

FIGURE 3

SUMMARY OF PREVIOUSLY PUBLISHED REPORTS

Date of Publication	Report Title
6/29/83	Groundwater Monitoring Program, Sparton Southwest, Inc., 9261 Coors Road, North-west, Albuquerque, New Mexico 87114; Harding Lawson Associates
3/19/84	Investigation of Soil and Groundwater Contamination, Sparton Technology, Inc., Coors Road Facility, Albuquerque, New Mexico; Harding Lawson Associates
3/13/85	Hydrogeologic Characterization and Remedial Investigation, Sparton Technology, Inc., 9621 Coors Road, Northwest, Albuquerque, New Mexico 87114; Harding Lawson Associates
6/30/86	Soil Investigation of the Unsaturated and Upper Saturated Zones, Sparton Technology, Inc., Coors Road Plant, Albuquerque, New Mexico; Harding Lawson Associates
7/15/86 (Rev. 9/22/86) (Rev. 10/3/86)	Vertical Profiling Program, Sparton Technology, Inc. Albuquerque, New Mexico; Harding Lawson Associates
4/87	Aquifer Testing, Sparton Technology, Inc., Coors Road Plant, Albuquerque, New Mexico; Metric Corporation
7/23/87	Corrective Measures Study Report, Sparton Technology, Inc., Coors Road Plant, Albuquerque, New Mexico; Harding Lawson Associates
10/19/87	Off-Site Investigation, Sparton Technology, Inc., Coors Road Plant, Albuquerque, New Mexico; Harding Lawson Associates
5/88	*Aquifer Testing, Sparton Technology, Inc., Coors Road Plant, Albuquerque, New Mexico; Metric Corporation*

FIGURE 3

SUMMARY OF PREVIOUSLY PUBLISHED REPORTS (Continued)

Date of Publication	Report Title
11/18/88	*Aquifer Testing, Sparton Technology, Inc., Coors Road Plant, Albuquerque, New Mexico; Metric Corporation*
10/26/89 (Revised 2/23/90)	*Effectiveness of the Groundwater Recovery Well System, Coors Road Facility, Albuquerque, New Mexico; Harding Lawson Associates*
12/27/89	*Preliminary Environmental Assessment-Properties Surrounding Sparton Technology, Inc., 9621 Coors Road, N.W., Albuquerque, New Mexico; Harding Lawson Associates*
7/6/90	*Areal Extent of the Zones of Relatively Lower Permeability; Sparton Technology, Inc., 9621 Coors Road, N.W., Albuquerque, New Mexico; Harding Lawson Associates*

III SOURCE CHARACTERIZATION

A. Description of Ponds and Sump

The pond and sump area at the Coors Road facility is believed to be the source of soil and groundwater contamination at the site. The pond and sump area is located on the north side of the main building (See Figure 2).

The East and West ponds were used to store aqueous plating wastes from the process areas. Some evaporation took place from the ponds, but the aqueous wastes were routinely removed on an approximate monthly basis and shipped off-site to a permitted disposal facility.

The location of the ponds, or surface impoundments, is shown in Figure 2. Each of these two adjacent ponds was approximately 19 feet by 28 feet in surface dimension, and approximately 5 to 6 feet deep. The top of each pond was flush with the ground surface. The ponds had vertical concrete walls and a natural sand bottom. The ponds and the area between the ponds were lined with a 30-mil, two-ply Hypalon^{R} membrane, and a one-ply, polyester, scrim liner. A sloped sand backfill within the concrete walls provided support for the liner.

The solvent storage sump was located near the ponds (See Figure 2). The sump was constructed of concrete blocks, and measured approximately 5 feet by 5 feet in surface dimension by 2 feet deep. This sump was used for storage of waste chlorinated and nonchlorinated solvents.

As described earlier, the ponds were used from approximately 1961 until August 1983, at which time discharge to the ponds ceased, and the ponds were emptied. The sump was originally closed in October 1980 by removing the remaining wastes and filling the sump with sand. Final pond and sump area closure was conducted in December 1986 under a State-approved closure plan. This closure consisted of backfilling the ponds, and the construction of an asphaltic concrete cap over the entire area to divert rainfall and surface water runon, thus minimizing infiltration of surface water into the ground in this area (See Figure 4).

B. Waste Description

The wastes which were stored in the pond and sump area are typical of electronic manufacturing facilities. The waste stream stored in the ponds was an aqueous stream from the metal plating process which contained a variety of metal ions. The sump was used to store a mixture of waste solvents from process and degreasing operations. Historical analyses of the contents of either the ponds or sump are not available, however the predominant constituents can be inferred from the groundwater analyses. Groundwater analyses were first conducted in 1983, and in 1985, routine quarterly analyses were instituted under a State-approved program for a number of on-site monitoring wells. Results from these analyses are summarized in Attachment 1.

Based on these historical groundwater analyses, the primary hazardous constituents appear to include trichloroethylene (TCE) and 1,1,1-trichloroethane (TCA), with lesser

FIGURE 4

LAYOUT SHOWING CAP OVER POND & SUMP AREA

amounts of methylene chloride (MeCl) and 1,1-dichloroethylene (DCE). Physical, chemical, and toxicological characteristics of these chemicals are presented in Attachment 2. Based on these analytical results from groundwater samples taken from on-site monitoring wells, it is apparent that the contaminant release originated primarily from the solvent storage sump.

Free-phase solvents have not been identified in the sub-surface at the Sparton site. However, the historical maximum concentrations detected in groundwater on site and given in Figure 5 are approximately four percent of the solubility limit. Groundwater concentrations of approximately one percent of the solubility limit may indicate the presence of free-phase compounds. All of the chlorinated organic compounds identified at this site are denser than water and, if present in free-phase, would sink to the bottom of the water column.

Various metals have been detected in both soil and groundwater samples. Historically, chromium has the highest frequency of occurrence at elevated concentration.

FIGURE 5

SOLUBILITY DATA

[---------- Solubility, mg/l ----------]				
Parameter	Hazardline	MSDSs	Lange's Handbook of Chemistry	Historical Maximum Concentration @ MW-16, mg/l
TCE	1000 @ 68°F	1100 @ 77°F	1000 @ 77°F	37
TCA	700 @ 68°F	900 @ 68°F	----	30
MeCl	----	13,800 @ 68°F	20,000 @ 68°F	49
DCE	2250 @ 77°F	----	----	3.5

C. Fate and Transport *of Volatile Organic Compounds*

Previous analytical work has established the presence of volatile organic compounds (VOC) in the subsurface. The identified compounds are classified as halogenated nonaromatic, aliphatic compounds. These compounds include TCE, TCA, MeCl and DCE. These compounds have been observed in the vapor phase, absorbed in the soil matrix, and dissolved in the groundwater. Considering the hydrogeologic conditions present at the site, it is anticipated that the fate and transport of these compounds will be influenced by both physical and chemical processes occurring in both the saturated and unsaturated zones.

1. Physical Processes - Saturated Zone

Due to the heterogeneous conditions in the saturated zone, fate and transport of the organic compounds will be affected by physical processes including advection, dispersion, and molecular diffusion. Advection is the transport of a constituent at the average groundwater particle velocity. The advection mechanism will dominate in cleaner sands and gravels (more porous structure) where the groundwater particle velocity is relatively higher. Advection will be primarily a horizontal phenomenon due to the anisotropic conditions caused by the horizontal geologic bedding structure. Advection will tend to elongate or extend the contaminant plume in a downgradient (hydraulic) direction from the source area. Advective processes will be slowed down or retarded by chemical processes affecting the plume.

Mechanical dispersion will occur as a result of velocity variation within the soil pore structure. Dispersion will impact the advection component and also result in lateral or transverse spreading of the plume.

Molecular diffusion will predominate in the low-permeability silt and clay layers and in those areas to the west where groundwater velocity is significantly reduced. Molecular diffusion will be controlled by concentration gradients and the tortuosity of the porous media.

2. Chemical Processes - Saturated Zone

For the volatile organic compounds identified at this site, chemical processes affecting their fate and transport in the saturated zone will include hydrolysis, sorption, volatilization and dissolution, and biodegradation.

Hydrolysis is the direct reaction of dissolved compounds with water molecules and can be an important abiotic degradation process for the identified compounds. Hydrolysis of TCE and TCA to DCE, and then to vinyl chloride (VC), is well documented in the literature. In addition, the presence of metal chloride catalysts in the subsurface can also result in the hydrolytic formation of organic acids.

Sorption is a generic description for both adsorption to the solid surfaces and absorption or penetration of the chemical compound into the solids. For the non-polar volatile organic compounds (VOC) present at this site, sorption will be essentially an equilibrium partitioning process between the dissolved aqueous phase and the porous

media. The sandy/gravelly materials will offer little in the way of sorptive surfaces or materials while silts and clays--particularly those containing any organic material--will provide a rich sorptive environment. Only a small percentage of silts and clays and/or organic materials can result in a significant amount of chemical sorption. The relative sorption potential for organics is given by the organic carbon partition coefficient, Koc, which is the ratio of the amount of chemical absorbed per unit weight of organic carbon to the chemical concentration in solution at equilibrium. Higher values of Koc indicate a higher sorption potential and tendency to bioaccumulate. Conversely a lower Koc indicates a higher mobility in the subsurface. Koc values for the identified compounds indicate relatively high mobility with low to moderate sorption.

Volatilization and/or dissolution from the aqueous phase is another chemical process affecting fate and transport. Henry's Law describes solution/vapor equilibrium for the VOC present at the site. Henry's Law constants, which combine the effect of vapor pressure with solubility and molecular weight, can be used to evaluate the effects of chemical volatility on aqueous phase fate and transport. Due to the low groundwater velocities, the gas-porous nature of the subsurface, and Henry's Law constants for the identified VOC, volatilization and/or dissolution from the aqueous phase is anticipated to be a significant fate and transport process.

The final chemical process is biodegradation. Significant documentation exists to show that chlorinated compounds present at this site such as TCE and TCA can be biologically reduced under both aerobic and anaerobic conditions. Anaerobic conditions

would include both sulfate reducing and methanogenic microorganisms. Biodegradation of the organic compounds identified on site *can* produce vinyl chloride, *carbon dioxide, hydrogen chloride, chlorine, acetic acid, chloroethane, and/or biomass*. It should be noted that the product vinyl chloride will be very persistent under anaerobic conditions but can be rapidly degraded under aerobic conditions.

3. Unsaturated Zone Processes

Fate and transport in the unsaturated (vadose) zone will be controlled by similar processes to those previously discussed. Sorption will probably be a significant process. The vadose zone generally contains greater amounts of organic materials and at this site the vadose zone contains significantly more clay and silt materials. Biodegradation may also be a major process in fate and transport. Microbial activity is generally much greater in the vadose zone than below the water table. Accordingly increased biodegradation is expected.

Due to the porous nature of the subsurface and wind and temperature effects, volatilization is the other significant process affecting fate and transport. Volatilization into a subsurface vapor phase (soil gas) with subsequent diffusion into the subsurface pore structure and/or dispersion into the atmosphere are anticipated to be occurring. The vertical soil gas profile will be a function of vapor density and source quantity. The horizontal soil gas extent will be controlled by the aqueous plume limits.

D. Fate and Transport of Metals

Fate and transport of metals, and particularly chromium, in both soil and groundwater will be controlled by sorption, chelation, and redox reactions. The mobility of chromium is strongly influenced by its oxidation state (valence) and/or ionic presence as chromate, etc. Sorption will predominate in fine-grained soils--particularly clays. Chromium is relatively insoluble in the metallic form; however, anions such as chromate are highly soluble. In addition, the chromate anion is readily soluble in, and mobile with, chlorinated solvents. As a result, chromium will be linked to the fate and transport of the VOC as discussed in previous sections.

IV ENVIRONMENTAL SETTING

A. Regional

1. Physiography

The Sparton Technology facility is centrally located within the Albuquerque Basin of central New Mexico. The basin is approximately 102 miles long (north-south) and 25 to 40 miles wide (east-west). The Albuquerque Basin is in the middle part of the Rio Grande Valley which extends through the length of New Mexico (see Figure 6).

On the east flank of the Rio Grande are the Sandia and Manzano Mountains. Sandia Peak has an approximate elevation of 10,700 feet mean sea level (MSL). Sloping westward towards the river, pediments, bajada deposits, and terraces are located at the base of the mountain ranges. The elevation of the Rio Grande is approximately 4990 feet MSL in the vicinity of the site. The site is situated on the edge of a terrace next to the river flood plain at about elevation 5050 feet MSL. West of the facility, the elevation increases to about 5300 feet MSL. Southwest of this mesa-like topography are gentle, even slopes which are remnant volcanic flow areas.

FIGURE 6

LOCATION OF ALBUQUERQUE BASIN

2. Geology/Hydrogeology

a. Stratigraphy

The basin fill is estimated to be approximately 18,000 feet thick along the axis with sediment thickness varying throughout the basin boundaries. A generalized description of the sediments in the basin is presented in ascending order by age as follows:

(1) The Precambrian bedrock is overlain by Paleozoic and Mesozoic age sedimentary rocks which are comprised primarily of sandstones, shales, and marine limestones. The upper section consists mainly of continental and marine shale, and of sandstone with some gypsum, coal, and conglomerate. Both Paleozoic and Mesozoic rocks outcrop east of Albuquerque in the Sandia and Manzano Mountains. Only Mesozoic age rocks outcrop to the west in the Rio Puerco Valley.

(2) Sedimentary rocks of the Tertiary and Quaternary age sequence unconformably overlie the rocks of pre-Tertiary age. They are generally composed of unconsolidated to loosely consolidated fluvial deposits of gravel, sand, and silt interbedded with some volcanic basalts and tuffs.

(3) The Galisteo Formation consists of Eocene and Oligocene(?) age beds of variegated sandstone, sand, clay, shale, minor amounts of conglomerate, tuff, and limestone.

(4) The Miocene-Pliocene basin fill consists of up to 12,000 feet of sandstone, mudstone, and gravel of the Santa Fe Formation or Group. Facies changes of the Santa Fe occur throughout the area and are, in some cases, divided into different units within the Santa Fe Formation. The Santa Fe Group is divided into two formations, both of which underlie the surficial deposits in the Rio Grande Valley. Before the Santa Fe was raised from formation to group status, Bryan and McCann (1937) had divided it into three members -- the Lower Gray, the Middle Red, and the Upper Buff. The units within the Santa Fe Formation were later reclassified as the Ceja Member (upper Pliocene), Middle Red Member (Pliocene), and the Zia Member (Miocene). All units are overlain by the Pleistocene age Ortiz gravel, (Kelly 1977).

The units of the Santa Fe Group in the Albuquerque area are lenticular, faulted, folded, and generally discontinuous in outcrops. Therefore, it is difficult to correlate these units with recognized units of the Santa Fe Group in other areas. The lithology of the Santa Fe Group can be described as unconsolidated to loosely consolidated sediments and interbedded volcanic rocks ranging in size from boulders to clay particles. In the Albuquerque area, the Santa Fe Group east of the Rio Grande Valley and adjacent to the Sandia and Manzano Mountains consists of feldspar and quartz fragments eroded from these mountains. West of the Rio Grande Valley in the Albuquerque area, sediments consist chiefly of fine-grained sand, silt, and clay. The central portion of Albuquerque Basin consists of sediments derived from the Sandia and Manzano Mountains, western highlands, and erosion of the highlands farther north.

On the eastern edge of the Rio Grande Valley in the Albuquerque Basin, the series of confluent alluvial fans at the base of the mountain range, also known as bajada deposits, are derived from the Sandia and Manzano Mountains and unconformably overlie the Santa Fe Group. These sediments are of Recent age and range from poorly sorted mud flow material to well sorted stream gravel. The bajada deposits can be lithologically described as mostly arkosic derived from granite rocks in the mountains. The bajada deposits in this area range in thickness from 0 - 200 feet and are thickest toward the east edge of the Albuquerque Basin.

Recent age alluvial sediments underlie the Rio Grande floodplain and its tributaries. The Recent age alluvium and the sediments of the underlying Santa Fe Group

can be differentiated in well cuttings. The unit contact usually occurs approximately 80 to 120 feet below the land surface. A change in lithology and unit consolidation is a major indication of the top of the Santa Fe Group and the bottom of the alluvium which is estimated to be considerably less than 200 feet thick. The thickest accumulations of alluvium occur in fans extending from tributary valleys into the main valley. Thinner accumulations are found in the tributary valleys.

b. Structural

The Sparton facility is located in the Rio Grande Rift system. This system trends north-south and is comprised of a series of fault blocked horst and graben structures. The Albuquerque Basin is situated in the Rio Grande Valley and is formed by a compound graben. The eastern border of the depression is formed by the upfaulted blocks of the Sandia and Manzano Mountains. The Albuquerque Basin is bounded on the west by the Colorado Plateau and the southern end of the Nacimiento uplift (see Figure 7). Rocks of the Santa Fe Group cover most the exposed faults. Some exposed faults appear to be en echelon but cannot be determined with certainty in some areas. Approximately 2.5 miles northwest of the Sparton facility is a fault scarp in the rocks of the Santa Fe Group that can be traced to within approximately one mile north of Arroyo de las Calabacillas. The fault does not displace a basalt flow southwest of the arroyo. The

FIGURE 7

TECTONIC MAP OF RIO GRANDE RIFT SYSTEM

downthrown side of the fault is located on the west side of the scarp. Other indications of faults, active or inactive, are not evident at this time.

c. Depositional History

The sedimentary rocks of the Rio Grande Valley area are of marine and continental origin and are underlain by crystalline rocks which were intruded, deformed, and eroded before Cambrian time. This region was reduced to a nearly flat broad undulating plain in the late Precambrian and early Paleozoic. This allowed the transgression of the epicontinental seas. From early Pennsylvanian to late Permian, alternating transgressions and regressions of shallow seas deposited 2,000 to 5,000 feet of sandstone, siltstone, limestone, and evaporites.

A major regression during most of the Mesozoic Era formed erosional sediments of continental origin. Sediments consisting of continental sandstones and shales were deposited during the Triassic, Jurassic, and early Cretaceous. During the late Cretaceous period, a major transgression covered the region and marine sandstone and shale were deposited. This was followed by uplift and erosion of the region in the early Tertiary period. During the early Tertiary and Eocene time, local basins in the Albuquerque area were filled with sandstone and shale creating the Galisteo Formation.

The Santa Fe Group which overlies the Galisteo Formation and underlies bajada deposits and Recent alluvium, was initially formed in the middle Miocene. Subsidence of the Rio Grande depression was simultaneously occurring with the formation of the Santa Fe Group, uplift of the western highlands, and the Sandia and Manzano

Mountains. Tectonic activity in this area increased erosional activity and filled the Rio Grande depression with sediments.

Drainage during most of the Miocene probably was into a closed basin (Wright, 1956, p. 390). By the close of the Miocene, drainage had become integrated and the ancestral Rio Grande developed as a through flowing stream. By the end of Pleistocene time, the Rio Grande was established near its present course but several hundred feet higher. Rejuvenation of the river in Pleistocene time resulted in downcutting to a depth about 120 feet below the present valley floor. Several cut terraces were developed on the valley fill above the present valley floor. Aggradation, which began after downcutting, has partially refilled the inner valley and is continuing today.

d. Water Levels/Seasonal Changes

Regional water table fluctuations occur as water is added to or withdrawn from the groundwater reservoir in the Albuquerque area. Long term water level declines may be attributed to heavy pumping from industrial and municipal wells in the Albuquerque area. The water table in the Albuquerque area will maintain a consistently lower level than the surrounding water table as long as the water demand remains the same. Deficient rainfall for long periods of time will also affect the water level on a long term basis.

Seasonal fluctuations are due to heavy precipitation and irrigation by surface water diverted from streams which tends to raise the water table. High water levels occur during the summer months in the inner valley when land is irrigated by water diverted from

the Rio Grande or where inundation by flood runoff is common. The lowest water levels in the area typically occur in the early spring before the first application of irrigation water. Fluctuations of water levels are quite consistent from year to year in areas where diverted river water is used for irrigation and where drains have been constructed.

e. Groundwater Flow Direction

The shape and slope of the water table throughout the valley fill, in most instances, is not uniformly planate. The irregularities in the surface occur as a result of lithologic facies changes which directly affect permeabilities and saturated thickness. This may cause mounding, coning, or troughing with the addition or withdrawal of water. The shape and slope of the groundwater is also affected by groundwater pumping in limited areas. The numerous water wells located at the intersection of Interstates 25 and 40 in Albuquerque and within 5 miles north and south of this location have a significant affect on the groundwater table. It is estimated that the water table has declined 40 feet in the last 50 years in this area. However, the influence that these wells have on the water table does not extend to the region around the Sparton facility. Groundwater pumping does not affect the water table in this area because large municipal and industrial wells are infrequent and widely spaced as seen on Figure 8. Map index numbers given on this figure are keyed to water well information detailed in Attachment 10.

The water table within the valley fill generally slopes southwestward at a low gradient diagonally down valley from the western bases of the Sandia and Manzano

FIGURE 8

WELL LOCATION MAP

Mountains. This southwestward slope is approximately 5 to 20 feet per mile with an increasingly steeper gradient near the mountain fronts. The water table becomes almost flat where the base of the Sandia and Manzano Mountains is 5 to 10 miles from the valley floor.

From the eastern side of the Rio Puerco, west of the Rio Grande, there is a southward trending zone approximately 8 miles wide, where the water table is lower than the water surface of the Rio Grande as shown on Figure 9. This zone hereafter will be referred to as the "groundwater trough" or simply "the trough." It extends from north to south, through the western half of the Albuquerque Metropolitan area, and coincides with the Rio Grande at some point downstream in Valencia County (F.B. Titus, U.S. Geological Survey, Oral Communication, 1960).

The regional groundwater movement is generally to the southwest. Groundwater movement from the Sandia and Manzano Mountains moves in a southwesterly direction and groundwater movement east of the groundwater trough and west of the Rio Grande is also in the southwestward direction. Groundwater flow between the groundwater trough and the Rio Puerco is eastward to southeastward.

The water table beneath the floor of the inner valley slopes approximately the same as the downstream slope of the Rio Grande. The water table is at or very close to the surface under the river channel. Near the Rio Grande, the water table slopes sharply toward drains excavated on both sides of the river which are designed to lower groundwater levels so that adjacent acreage can be farmed. Water table levels associated

FIGURE 9

WATER LEVEL CONTOURS

with these drains are about 8 feet below average land levels nearby. Drains also steeply sharpen the slope of the water table beneath most of the inner valley.

The contour lines in Figure 9 show the configuration of the water table and the direction of movement of groundwater. The groundwater moves generally downgradient at right angles to these lines. The steeper slopes indicated by the contour lines on the map show a greater resistance to the movement of water within the aquifer or, in some places, a greater amount of recharge. The greater resistance probably is caused by a reduction in the thickness of the water bearing materials, as the sediments are similar to those in other areas to the south where the transmissivity is known to be high. Cones of depression are evident on the water table and are caused by pumping large quantities of water from municipal water supply wells in the area.

f. Regional Groundwater Volumes and Velocities

The groundwater gradient in the valley is approximately equal to that of the Rio Grande. If the average coefficient of transmissibility of the valley fill - which includes the Santa Fe Group and the Alluvium - is about 200,000 gallons per day (gpd) per foot, and if the permeable part of the fill is 20 miles wide, the quantity of groundwater moving into the area would be about 26,000,000 gpd, 41 cubic feet per second (cfs), or 18,000 gallons per minute (gpm). This figure is only approximate and does not indicate more than the general order of magnitude, because the value of the coefficient of transmissibility is an

estimate based on a number of scattered pumping tests and may be considerably different from the true average (L.J. Bjorklund, B. W. Maxwell, Technical Report No. 21).

g. Groundwater Recharge

The groundwater reservoir in the Albuquerque area is recharged from many sources which include precipitation, underflow of groundwater from adjacent areas, applied irrigation water, seepage from streams, springs, seeps, drains, and canals.

The ephemeral streams such as Rio Puerco, Jemez River, arroyos, and canyons contribute a large amount of recharge water to the groundwater reservoir.

Some of the water from most of the ephemeral streams is evaporated after the flow ceases, but much of it seeps into the underlying alluvium and Santa Fe Group. Small floods in the arroyos usually fail to reach the inner valley because the flow is lost to the underlying sediments.

The only perennial stream flow in the basin is that of the Rio Grande. Infiltration of water diverted from the Rio Grande for irrigation is the greatest source of recharge. Recharge from this source is limited to the valley floor. Water diverted from the Rio Grande seeps to the groundwater reservoir from canals, ditches, and fields, and usually causes the water levels in wells in the irrigated area to rise during the irrigation season.

Discharge from the groundwater reservoir in the Albuquerque area occurs by means of evapotranspiration, springs and seeps, drains, water wells, and as base flow of the Rio Grande. In the Albuquerque area, the Rio Grande generally loses, rather than

gains, water. The net effect of all of these discharge phenomena over a period of years on groundwater storage is negligible, and recharge is approximately equal to discharge under natural conditions.

B. Site-Specific

1. Site Topography

Numerous terraces were formed along the sides of the Rio Grande, Rio Puerco, and some of the larger tributary valleys during Quaternary channelling of the basin. Some terraces extend up to nearly 20 miles, whereas others are short and quite local. The Sparton facility is constructed on the eastern edge of a terrace approximately 60 feet (5050 MSL) above and 3,000 feet west of the Rio Grande (see Figure 10).

2. Geology/Hydrogeology

a. General

Several reports have been issued since 1983 describing various aspects of the site geologic and hydrogeologic regimes. Figure 3 lists the reports that contain logs of soil boring and well installation diagrams for soil borings and monitoring wells MW-1 through MW-33. Copies of these reports have been previously furnished to EPA. Figure 11 shows the locations of all on- and off-site groundwater monitoring wells. Attachment 4 includes copies of the logs of borings and well installation diagrams for wells completed after MW-33; specifically, MW-34 through MW-64 and PZ-1.

FIGURE 10

TOPOGRAPHIC FEATURES

FIGURE 11

MONITOR WELL LOCATION PLAN

b. Soil Characterization

The representative surface soil series at the Sparton facility is the Bluepoint Series. It is classified as belonging to the Family Mixed Thermic, the Subgroup Topic Torripsamments, and the Order Entisols. A combination of the Blue-point Series converges (see Figure 12) at the Sparton facility and includes the Bluepoint loamy fine sand (BCC), the Bluepoint fine sand, hummocky (Bb), and the Bluepoint-Kokan Association, hilly (BKD). These soils are described as SM and SM/SP, respectively, within the Unified Soil Classification System. This system further describes these soils as well to poorly graded gravelly sands, with little or no fines. A wide range in grain size and a substantial amount of all intermediate particle sizes can be found in most SW soils, whereas predominantly one size or a range of sizes with some intermediate sizes missing can be found in the SP soils.

In a representative profile of the Bluepoint series, the surface layer is pale brown loamy fine sand about 8 inches thick. The underlying material to a depth of 60 inches or more is pale brown and light yellowish brown loamy sand. The soil is slightly calcareous and mildly to moderately alkaline. Permeability is high and infiltration is rapid.

Effective rooting depth is 60 inches or more. Bluepoint soils are used for range, irrigated crops, watershed, wildlife habitat, and community development.

FIGURE 12

SOIL TYPES MAP

A representative soil profile of the Sparton facility is presented in the "Soil Survey of Bernalillo County and Parts of Sandoval and Valencia Counties, New Mexico." The three soil types which converge at the Sparton site can be described as follows.

The Bluepoint fine sand, hummocky (Bb), occurs near basalt flows on the piedmont, east of the Rio Puerco, and is a gently-rolling to rolling soil. The soil forms dunes of reworked sand 8 to 50 feet high with 5 to 15 percent slopes. The windward side is generally a deflation basin, and the leeward side is a low dune. The soil profile is similar to that described as the representative series, however, the surface texture differs.

The Bluepoint loamy fine sand, (BCC) is level to moderately sloping at 1 to 9 percent slopes. The soil profile is similar to that described as the representative series, however, about 10 percent of the surface layer acreage is sand.

The Bluepoint-Kokan Association, hilly (BKD) is composed of about 50 percent Bluepoint loamy fine sand that has 5 to 15 percent slopes and 40 percent Kokan gravelly sand that has 15 to 40 percent slopes. The Bluepoint soils are on fans between gravelly ridges of the hilly to steep Kokan soils that formed in old alluvial sand and gravel channels. The Kokan soil is found to have a high lime layer in the substratum.

Other characteristics used to further describe these soils include the relative permeability which ranges from 6.0 to greater than 40.0 inches per hour, and storage and available water capacity ranging from 0.03 to 0.09 inches per inch of soil. The pH of the soil ranges from 7.4 to 8.4 and has a salinity of 0-1 millimhos per centimeter at 25^0 C. Particle size distribution ranges from 0.074 mm to 2.0 mm with the greater size distribution

falling within the 2.0 mm to the 0.42 mm range. The Bluepoint soils are predominantly sandy with little or no clay fines and a low organic content. Therefore, the cation exchange capacity (CEC) is low.

c. Site Stratigraphy

The Sparton RCRA facility investigation area is situated within the Albuquerque Basin, a fault trough defined by Bryan (1938) as a component of the Rio Grande depression. Several structural benches are delineated within the basin; fault scarps striking north-south face the trough.

Geologic materials of the Albuquerque Basin are Precambrian to Holocene (Recent age). Outcrops of Precambrian, Paleozoic, and Mesozoic rock which preceded basin formation are essentially confined to the basin's east and west rims. The bulk of the basin fill, estimated to be as much as 18,000 feet in depth, is represented by the Santa Fe Group of Tertiary age overlain by Quaternary fill deposits. These deposits together comprise the local aquifer relevant to the Sparton RCRA facility investigation.

Kelley (1977) characterized the Santa Fe Group as three stratigraphic members; the lower Zia Sandstone Member, the middle Red Member, and the Ceja Member (uppermost part). Monitoring wells of the RCRA facility investigation area are estimated to be completed above the top of the Ceja Member. Lambert (1967, p.74) described the upper part of the Ceja as being "dominantly yellowish to grayish sandy pebble gravel and pebbly sand with lesser amounts of interbedded clay, mud, and sand".

Kelley (1977, p.18) described the lithology of the Ceja Member as quite variable, with the gravel being the principal characterizing aspect.

As described by Spiegel and Baldwin (1963) the upper Santa Fe Group (Ceja) is characterized by intertonguing pediment (alluvial fan) and axial river (fluvial) deposits. Basin aggradation during Ceja time was slower than early Santa Fe time because tectonic activity had decreased. Ceja deposition ended about half a million years ago when initial entrenchment of the present Rio Grande occurred. Since that time, the basin has been primarily degradational, undergoing several more cycles of river valley incision producing the present day inner valley of the Rio Grande. The basin had been primarily aggradational during Santa Fe time.

Above the Ceja Member, Lambert (1967, Fig. 2) mapped cobble and pebble gravels resting on a lower part of a much larger and deeper inset of sands and muds termed Los Duranes which represents significant aggradation occurring in the major drainages during post-Ceja backfilling episodes. He concluded that these gravels are younger insets of inner valley terrace fills and described them as overbank river beds. Lambert originally designated the Los Duranes as a formation within the Santa Fe Group, based on its difference in lithology from the Ceja. Kelley (1977, p.19) believes this difference and the considerable erosion unconformity implied, is the principal reason for separating this gravel from the Ceja Member and the balance of the Santa Fe Group.

The Los Duranes Formation, according to Lambert (1967, p. 154), is a relatively thick sequence of clay, mud, sand, and gravel deposited by the Rio Grande. He

estimated the formation to be 300 to 400 feet thick, filling a broad valley cut into the Ceja Member of the Santa Fe Formation. The Los Duranes, as described by Lambert at exposed sections, consists of well-stratified sequences of alternating clay and sandy mud layers of overbank origin. Interbedded with these mud-clay sequences are channel deposits consisting of beds and lenses of pebbly sand and sandy pebble gravel. Gravel is much less abundant in the Los Duranes Formation than mud-clay or pebble sand. It occurs locally within the sand beds and as separate layers of up to 15 to 20 feet thick, according to Lambert. In driller's logs the Los Duranes is very difficult to differentiate from the Rio Grande Floodplain Alluvium (Lambert 1967, p. 160).

Floodplain alluvium of fine to medium sand and gravels overlies the Los Duranes Formation and interfingers with alluvial fans and aprons of Young alluvium. Owing to the difficulty of picking the contact between the alluvium and the Los Duranes, Lambert (1967, p. 213) estimates total thickness of the alluvium to be 120 to 130 feet. Bjorklund and Maxwell (1961) estimate the thickness at 80 to 120 feet.

Young alluvium occurs as alluvial fans and aprons at the Coors Road Plant site and to the west on terrace surfaces. It consists principally of muddy fine sand, with lesser amounts of sandy gravel and mud. These sediments are derived primarily from the Los Duranes and Ceja Formations and deposited by generally small east-flowing tributaries to the Rio Grande.

Figure 13 provides a characterization of site specific stratigraphy by section through the project vicinity. A plan view indicates the trace of the section which is

FIGURE 13

STRATIGRAPHIC SECTION

perpendicular to the Santa Fe Formation axis of deposition and parallel to the groundwater flow axis. Six monitoring wells located along section A-A' are completed in the Los Duranes Formation, above the Santa Fe Group. The basic lithology at each well boring is represented and illustrates the variability of thickness and lithologic occurrence in the formation.

Details from logs of borings made prior to the installation of monitor wells and piezometers have provided data for the construction of geologic cross-sections. Cross-section identification is presented in Figure 14. Figure 15 is a legend of geologic symbols which identify sediment types. Cross-sections A-A' through H-H' are presented in Figures 16 - 24. The stratification shown on these sections is based on boring log descriptions (classification) and may not represent correlatable geologic units and/or actual stratigraphy. However, these sections are useful to demonstrate the range and variability of subsurface conditions.

d. Project Hydrogeology

Previous reports for this project have used three flow zones to describe site-specific hydrogeology. These flow zones were identified as the upper, lower, and third flow zones. The lower flow zone was divided into two members; the upper lower flow zone and the lower lower flow zone. These flow zone divisions were based on stratigraphic and

FIGURE 14

CROSS-SECTION IDENTIFICATIONS

FIGURE 15

RELATIVE PERMEABILITY/SOIL CLASSIFICATION

FIGURE 16

SUBSURFACE PROFILE A-A[1]

TO VIEW THE MAP AND/OR MAPS WITH THIS DOCUMENT, PLEASE CALL THE HAZARDOUS WASTE BUREAU AT 505-476-6000 TO MAKE AN APPOINTMENT

FIGURE 17

SUBSURFACE PROFILE B-B[1]

FIGURE 18

SUBSURFACE PROFILE B-B^1 (EXPLODED VIEW)

FIGURE 19

SUBSURFACE PROFILE C-C[1]

FIGURE 20

SUBSURFACE PROFILE D-D[1]

FIGURE 21

SUBSURFACE PROFILE E-E[1]

FIGURE 22

SUBSURFACE PROFILE F-F[1]

FIGURE 23

SUBSURFACE PROFILE G-G[1]

FIGURE 24

SUBSURFACE PROFILE H-H[1]

potentiometric differences observed on site. However, as the investigation was expanded to a large area off site, the stratigraphic, and particularly the potentiometric, bases for these flow zone divisions were no longer encountered. All investigative work to date indicates that all of the referenced flow zones are hydraulically connected and constitute a single groundwater unit. However, due to the saturated thickness and the heterogeneous *nature* of this single groundwater unit, retention of the flow zone identification is very useful for vertical location purposes and assisting in three-dimensional description of the hydrogeology. For this reason and to maintain continuity with the previous reports and correspondence, the flow zone distinctions have been retained in this report.

An evaluation of the extent of interconnection of the upper and lower flow zones was conducted in late 1989 and the results were issued in a report titled "Areal Extent of the Zones of Relatively Lower Permeability" (*HLA, 1990*). This report evaluated the presence of various fine-grained layers at the facility. Review of well installations indicated that there was a noticeable potentiometric difference between wells set in the upper flow zone and the upper lower flow zone. A review of the logs of borings showed that the fine-grained layers or aquitards between these zones were composed of sediments ranging from clays to compacted silty sands, the latter of which is not typically thought of as an aquitard. Therefore, the term "zones of relatively lower permeability" (ZORLP) was used in place of the word "aquitard". The scale for classifying sediments or sediment groups was subjective and not based upon laboratory permeability tests. The nomenclature was used in an attempt to group sediment types for clearer understanding

of a complex subsurface regime. The ZORLP acronym is not intended to imply any level of effectiveness that a fine-grained layer may have to serve as a hydraulic barrier.

Conclusions of this report state that approximately 94% of the facility is underlain by the ZORLP. Areas where this unit is not present represent direct communication or interconnection of the flow zones. Additional details can be found in the ZORLP report.

The depth to groundwater varies from approximately 65 to 75 feet at the facility to approximately 200 feet in the hills to the west. On-site, groundwater elevation varies as much as two to three feet as a result of recharge from irrigated fields and the Corrales Main Canal. Potentiometric contour maps for the upper, upper lower, and lower lower flow zones have been prepared showing the effects of irrigation (highest water levels) and non-irrigation (lowest water levels). These maps are presented on Figures 25, 26, 27, 28, 29 and 30. The contour maps indicate a significant difference in piezometric elevation and gradient between the upper and lower flow zones on the north side of the facility. The noted difference corresponds to the presence and relative position of the ZORLP and suggests that the observed difference is the result of "perching" of the upper flow zone to the north of the facility. Over the remainder of the study area, piezometric levels and gradients are in good agreement. This agreement demonstrates the hydraulic continuity or interconnection between the designated flow zones and indicates that only a single shallow groundwater unit is present.

FIGURE 25

UPPER FLOW ZONE

HIGHEST WATER LEVEL CONTOURS

FIGURE 26

UPPER FLOW ZONE

LOWEST WATER LEVEL CONTOURS

FIGURE 27

UPPER LOWER FLOW ZONE

HIGHEST WATER LEVEL CONTOURS

FIGURE 28

UPPER LOWER FLOW ZONE

LOWEST WATER LEVEL CONTOURS

FIGURE 29

LOWER LOWER FLOW ZONE

HIGHEST WATER LEVEL CONTOURS

FIGURE 30

LOWER LOWER FLOW ZONE

LOWEST WATER LEVEL CONTOURS

To the west of Irving Boulevard, hydraulic gradients are relatively flat and vary from 1:350 to 1:780 in a generally westward direction. Under the Sparton facility, gradients range from 1:50 to the southwest in the upper flow zone to 1:200 to 1:350 to the northwest in the lower flow zone.

Based on the results of field work and interpretations of pumping tests and water level data, the following aquifer parameters have been calculated for the upper and lower flow zones at the Sparton site:

Upper Zone	Lower Zone
T = *150-3,000* gpd/ft	T = *12,000-19,000* gpd/ft
K = *0.007-0.014* cm/sec *15-300* gpd/ft^2	K = *0.009-0.013* cm/sec *200-275* gpd/ft^2
S = 0.10	S = 0.002
N = 0.25-0.40	N = 0.25-0.40

T = Transmissivity
K = Hydraulic Conductivity
S = Storativity (dimensionless)
N = Porosity (dimensionless)

No pump test data exist for the third flow zone.

Two major sediment types were encountered in borings at the Sparton facility. *These sediment types include clays and sandy muds interbedded with gravelly sands. The gravelly sands predominate in the upper and lower flow zones. Both* sediment types are found in every boring, however, correlation from boring to boring is not consistent because

the depositional environment changes vertically as well as horizontally. Even at cluster well locations, where borings are in close proximity, significant lithologic variation has been observed.

The third flow zone on-site has been encountered at the southwest corner of the facility in well boring MW-49. Between the lower flow zone and the third flow zone, a stratum of clayey sand is present from a depth of 120 feet to 129 feet. Silty sands with clay laminations underlie this *clayey sand* layer to a depth of 138 feet. Below 138 feet are medium- to coarse-grained sands and sandy gravels to a depth of 148 feet. Monitoring well MW-49 is screened from 138 to 148 feet. The difference in potentiometric head between the lower portion of the lower flow zone (MW-40) and the third flow zone is 0.14 feet under highest water conditions and 0.08 feet under lowest water conditions. MW-49 is the only third flow zone well on/ or off/site.

Off-site well locations are presented in Figure 11. Monitoring wells MW-34, 35, 36, 37, 47, 48, 50, 51, 52, 53, 54, 57, 58, 61, 62, 63, and PZ-1 are screened in the upper flow zone. Monitoring wells MW-44, 45, 46, 56, 59, 60 and 64 are screened in the upper lower flow zone. Monitoring well MW-55 is the only off-site well screened in the lower lower flow zone. No off-site wells are screened in the third flow zone. Logs of borings for these wells are presented in Attachment 4. Sediments encountered in all bore holes are consistent with regional descriptions. Of the five off-site well clusters that monitor the upper flow zone and the upper part of the lower flow zone, only cluster MW-37/45 had a clay layer at a depth of 137 feet to 138 feet *potentially* correlatable to an on-site clay

layer *(ZORLP)*. The absence of this clay layer *(ZORLP)* and comparison of piezometric data offsite indicate that the flow zones merge off-site and downgradient as *the on-site* clay layers pinch out. Groundwater potentiometric contour maps and presumed flow directions are presented on Figures 25, 26, 27, 28, 29, and 30.

Interpretations of hydraulic interconnections between flow zones are shown on potentiometric profiles located as shown on Figure 31. Profiles are shown on Figures 32, 33, 34, 35, 36 and 37. These profiles show the influence of the subsurface heterogeneity and anisotropy--particularly the gravelly layers and the horizontal structure. Due to the large variations in permeability resulting from the anisotropic and heterogeneous subsurface conditions, larger vertical hydraulic gradients depicted on the potentiometric profiles and contour maps reflect the hydraulic resistance to flow rather than the preferred direction of flow. There do not appear to be any significant vertical flow components.

FIGURE 31

KEY TO PROFILE LOCATIONS

FIGURE 32

POTENTIOMETRIC PROFILE

HIGHEST WATER LEVEL CONTOURS

SECTION A-A

FIGURE 33

POTENTIOMETRIC PROFILE

LOWEST WATER LEVEL CONTOURS

SECTION A-A

FIGURE 34

POTENTIOMETRIC PROFILE

HIGHEST WATER LEVEL CONTOURS

SECTION B-B

FIGURE 35

POTENTIOMETRIC PROFILE

LOWEST WATER LEVEL CONTOURS

SECTION B-B

FIGURE 36

POTENTIOMETRIC PROFILE

HIGHEST WATER LEVEL CONTOURS

SECTION C-C AND SECTION D-D

FIGURE 37

POTENTIOMETRIC PROFILE

LOWEST WATER LEVEL CONTOURS

SECTION C-C AND SECTION D-D

e. Summary of Recent Groundwater Levels and Flow Direction

Figure 25 is a water table contour map for the upper flow zone based upon November 13, 1990 data. This data is representative of highest groundwater conditions corresponding to the end of the irrigation (recharge) season. Figure 26 is a water table contour map for April 4, 1991 data. This data is representative of lowest groundwater conditions prior to the start of the irrigation season. Maximum water levels occur to the north of the Sparton facility. Gradients are generally to the southwest across the Sparton property. Between the facility and Irving Boulevard, the gradients are generally to the west and northwest. Beyond Irving Boulevard the gradients begin a gradual arc back to the established southwestward regional gradient. On a large scale, groundwater flow direction can be assumed to be normal to the potentiometric contours.

The high groundwater elevation to the north of the facility and the onsite contours show some correspondence to the ZORLP. Comparison of the upper flow zone data with lower flow zone data indicates probable "perching" of the upper flow zone groundwater on the ZORLP on the north side of the facility.

The effect of irrigation results in a two-to three-foot change in potentiometric elevation to the south of the facility. However, west of Irving Boulevard the potentiometric elevation is relatively unaffected.

Figures 27 and 28 are potentiometric contour maps for the upper lower flow zone for the highest and lowest water conditions respectively. Both maps indicate hydraulic gradients to the northwest with irrigation causing a two-foot increase in

piezometric elevation at the facility. At the northwest limit of the contours, season has little effect on level. Contours may show the effect of flow "channeling" in gravelly zones under Irving Boulevard.

Figures 29 and 30 are potentiomentric contour maps for the lower lower flow zone for the highest and lowest water conditions respectively. Although data for this zone is limited, the piezometric levels and gradient directions agree closely with the upper lower flow zone mappings.

It should be noted that, from Irving Boulevard west, piezometric levels and gradients of both upper and lower flow zones correspond closely. Confirmation of this correspondence can be seen on the potentiometric profiles given on Figures 32, 33, 34, 35, 36 and 37.

No gradient direction can be determined for the third flow zone as only one well has been set in that zone. However, based on the potentiometric equivalence to the lower lower flow zone well at the same location, the third flow zone is anticipated to have similar levels and gradients to the lower flow zone.

C. Surface Waters

Surface waters in the vicinity of the Sparton facility include the Rio Grande, Las Calabacillas Arroyo, and Corrales Main Canal. The Rio Grande is located approximately 3,000 feet east of the Sparton facility. Las Calabacillas Arroyo located approximately 2,800 feet north of the site is an intermittent stream. The Corrales Main Canal, a manmade

hydraulic structure, is located approximately 300 feet east of the site and contains flowing water (Rio Grande source water) eight months out of the year. The canal is used primarily for irrigation. It is put into operation about March 1, and taken out of operation about October 31. During the winter months, the canal is dry and only receives water from precipitation or snowfall.

The level of the Rio Grande through most of the Albuquerque area is controlled by levees which maintain the river level above the level of the inner valley floor and the surrounding water table. The natural buildup of sediment which raises the river level allows recharge of the water table through a downward movement. As the water table rises under the riverbed, the water spreads out to the surrounding water table.

The chemical quality of the Rio Grande is good. A typical analysis of surface water of the Rio Grande from samples taken at the Albuquerque gauging station located on the downstream side of the Central Avenue Bridge, made by the U.S.G.S., is shown on Figure 38.

FIGURE 38
RIO GRANDE CHEMICAL QUALITY ANALYSIS[1]

Dissolved Constituent	Concentration mg/L[2]
Calcium (Ca)	53.0
Magnesium (Mg)	9.7
Sodium (Na)	33.0
Potassium (K)	3.8
Sulfate (SO_4)	73.0
Chloride (Cl)	13.0
Fluoride (F)	0.40
Silica (Sio_2)	22.0
Total Dissolved Solid (TDS)	298
Nitrogen NO2+NO3 (N)	<0.100
Phosphorous (P)	0.020
Boron (B)	0.080
Iron (Fe)	0.010
Arsenic (As)	0.004
Cadmium (Cd)	0.001
Chromium (Cr)	<0.001
Copper (Cu)	0.004
Lead (Pb)	<0.005
Mercury (Hg)	<0.0001
Selenium (Se)	<0.0001
Zinc (Zn)	0.005

FIGURE 38
RIO GRANDE CHEMICAL QUALITY ANALYSIS[1]
(Continued)

Chemical Quality Indicators	Concentrations
Specific Conductance	470 us/cm[3]
pH	8.46 standard units
Temperatures	16.0 °C[4]
Dissolved Oxygen	8.3 mg/l
Total Hardness ($CaCO_3$)	170 mg/l

(1) Analysis performed for samples taken on November 7, 1988
(2) mg/L = milligrams per liter
(3) us/cm = microsiemers per centimeter
(4) °C = degrees celsius

The average annual suspended sediment load for the Rio Grande in water year October 1988 to September 1989 was approximately 454 tons per day, with a maximum daily load of 13,900 tons on August 2 and a minimum daily of 7.9 tons on June 9.

The Rio Grande serves as the source water for the Corrales Main Canal. Therefore, the water quality of the Canal should be similar to that of the Rio Grande. The Corrales Riverside Drain is constructed approximately 200 feet west of the Rio Grande and approximately 2,800 feet east of the Sparton facility. The Corrales Main Canal is located approximately 300 feet east of the Sparton facility. The Corrales Riverside Drain was constructed to lower the water table in the floodplain area adjacent to the river so that it could be farmed. A section of the topographic map locating these features is shown in Figure 39.

D. Climate

Albuquerque is located in Bernalillo County. The Rio Grande flows southward through the county, which is in the central part of New Mexico. The land rises on both sides of the river and forms mesas that have elevations of about 5,000 feet. The valley and mesa areas are arid, having average annual precipitation near eight inches.

Summer is the rainy season. Half the annual precipitation falls during the period from July to October, typically as brief but often heavy thunderstorms. An average of 44 such storms occur each year, mostly during this period. Moisture is supplied by the generally

FIGURE 39

MAN-MADE HYDRAULIC STRUCTURES

southeasterly circulation of moist air over the Gulf of Mexico from the Bermuda high pressure area, which shifts westward in summer. Winter precipitation is light because much of the moisture from storms over the Pacific Ocean falls over the mountains west of New Mexico as the storms move eastward.

There is considerable variation in precipitation from year to year and from month to month. The average number of days having 0.10 inch or more precipitation is 22.

The average annual temperature in Albuquerque is 57°F. The highest recorded temperature is 104°F, and the lowest recorded temperature is -17°F. The temperature reaches 90 on an average of 75 days a year, and freezing temperatures occur on an average of 105 days a year. The average frost-free season at Albuquerque is 190 days, from mid-April to late October.

Average annual relative humidity in Albuquerque is 43 percent, but ranges from near 60 percent early in the morning to nearly 30 percent in the afternoon. Sunshine occurs more than 75 percent of the possible hours, and is fairly evenly distributed in all seasons.

The average annual windspeed is 9 miles per hour. Spring is the windy season. Winds blow most frequently from the north in winter, and from the south along the river valley in summer. In Tijeras Canyon, the heavy cold air held back by the Sandia and Manzano Mountains finds access to the basin area and literally pours through the Canyon, spreading out on the mesa and valley below in gusts of up to 50 miles per hour.

Figure 40 shows annual patterns of precipitation, temperature, and wind speed and direction in Albuquerque.

FIGURE 40
ALBUQUERQUE CLIMATOLOGICAL PATTERNS

Month	Temperature, degree F			avg. total precipitation inches	avg. speed m.p.h.	Prevailing Direction
	avg. daily max	avg. daily min	daily mean			
January	47	24	35	0.31	8.0	N
February	53	27	40	0.40	8.8	N
March	59	32	46	0.47	10.1	SE
April	70	41	56	0.47	11.0	S
May	80	51	65	0.56	10.5	S
June	89	60	75	0.53	10.0	S
July	92	65	79	1.37	9.1	SE
August	90	63	77	1.38	8.2	SE
September	83	57	70	0.83	8.6	SE
October	72	45	58	0.78	8.3	SE
November	57	32	44	0.34	7.9	N
December	48	25	37	0.52	7.7	N

V CONTAMINATION CHARACTERIZATION

A. Soil Contamination

1. Vadose Zone Investigation

An investigation of the vadose zone beneath the pond and sump area was conducted in September 1985. The results of this investigation were published in a report titled "Soil Investigation of the Unsaturated and Upper Saturated Zones, Sparton Technology, Inc., Coors Road Plant, Albuquerque, New Mexico" *(HLA, 1986)*. A copy of *the boring logs and analytical results from that report are included as Attachment 6.*

The results of PID field screening during drilling, surface soil gas screening, and analytical testing of soil samples indicate that contaminants migrated downward from the ponds and sump. The vertical migration was influenced by the relative location of fine grained silt and/or clay lenses and the presence of more porous course-grained sand and gravel layers. Interpretation of the results indicates both sorption and lateral spreading occurred due to the silt/clay. However, based on *available* results, the bulk of the contaminant release has completed its migration to the water table, leaving behind only scattered residual levels in the vadose zone in the pond and sump area.

a. Volatile Organic Constituents

Soil gas screening indicated a general increase in soil gas VOC concentrations with depth with the highest concentrations observed under the sump/pond

area. Isolated occurrences of higher soil gas concentrations were also observed at depths corresponding to fine-grained clay/silt lenses. These localized soil gas concentrations are believed to be related to residual VOC sorbed onto the finer-grained soil materials.

To identify residual concentration in the soil, total organic halogen (TOX) determinations were conducted on 126 soil samples using a modified Test Method 9020 procedure. The detection limit for this modified 9020 procedure was 2 milligrams per kilogram (mg/kg). Positive TOX detections were obtained in 21 of the soil samples from a total of 7 borings. Samples with positive TOX detections were also tested for target VOC previously identified in groundwater at the site. Target VOC concentrations were determined using Method 8010. However, the 8010 analyses confirmed the TOX analysis in only six of the samples representing three soil borings (B-5, B-7, and B-8) in the sump/pond area.

b. Total Metals

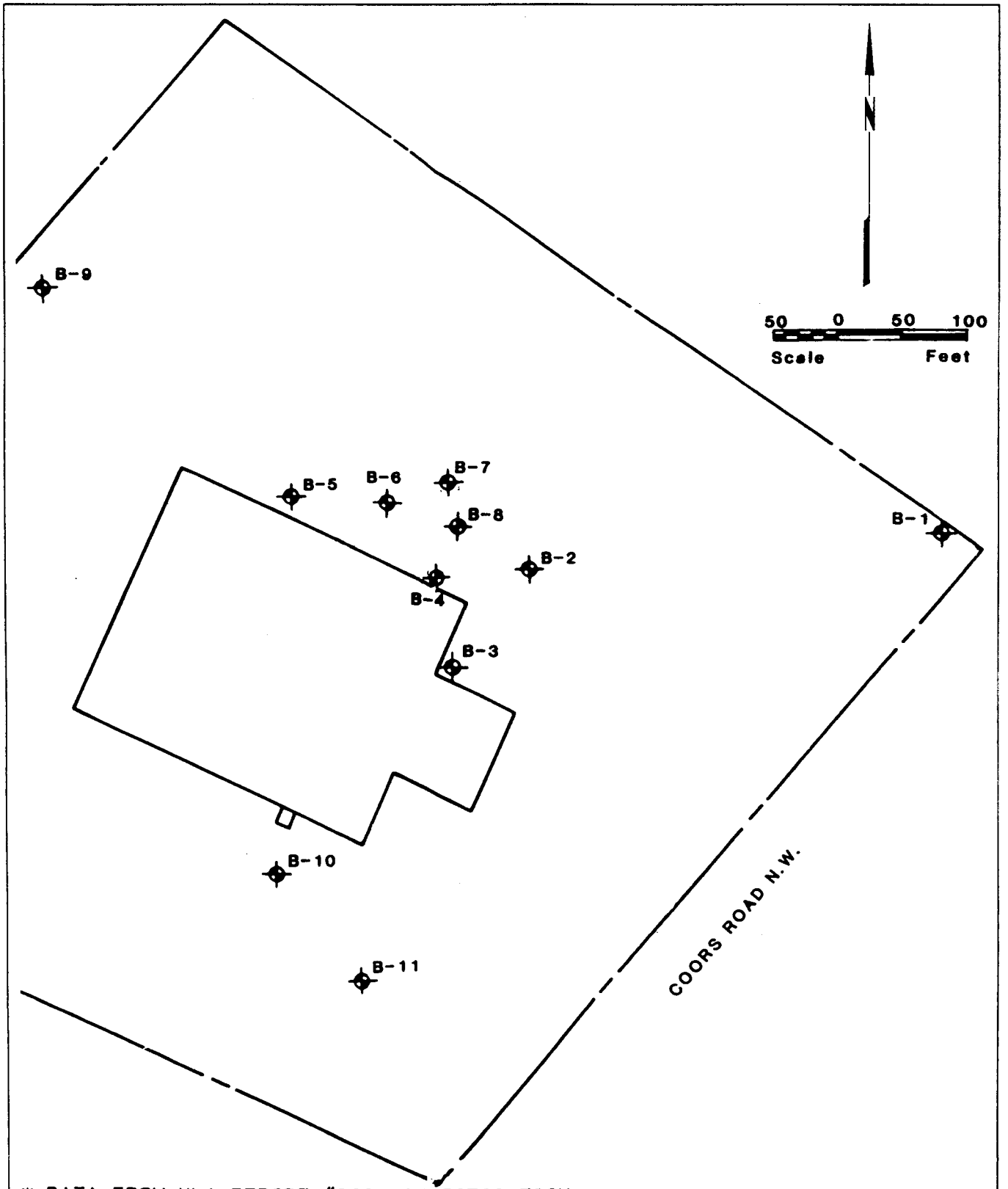
Total metals analyses were conducted on 126 soil samples to determine concentrations of cadmium, chromium, lead, and nickel. Analytical results on 34 samples exceeded nominal background levels for chromium (2-3 mg/kg). Maximum chromium concentration exceeded 3000 mg/kg at B-4 and B-8 underneath the sump/pond area. Evaluation of the data indicates sorption onto fine-grained silts and clays is probably the

dominant process affecting chromium concentration. The variation in chromium concentration is graphically depicted on Figures 41 through 52 which show the depth profiles of chromium concentration relative to subsurface lithology.

2. Surface Soil Gas Investigations

Three soil gas investigations have been conducted at the Sparton facility. The first soil gas investigation was conducted in 1984, and involved primarily on-site locations. The second investigation was conducted in 1987, and involved both on-site and off-site locations for soil gas measurements. The third investigation was conducted in June 1990, and covered both on-site and off-site locations. The investigations were conducted by Tracer Research Corporation using the same techniques and equipment. The results of the first two investigations were published in *an HLA* report dated October 19, 1987 and titled "Off-Site Investigation, Sparton Technology, Inc., Coors Road Plant, Albuquerque, New Mexico", a copy of which is included in Attachment 7. The report on the third investigation, "Shallow Soil Gas Investigation, Sparton Technology Building, 9621 North Coors Road, Albuquerque, New Mexico", is included in Attachment 9.

The purpose of these investigations was to obtain an estimate of the areal extent of the contaminant plume and to examine the impact of the upper flow zone pump and treat remediation on soil gas. All soil gas samples were taken in the shallow subsurface, approximately five to six feet below ground surface.



* DATA FROM HLA REPORT "SOIL INVESTIGATION OF THE UNSATURATED AND UPPER SATURATED ZONES"

HDR

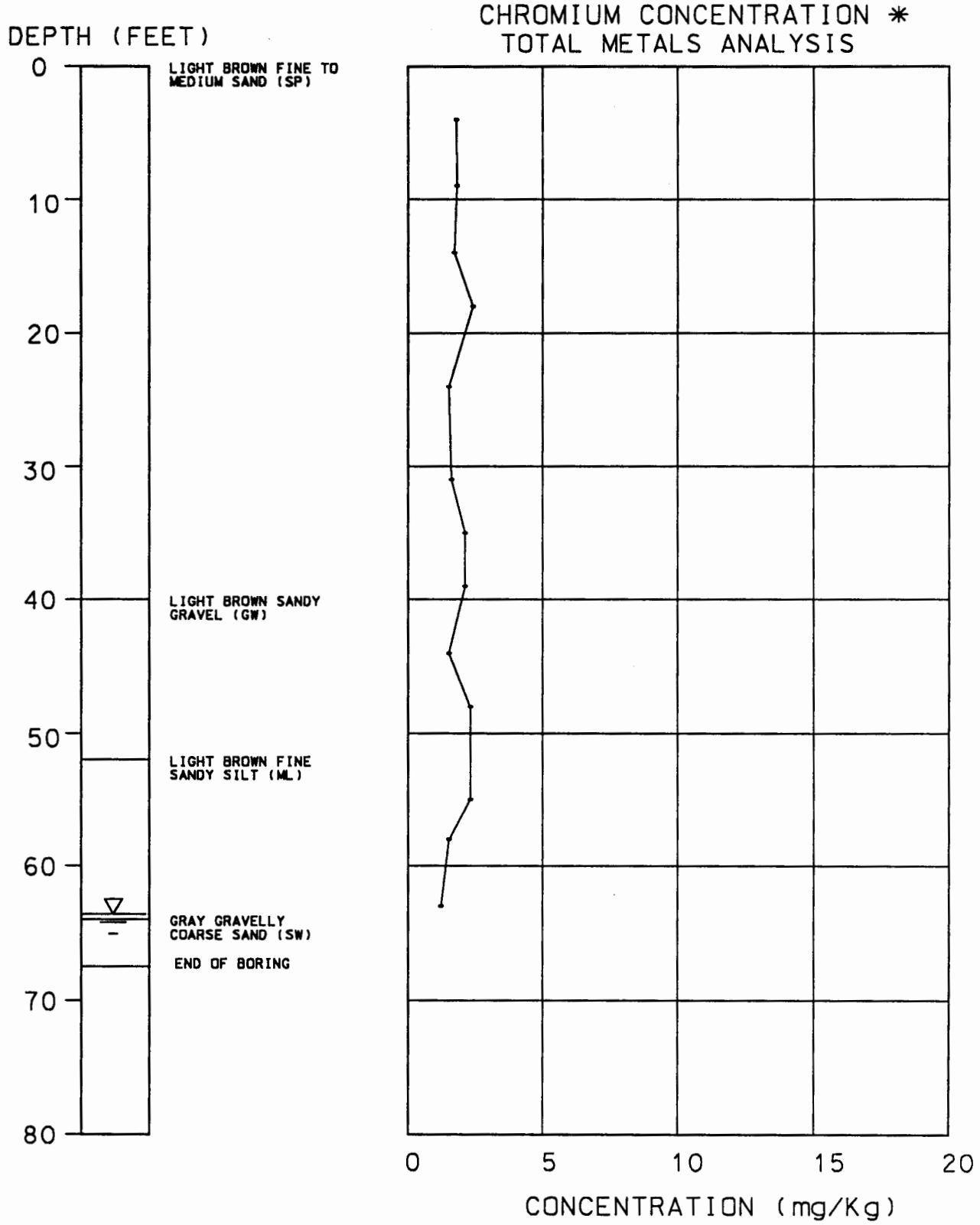
HDR ENGINEERING, INC.
DALLAS, TEXAS

PLAN OF SOIL BORINGS

SPARTON TECHNOLOGY, INC.
ALBUQUERQUE, NEW MEXICO

Date 12/01/91

Figure 41



* DATA FROM HLA REPORT "SOIL INVESTIGATION OF THE UNSATURATED AND UPPER SATURATED ZONES"

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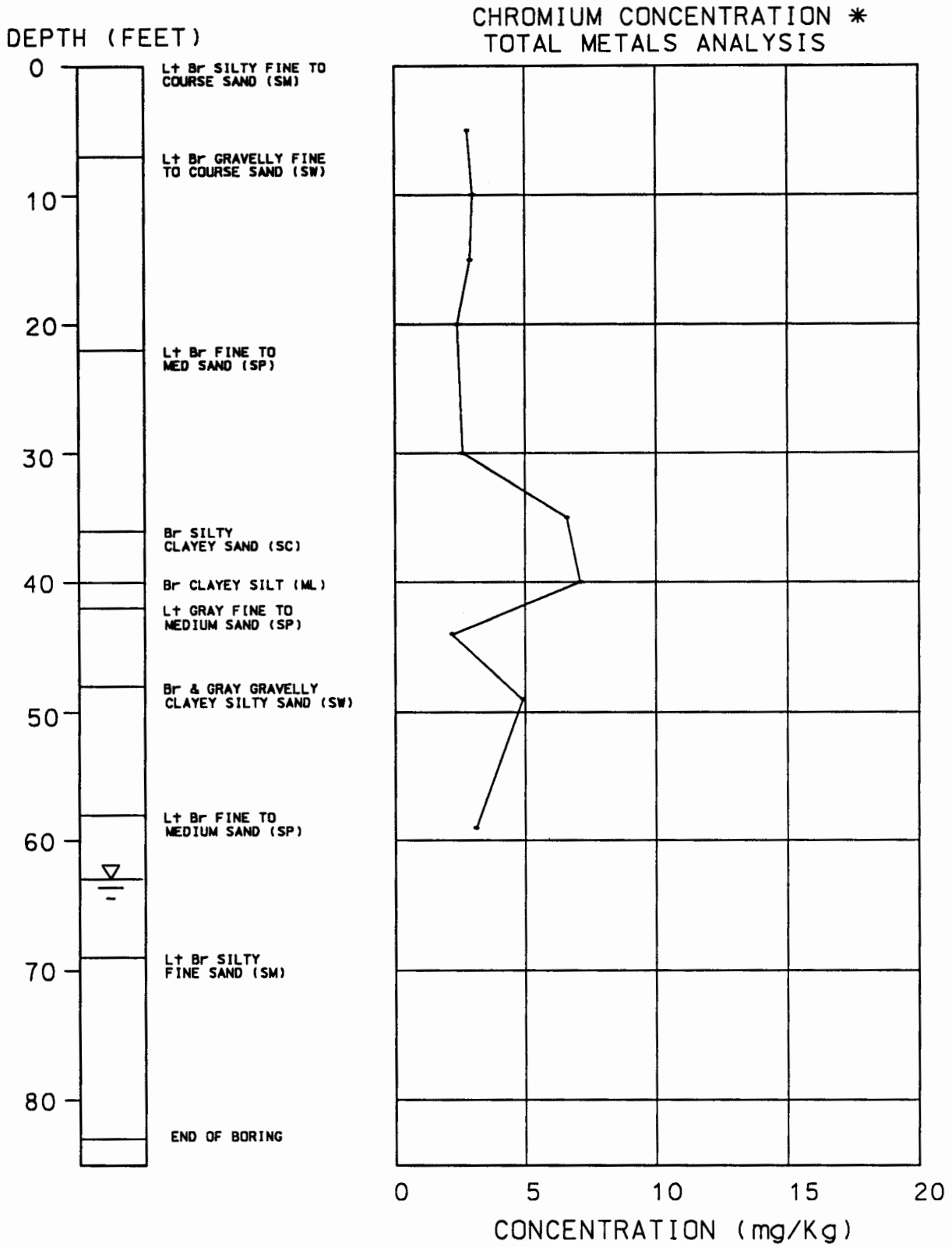
SOIL CHROMIUM CONCENTRATION

BORING B-1

SPARTON TECHNOLOGY, INC.
ALBUQUERQUE, NEW MEXICO

Date 12/01/91

Figure 42



* DATA FROM HLA REPORT "SOIL INVESTIGATION OF THE UNSATURATED AND UPPER SATURATED ZONES"

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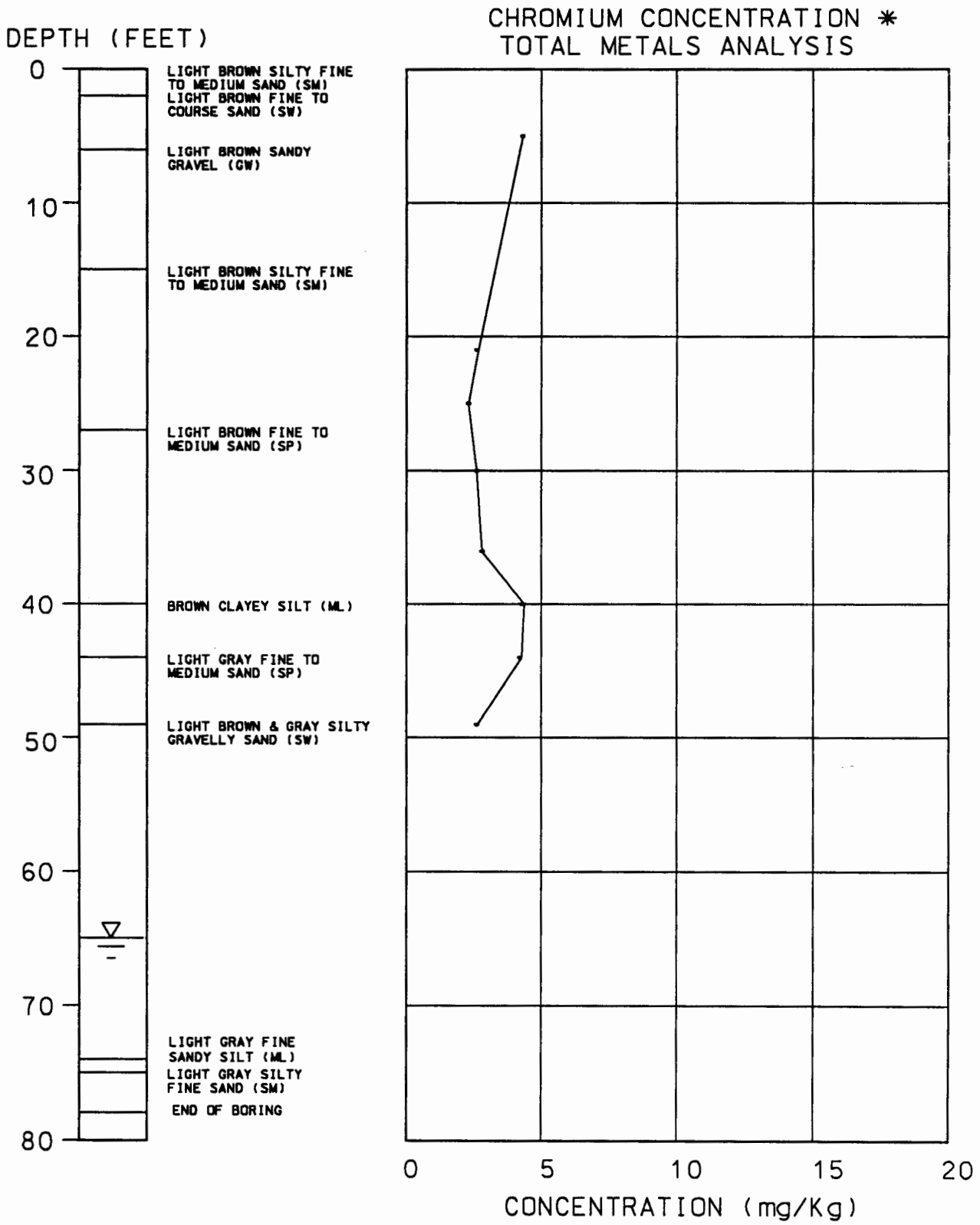
SOIL CHROMIUM CONCENTRATION

BORING B-2

SPARTON TECHNOLOGY, INC.
ALBUQUERQUE, NEW MEXICO

Date 12/01/91

Figure 43



* DATA FROM HLA REPORT "SOIL INVESTIGATION OF THE UNSATURATED AND UPPER SATURATED ZONES"

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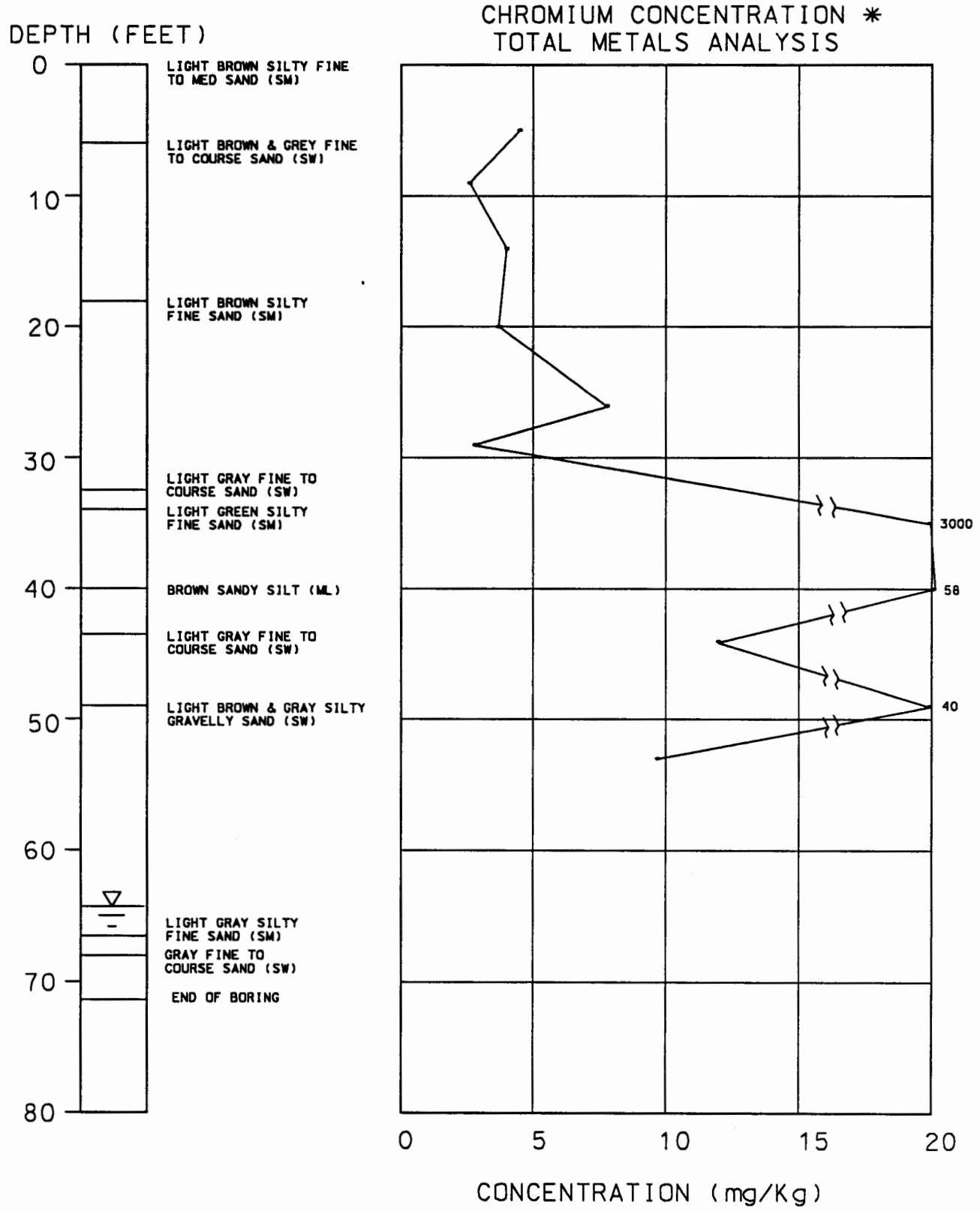
SOIL CHROMIUM CONCENTRATION

BORING B-3

SPARTON TECHNOLOGY, INC.
ALBUQUERQUE, NEW MEXICO

Date 12/01/91

Figure 44



* DATA FROM HLA REPORT "SOIL INVESTIGATION OF THE UNSATURATED AND UPPER SATURATED ZONES"

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SOIL CHROMIUM CONCENTRATION

BORING B-4

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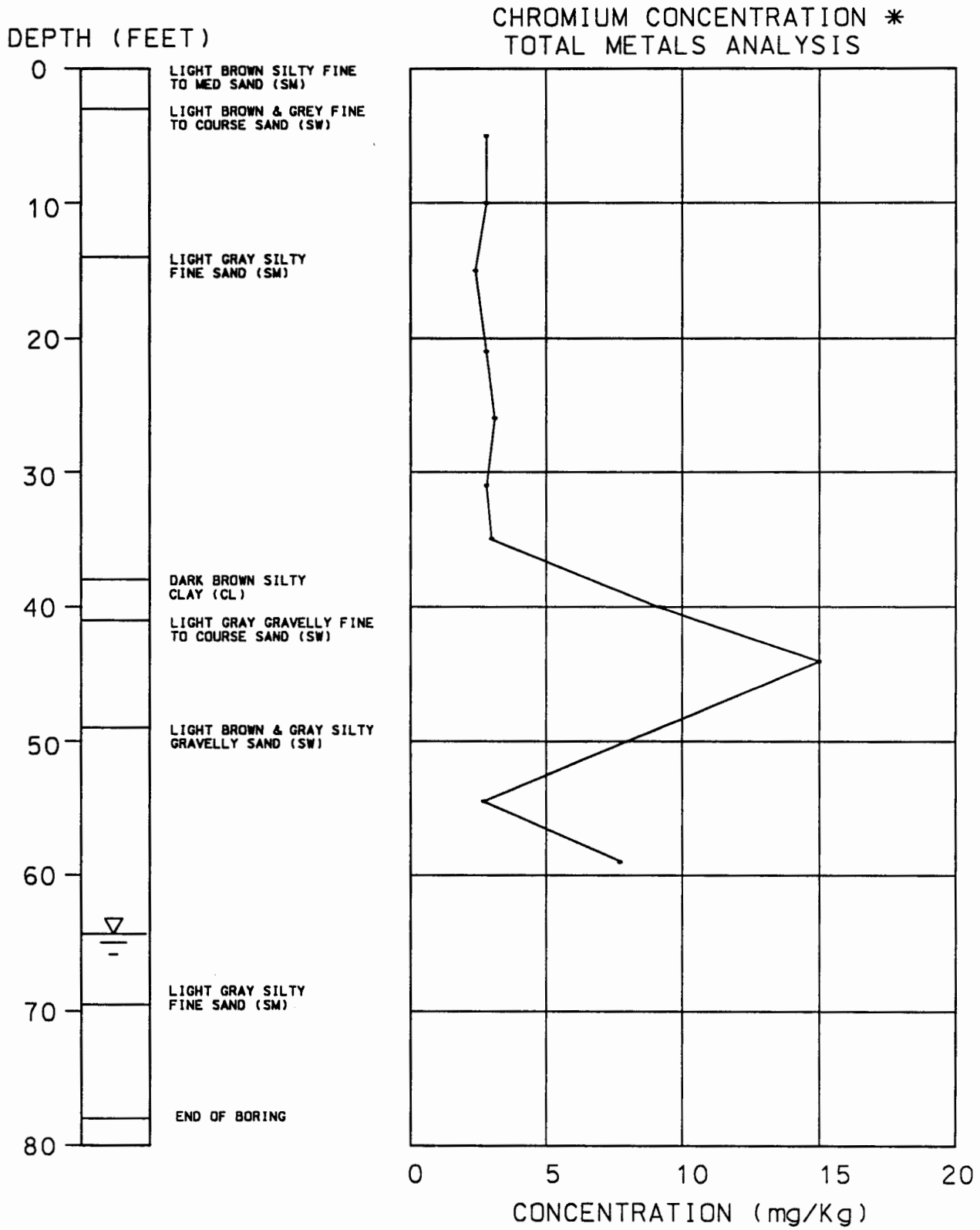
Date 12/01/91

Figure 45



* DATA FROM HLA REPORT "SOIL INVESTIGATION OF THE UNSATURATED AND UPPER SATURATED ZONES"

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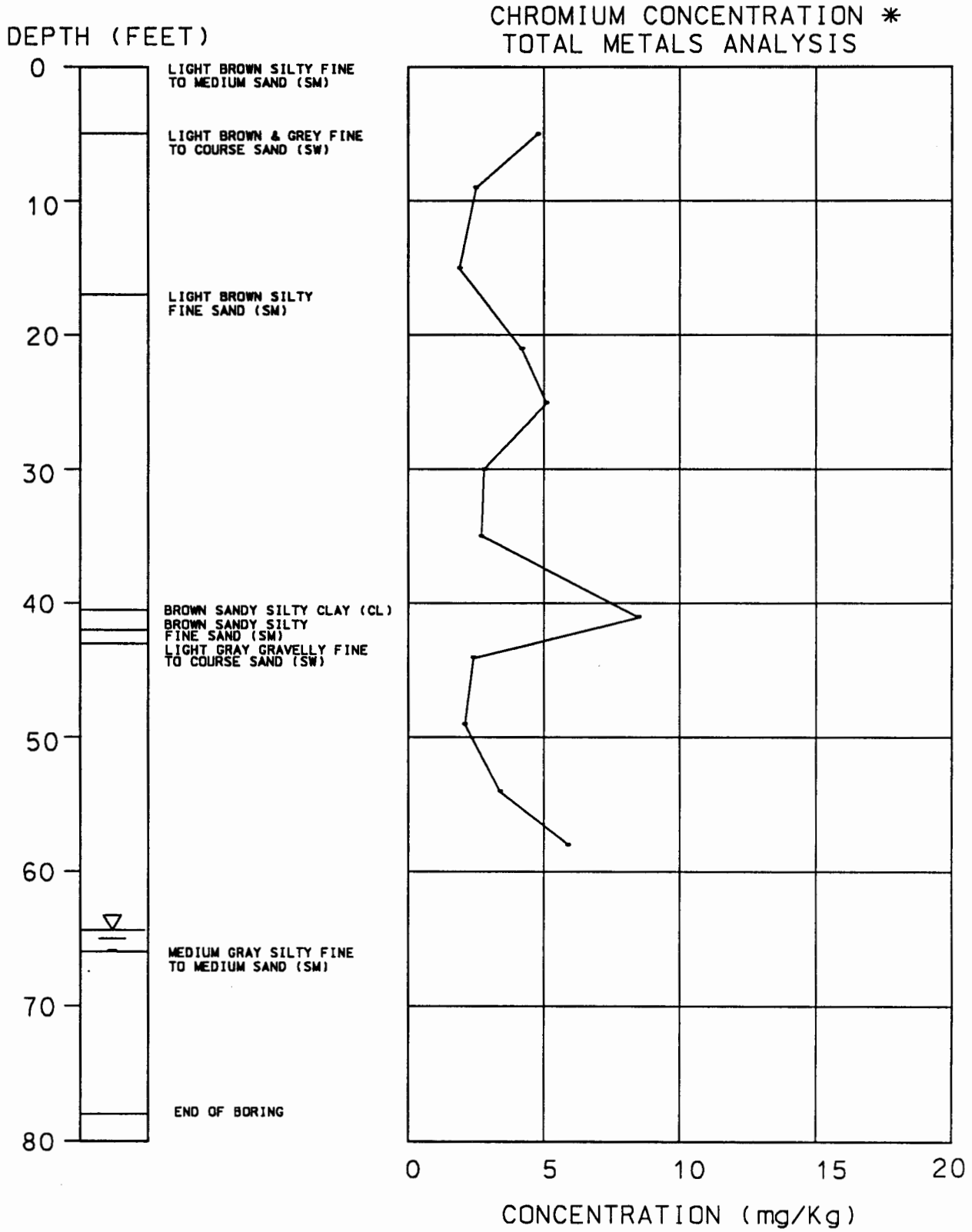
SOIL CHROMIUM CONCENTRATION

BORING B-5

SPARTON TECHNOLOGY, INC.
ALBUQUERQUE, NEW MEXICO

Date 12/01/91

Figure 46



* DATA FROM HLA REPORT "SOIL INVESTIGATION OF THE UNSATURATED AND UPPER SATURATED ZONES"

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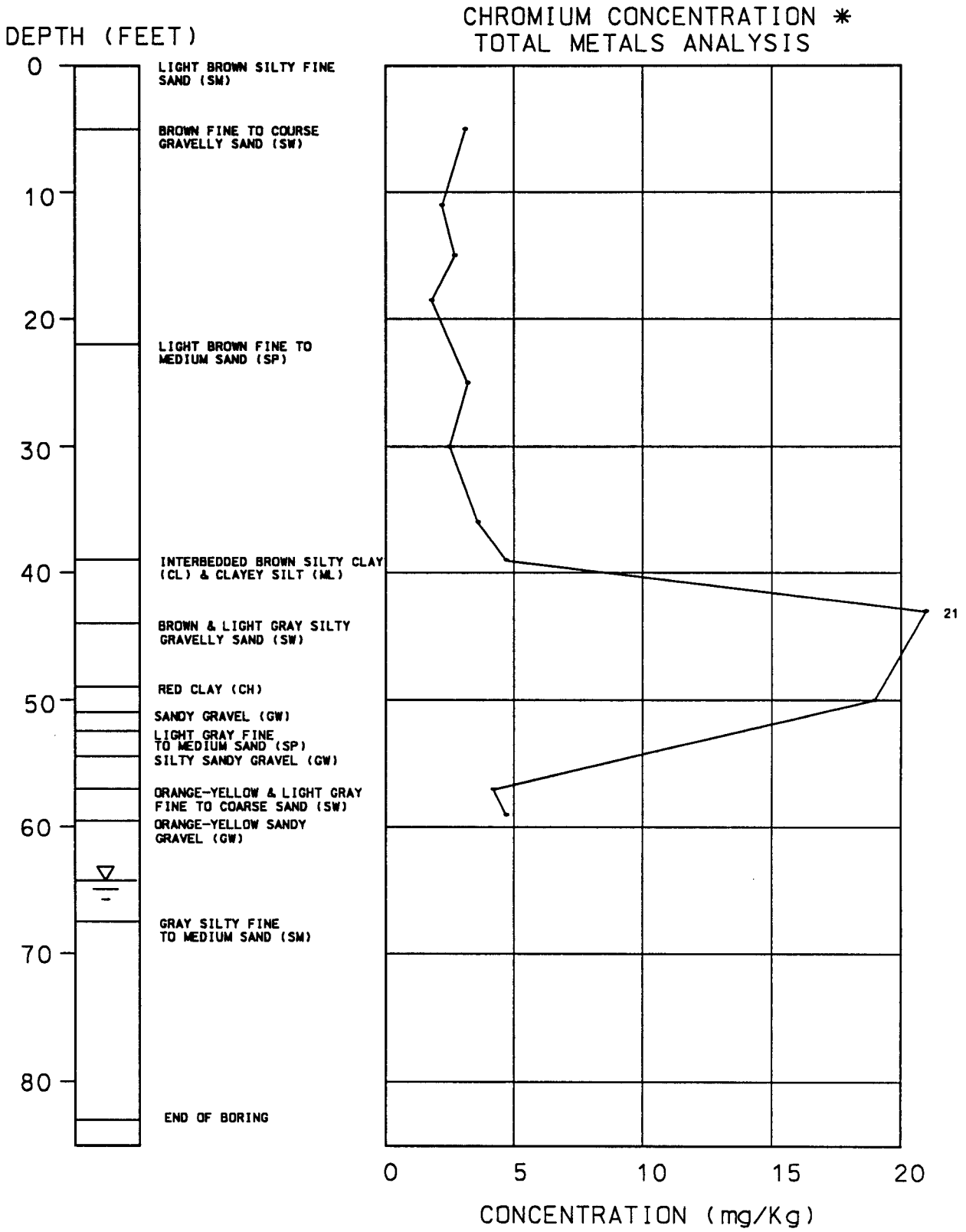
SOIL CHROMIUM CONCENTRATION

BORING B-6

SPARTON TECHNOLOGY, INC.
ALBUQUERQUE, NEW MEXICO

Date 12/01/91

Figure 47



* DATA FROM HLA REPORT "SOIL INVESTIGATION OF THE UNSATURATED AND UPPER SATURATED ZONES"

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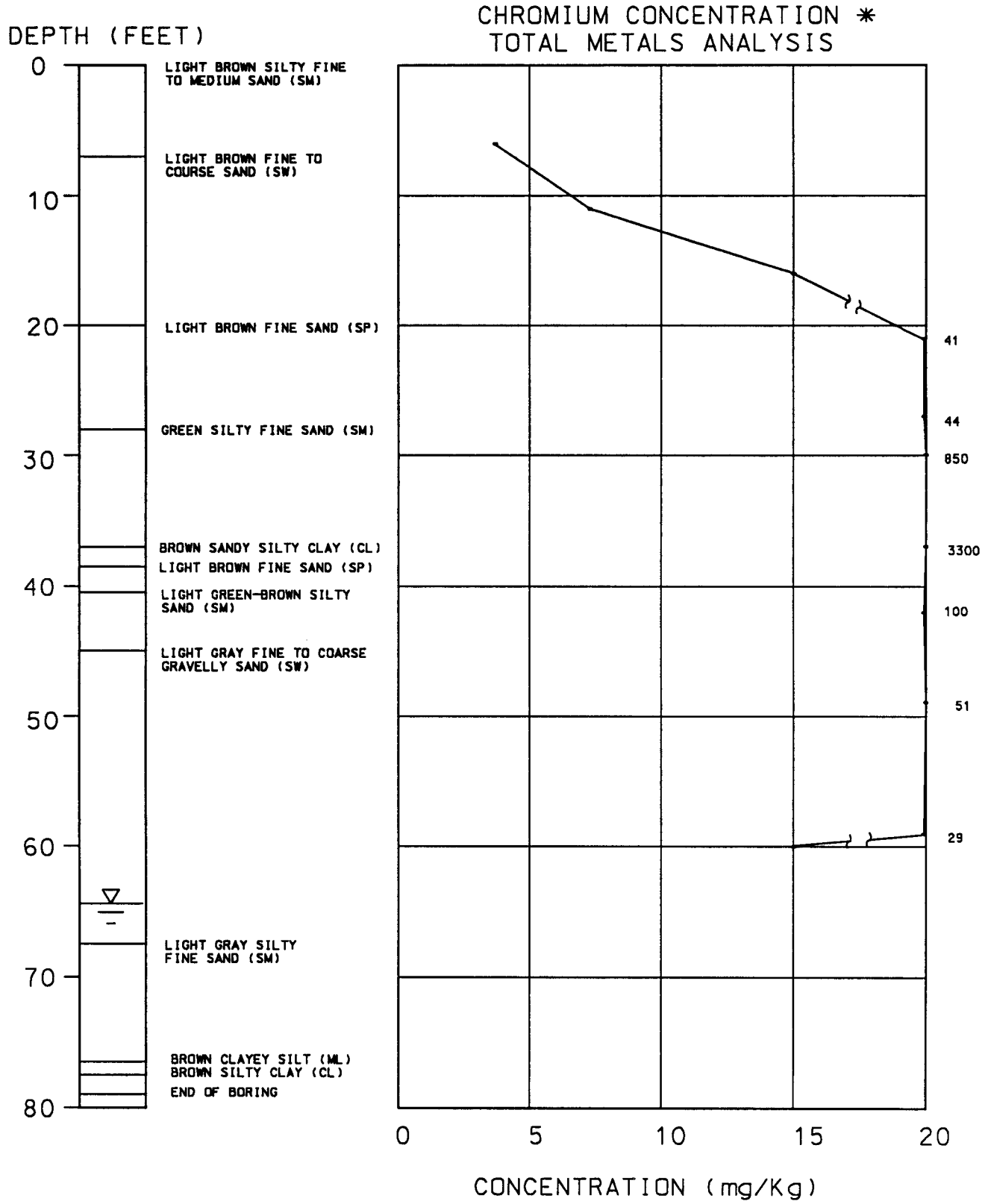
SOIL CHROMIUM CONCENTRATION

BORING B-7

SPARTON TECHNOLOGY, INC.
ALBUQUERQUE, NEW MEXICO

Date 12/01/91

Figure 48



* DATA FROM HLA REPORT "SOIL INVESTIGATION OF THE UNSATURATED AND UPPER SATURATED ZONES"

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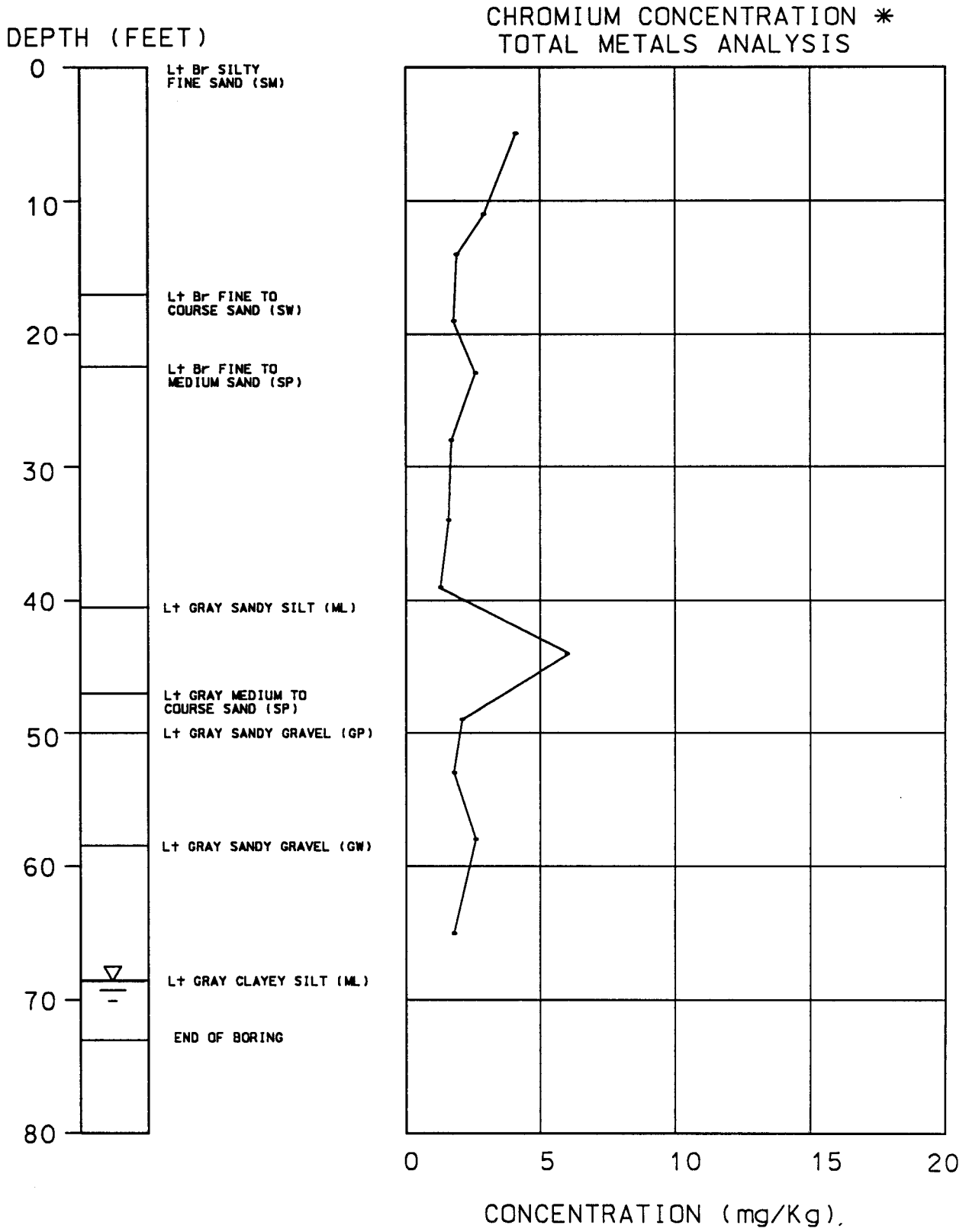
SOIL CHROMIUM CONCENTRATION

BORING B-8

SPARTON TECHNOLOGY, INC.
ALBUQUERQUE, NEW MEXICO

Date 12/01/91

Figure 49



* DATA FROM HLA REPORT "SOIL INVESTIGATION OF THE UNSATURATED AND UPPER SATURATED ZONES"

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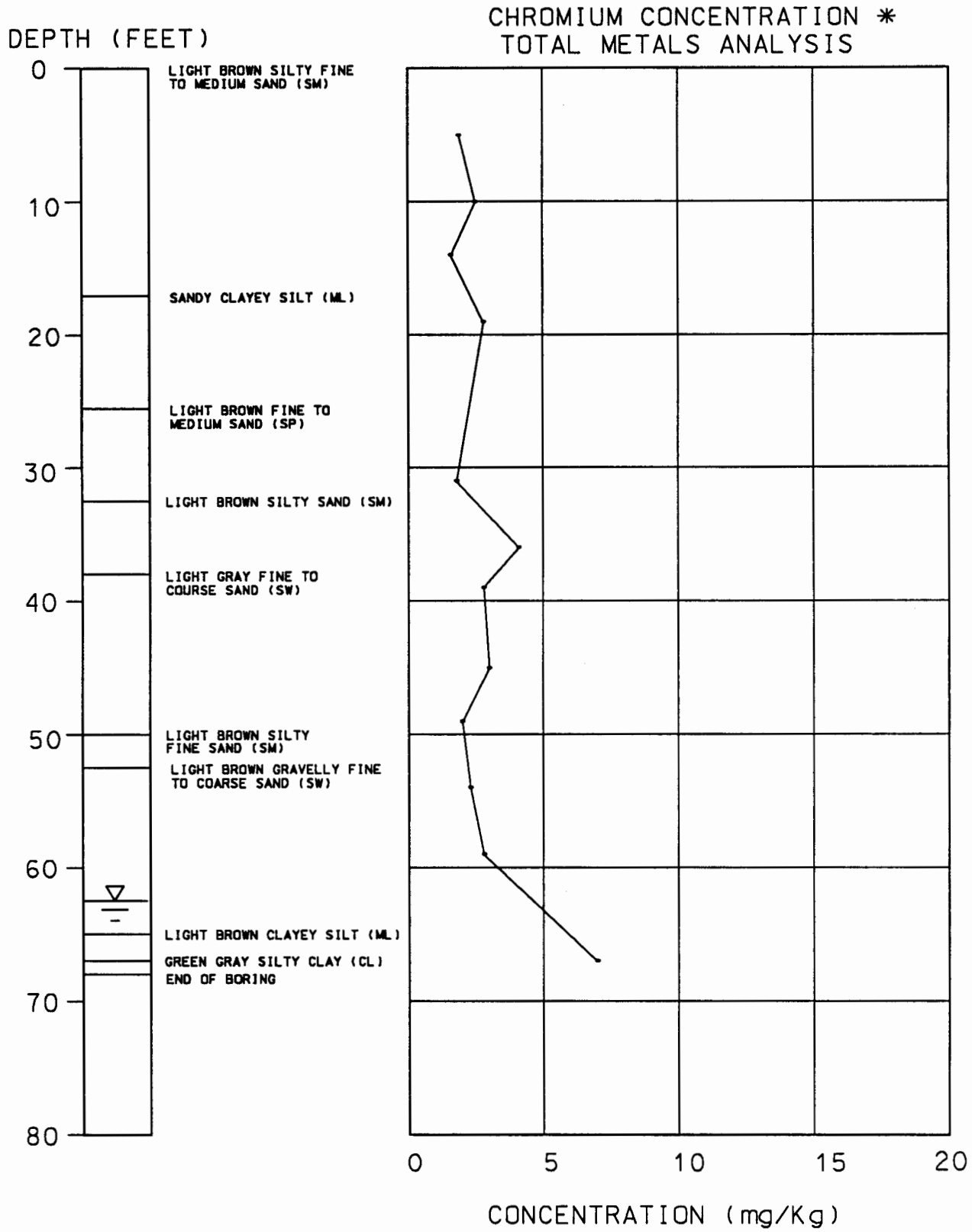
SOIL CHROMIUM CONCENTRATION
BORING B-9

SPARTON TECHNOLOGY, INC.
ALBUQUERQUE, NEW MEXICO

Date 12/01/91

Figure 50



* DATA FROM HLA REPORT "SOIL INVESTIGATION OF THE UNSATURATED AND UPPER SATURATED ZONES"

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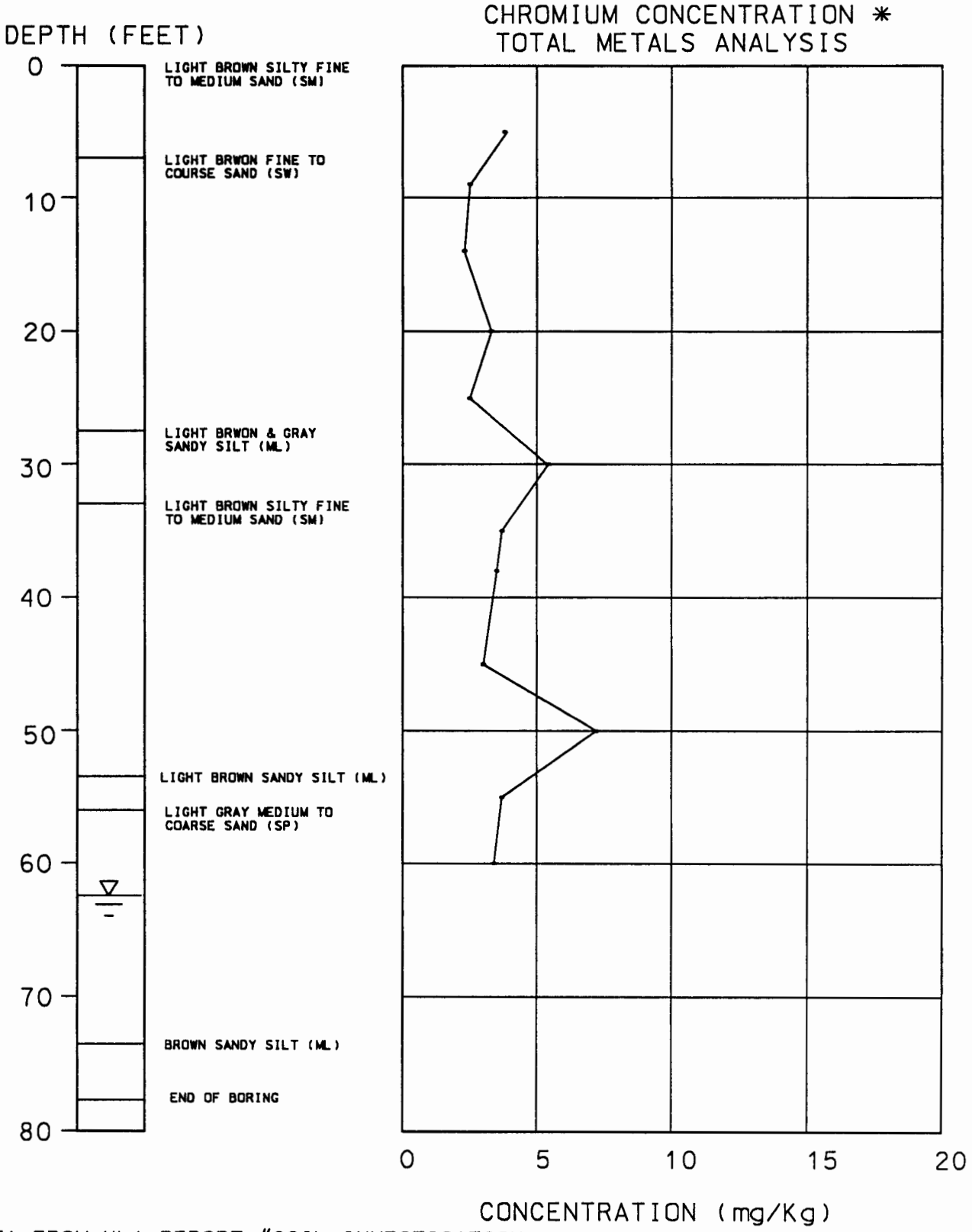
SOIL CHROMIUM CONCENTRATION

BORING B-10

SPARTON TECHNOLOGY, INC.
ALBUQUERQUE, NEW MEXICO

Date 12/01/91

Figure 51



* DATA FROM HLA REPORT "SOIL INVESTIGATION OF THE UNSATURATED AND UPPER SATURATED ZONES"

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SOIL CHROMIUM CONCENTRATION

BORING B-11

SPARTON TECHNOLOGY, INC.
ALBUQUERQUE, NEW MEXICO

Date 12/01/91

Figure 52

Based on these soil gas surveys, it appeared that the contaminant plume had moved a short distance beyond the facility boundaries. The shape of the soil gas plumes also seem to suggest dispersion and diffusion as the predominant plume transport mechanisms with a lesser advection influence.

Based on the results of the 1987 and 1991 soil gas surveys, TCA and TCE were detected in the soil gas over approximately the same area. Within the facility boundary, however, TCE concentration dropped approximately one order of magnitude with only a single sampling point south of the building above 10 ug/l. TCA decreased approximately 1/3 to 1/2 within the property boundary to a single peak level above 10 ug/l. Comparison to 1984 on-site data indicate over a 30X decrease in TCA and a 50X decrease in TCE.

The soil gas results indicate a significant change in soil gas concentration due to both source removal and initiation of the pump and treat remediation in 1989. The decrease in concentration with time is also reflected in the quarterly groundwater monitoring results which were collected under the state program.

An anomalous soil gas concentration of TCE and TCA southwest of Congress Avenue and Irving Boulevard has been observed in both the 1991 and 1987 surveys. Based on the general shape and location of the anomaly, the absence of analytical detection in MW-34 and MW-35, and the general groundwater flow characteristics, the soil gas anomaly is not related to the contaminant plume originating at the Sparton Facility.

B. Surface Water and Sediment Contamination

There are three surface water bodies in the vicinity of the Sparton facility. The Rio Grande is located approximately 3,000 feet east of the Sparton facility and is considered a permanent surface water body. The river flows from northeast to southwest in the vicinity of the Sparton facility. The Las Calabacillas Arroyo located approximately 2800 feet north of the facility is an intermittent stream used for area precipitation runoff control. The Corrales Main Canal, an irrigation channel, is located approximately 300 feet east of the facility, across Coors Road, and runs southwest from there. This irrigation canal is generally used from March through October, and, except for precipitation, is dry from November through February.

Based on regional and site-specific groundwater gradients, each of these surface water bodies is either upgradient or cross-gradient from the source area at the Sparton facility, and hence would not be expected to be affected by the contaminant plume.

C. Air Contamination

Since the contaminant release occurred in the subsurface soils and has subsequently migrated to the groundwater, the only ongoing release of constituents to the atmosphere from the release is by volatilization of the constituents from the groundwater and subsequent movement of these vapors through the vadose zone and ultimately to the ground surface where they are released into the atmosphere. Soil gas concentrations measured in 1991, approximately 5 to 6 feet below ground surface, indicated average TCE

and TCA soil gas concentrations of less than 10 micrograms per liter (ug/l) on-site at the Sparton facility, tapering off to 0.001 ug/l approximately 1/2 mile away. The mass flux rate of these constituents into the atmosphere, while not measured, is felt to be minimal due to the low concentrations of soil gas measured during the 1991 survey.

An additional source of air emissions is associated with the interim groundwater recovery system. The air stripper, which strips the volatile organic contaminants from the groundwater, releases these contaminants into the atmosphere. These emissions are permitted by the City Albuquerque Environmental Health Department (Air Quality Permit Number 187).

D. Groundwater Contamination

1. Definition of Plume

A total of 56 groundwater monitoring wells have been installed to determine groundwater elevations and to collect representative samples for chemical analyses in an effort to define the horizontal and vertical limits of the contaminant plume. Figure 53 presents pertinent well screen data for the wells. For the purposes of the investigation, TCE and TCA concentration values have been plotted to define the plume configuration. These two compounds are the major constituents of the groundwater contamination as they are found to be the most prevalent in groundwater sample analyses. Acetone, DCE and MeCl have also been detected, but are not as prevalent as TCE and TCA.

FIGURE 53

WELL SUMMARY

WELL NUMBER	ZONE *	MEASURING POINT ELEVATION	DEPTH TO TOP OF SCREEN (FT.)	DEPTH TO BOTTOM OF SCREEN (FT.)	ELEVATION AT TOP OF SCREEN (FT.,MSL)	ELEVATION AT BOTTOM OF SCREEN (FT.,MSL)	LENGTH OF SCREEN (FT.)
PW-1	UFZ	5044.54	60.0	70.0	4984.54	4974.54	10.0
7	UFZ	5044.80	63.5	68.5	4981.30	4976.30	5.0
9	UFZ	5044.11	62.5	67.5	4981.61	4976.61	5.0
12	UFZ	5042.58	64.0	74.0	4978.58	4968.58	10.0
13	UFZ	5043.25	60.0	70.0	4983.25	4973.25	10.0
14	UFZ	5041.91	61.5	71.5	4980.41	4970.41	10.0
15	UFZ	5047.49	60.0	70.0	4987.49	4977.49	10.0
16	UFZ	5047.50	68.0	73.0	4979.50	4974.50	5.0
17	UFZ	5049.28	67.0	72.0	4982.28	4977.28	5.0
18	UFZ	5045.58	68.0	78.0	4977.58	4967.58	10.0
19	ULFZ	5046.25	97.0	107.0	4949.25	4939.25	10.0
20	LLFZ	5045.79	125.0	138.0	4920.79	4907.79	13.0
21	UFZ	5048.36	64.5	69.5	4983.86	4978.86	5.0
22	UFZ	5048.06	72.0	77.0	4976.06	4971.06	5.0
23	UFZ	5048.51	72.0	77.0	4976.51	4971.51	5.0
24	UFZ	5048.70	68.4	73.4	4980.30	4975.30	5.0
25	UFZ	5049.00	67.7	72.7	4981.30	4976.30	5.0
26	UFZ	5045.71	73.0	78.0	4972.71	4967.71	5.0
27	UFZ	5045.50	67.0	72.0	4978.50	4973.50	5.0
28	UFZ	5042.69	65.0	70.0	4977.69	4972.69	5.0
29	ULFZ	5044.51	103.0	113.0	4941.51	4931.51	10.0
30	ULFZ	5044.70	97.0	107.0	4947.70	4937.70	10.0
31	ULFZ	5043.53	96.0	106.0	4947.53	4937.53	10.0
32	LLFZ	5048.05	108.0	118.0	4940.05	4930.05	10.0
33	UFZ	5044.29	63.0	73.0	4981.29	4971.29	10.0
34	UFZ	5034.49	56.5	66.5	4977.99	4967.99	10.0
35	UFZ	5042.50	63.2	73.2	4979.30	4969.30	10.0
36	UFZ	5059.35	82.3	92.3	4977.05	4967.05	10.0
37	UFZ	5091.66	115.0	125.0	4976.66	4966.66	10.0
38	LLFZ	5044.32	126.5	136.5	4917.82	4907.82	10.0
39	LLFZ	5044.06	123.0	133.0	4921.06	4911.06	10.0
40	LLFZ	5043.35	117.0	127.0	4926.35	4916.35	10.0
41	ULFZ	5046.77	92.0	97.0	4954.77	4949.77	5.0
42	ULFZ	5057.33	105.0	115.0	4952.33	4942.33	10.0
43	LLFZ	5057.74	127.0	137.0	4930.74	4920.74	10.0
44	ULFZ	5058.71	106.0	116.0	4952.71	4942.71	10.0
45	ULFZ	5090.11	143.0	153.0	4947.11	4937.11	10.0
46	ULFZ	5118.98	170.0	180.0	4948.98	4938.98	10.0
47	UFZ	5155.83	180.0	195.0	4975.83	4960.83	15.0
48	UFZ	5168.31	192.0	207.0	4976.31	4961.31	15.0
49	3rdFZ	5043.67	137.7	147.7	4905.97	4895.97	10.0
50	UFZ	5211.51	235.0	250.0	4976.51	4961.51	15.0
51	UFZ	5058.86	75.0	85.0	4983.86	4973.86	10.0
52	UFZ	5165.81	190.8	206.0	4975.01	4959.81	15.2
53	UFZ	5164.24	189.8	204.0	4974.44	4960.24	14.2
(**) 54	UFZ	5097.64	117.0	132.0	4980.64	4965.64	15.0
55	LLFZ	5168.61	255.0	265.0	4913.61	4903.61	10.0
56	ULFZ	5168.61	220.0	230.0	4948.61	4938.61	10.0
57	UFZ	5103.54	126.0	141.0	4977.54	4962.54	15.0
58	UFZ	5168.89	194.0	209.0	4974.89	4959.89	15.0

FIGURE 53 (continued)

WELL NUMBER	ZONE *	MEASURING POINT ELEVATION	DEPTH TO TOP OF SCREEN (FT.)	DEPTH TO BOTTOM OF SCREEN (FT.)	ELEVATION AT TOP OF SCREEN (FT.,MSL)	ELEVATION AT BOTTOM OF SCREEN (FT.,MSL)	LENGTH OF SCREEN (FT.)
59	ULFZ	5059.18	104.5	115.0	4954.68	4944.18	10.5
60	ULFZ	5133.62	185.0	195.0	4948.62	4938.62	10.0
61	UFZ	5133.98	158.0	173.0	4975.98	4960.98	15.0
62	UFZ	5075.00	95.0	110.0	4980.00	4965.00	15.0
63	UFZ	5065.74	83.0	98.0	4982.74	4967.74	15.0
64	ULFZ	5097.84	138.8	149.0	4959.04	4948.84	10.2
PZ-1	UFZ	5144.22	182.7	198.0	4961.52	4946.22	15.3

(*) UFZ = UPPER FLOW ZONE
ULFZ = UPPER LOWER FLOW ZONE
LLFZ = LOWER LOWER FLOW ZONE
3rdFZ = THIRD FLOW ZONE

(**) WELL # 54 IS NONFUNCTIONAL

THE FOLLOWING WELLS HAVE BEEN MODIFIED OR COMPLETELY PLUGGED:

Well Number	Status
PW-1	Plugged back to upper flow zone+ - Converted to recovery well
P-1	Plugged
1	Plugged
2	Plugged
3	Plugged
4	Plugged
5	Plugged
6	Plugged
8	Plugged
10	Plugged
11	Plugged
12	Plugged back to upper flow zone+
13	Plugged back to upper flow zone+
14	Plugged back to upper flow zone+
15	Plugged back to upper flow zone+
18	Converted to recovery well
23	Converted to recovery well
24	Converted to recovery well
25	Converted to recovery well
26	Converted to recovery well
27	Converted to recovery well
28	Converted to recovery well
54	Used only for water level measurements

+ ORIGINALLY OPEN TO UFZ, ULFZ, AND LLFZ

Revised 12/1/91

Various metals have been detected in groundwater samples as well. Elevated concentrations of barium, chromium, lead, and manganese have been identified. Historically, chromium has the highest frequency of occurrence of elevated concentration. The elevated chromium detections are exclusively within the boundaries of the TCE plume and restricted to the upper and upper lower flow zones.

The groundwater protection Maximum Concentration Limit (MCL) of 0.05 mg/l has been used as the Level of Significance for chromium. A comparison of results from 39 wells given in Figure 54 indicates that, out of 13 chromium detections, 8 samples exhibited concentrations above 0.05 mg/l. However, the analytical results are for total metals analyses and were conducted on unfiltered, acid-preserved samples obtained from stainless steel well screens. Accordingly, comparison of these total metals results to groundwater protection standards based on dissolved metals concentrations may be misleading and/or inappropriate. However, the total metals analyses do provide a conservative estimate of chromium concentration.

FIGURE 54
SPARTON TECHNOLOGY, INC.
MONITOR WELL DATA
TOTAL METALS SUMMARY
JUNE 1991 SAMPLING

WELL NO.	DATE SAMPLED*	BARIUM (mg/L)**	CHROMIUM (mg/L)**	LEAD (mg/L)**
UPPER FLOW ZONE				
13	06/17/91	0.047	< 0.01	< 0.01
21	06/18/91	0.064	< 0.01	< 0.01
22	06/20/91	0.15	< 0.01	< 0.005
33	06/17/91	0.083	0.48	< 0.01
34	06/14/91	0.1	< 0.01	< 0.005
35	06/15/91	0.063	< 0.01	< 0.005
36	06/13/91	0.066	0.077	< 0.005
37	06/14/91	0.046	< 0.01	< 0.01
47	06/11/91	0.05	0.14	< 0.005
48	06/11/91	0.046	0.27	< 0.005
51	06/14/91	0.12	< 0.01	0.006
52	06/13/91	0.038	< 0.01	< 0.005
53	06/11/91	0.063	0.019	< 0.005
57	06/13/91	0.15	0.044	0.029
58	06/11/91	0.046	0.017	< 0.005
61	06/10/91	0.051	< 0.01	< 0.005
62	06/10/91	0.068	< 0.01	< 0.005
63	06/14/91	0.053	< 0.01	< 0.005
UPPER LOWER FLOW ZONE				
19	06/17/91	0.04	< 0.01	< 0.01
29	06/19/91	0.14	< 0.01	< 0.005
30	06/18/91	0.081	0.07	< 0.01
31	06/19/91	0.061	< 0.01	< 0.005
41	06/19/91	0.043	0.016	< 0.005
42	06/14/91	0.056	< 0.01	< 0.005
44	06/20/91	0.1	< 0.01	< 0.005
45	06/13/91	0.047	0.16	< 0.005
46	06/13/91	0.075	0.34	< 0.005
56	06/16/91	0.049	0.18	< 0.005
59	06/14/91	0.07	< 0.01	< 0.005
60	06/10/91	0.06	< 0.01	< 0.005
64	06/13/91	0.046	< 0.01	< 0.005
LOWER LOWER FLOW ZONE				
20	06/17/91	0.12	< 0.01	< 0.01
32	06/20/91	0.14	< 0.01	
38	06/18/91	0.12	< 0.01	< 0.01
39	06/18/91	0.026	0.02	< 0.01
40	06/19/91	0.014	< 0.01	< 0.005
43	06/20/91	0.17	< 0.01	< 0.01
55	06/14/91	0.037	< 0.01	< 0.005
3rd FLOW ZONE				
49	06/20/91	0.12	< 0.01	< 0.005

* Q REFERS TO THE QUARTER OF THE YEAR

** < LESS THAN SYMBOL REFERS TO NON-DETECT AT INDICATED METHOD DETECTION LIMIT

*** COMBINED HEXAVALENT AND TRIVALENT RESULTS

Revised
12/01/91

Groundwater quality data for wells located in the Rio Grande Valley north of Albuquerque, obtained from a 1987 joint study conducted by the New Mexico Environmental Improvement Division and the New Mexico Health and Environment Department, indicate manganese concentrations that exceeded state standards in eleven out of twenty-one samples (*Gallaher, et al, 1987*). It is believed that the manganese concentrations found in the study area are either naturally occurring or are due to an outside source beyond the scope of this study.

All constituents detected in groundwater sample analyses are presented in Attachments 1, 3, and 9.

2. Horizontal Extent of Contamination

As indicated under site-specific hydrogeology in previous Section IV.B.2.d. of this report, only a single groundwater unit has been investigated beneath the site. Previous reports and correspondence subdivided this groundwater unit into flow zones-- the upper, the upper lower, the lower lower, and the third flow zones. Due to the saturated thickness of the groundwater unit, this subdivision has been retained to simplify three dimensional description. Use of these zone subdivisions is a convenient method to provide horizontal planes of reference at different depths within the groundwater unit.

a. Upper Flow Zone

1. TCE Plume Configuration

The general configuration of the contaminant plume has been determined by contouring TCE concentration data from 22 upper flow zone wells. These contours are given on Figure 55. TCE concentrations were obtained from sampling and analysis conducted during June 1991. Analytical results are included in Attachment 12. The June 1991 TCE data together with previous sampling results are tabulated on the figure as well.

The less than 5 microgram per liter (ug/l) isopleth or contour represents the detection limit of the perimeter of the plume. Based on this boundary, the length along the longitudinal axis of the plume is approximately 2100 feet northwest from the facility's western property line. The longitudinal axis of the plume closely parallels the groundwater hydraulic gradient given on Figures 25 and 26. Transverse width of the plume is approximately 1400 feet.

Comparison of the June 1991 data with data obtained in 1989 and 1990 indicates that the areal extent and concentrations of TCE are both decreasing. In addition, the plume migration has apparently stopped in response to source removal, on-site remediation, and various fate and transport processes.

FIGURE 55

UPPER FLOW ZONE TCE CONTOURS

(2) TCA Plume Configuration

Figure 56 presents the general TCA plume configuration based on June 1991 data from 22 upper flow zone wells. The TCA plume has a similar alignment to the TCE plume with a slight increase in width. However, off-site concentrations of TCA are generally over an order of magnitude less than the TCE plume.

Comparison of the June 1991 data with previous analyses indicates little change in areal extent. However, the average concentration of TCA has dropped. The data comparison also indicates no migration of the TCA plume over the last several years.

b. Upper Lower Flow Zone

(1) TCE Plume Configuration

Figure 57 presents the general configuration of a TCE plume based on analytical results from 13 wells screened in the upper lower flow zone. The isopleth contours are based on June 1991 data given in Attachment 12. The less than 5 ug/l isopleth represents the detection limit of the plume. Based on this boundary, the length of the plume along the longitudinal axis is approximately 1900 feet northwest from the west side of the facility. The longitudinal axis parallels the groundwater hydraulic gradient shown on figures 27 and 28. Width of the plume is approximately 1400 feet. Overall, the areal coverage is similar to the upper flow zone plume.

FIGURE 56

UPPER FLOW ZONE TCA CONTOURS

FIGURE 57

UPPER LOWER FLOW ZONE TCE CONTOURS

(2) TCA Plume Configuration

The general configuration of the TCA plume is given on Figure 58. Concentration isopleths on this figure are based on June 1991 analytical results included in Attachment 9. The TCA Plume is configured similarly to the TCE plume; however, TCA concentrations are, on the average, over an order of magnitude less.

Comparison with previous data indicates a reduction in TCA concentration with no detectable change in areal extent and/or location of the plume.

c. Lower Lower Flow Zone

(1) TCE Plume Configuration

The TCE plume for the lower lower flow zone is shown on Figure 59. The TCE plume configuration is based on June 1991 concentration data obtained from 7 wells screened in the lower lower flow zone. The plume alignment parallels the groundwater hydraulic gradients given on Figures 29 and 30. The plume is shorter and much narrower than the plumes above. Off-site length is 1800 feet and width is approximately 700 feet.

Comparison of the June 1991 data with data from 1989 and 1990 indicate over an order of magnitude decrease in TCE concentration with no measurable change in areal extent or plume location.

FIGURE 58

UPPER LOWER FLOW ZONE TCA CONTOURS

FIGURE 59

LOWER LOWER FLOW ZONE TCE CONTOURS

(2) TCA Plume Configuration

Figure 60 presents the general plume configuration based on June 1991 data. The TCA plume has the same basic configuration and alignment as the TCE plume; however, it is much shorter and narrower than the TCE plume. The TCA concentrations are also lower.

Comparison with previous data indicates a significant reduction in areal extent and a reverse migration or backup in the leading edge of the plume. In addition, TCA concentrations decreased.

d. Third Flow Zone

Only a single well has been constructed in the third flow zone (Well no. 49). June 1991 analyses from this well did not detect volatile organic constituents. Previous analyses in January 1990 detected trichlorofluoromethane at concentrations slightly above detection limits of 5 ug/l.

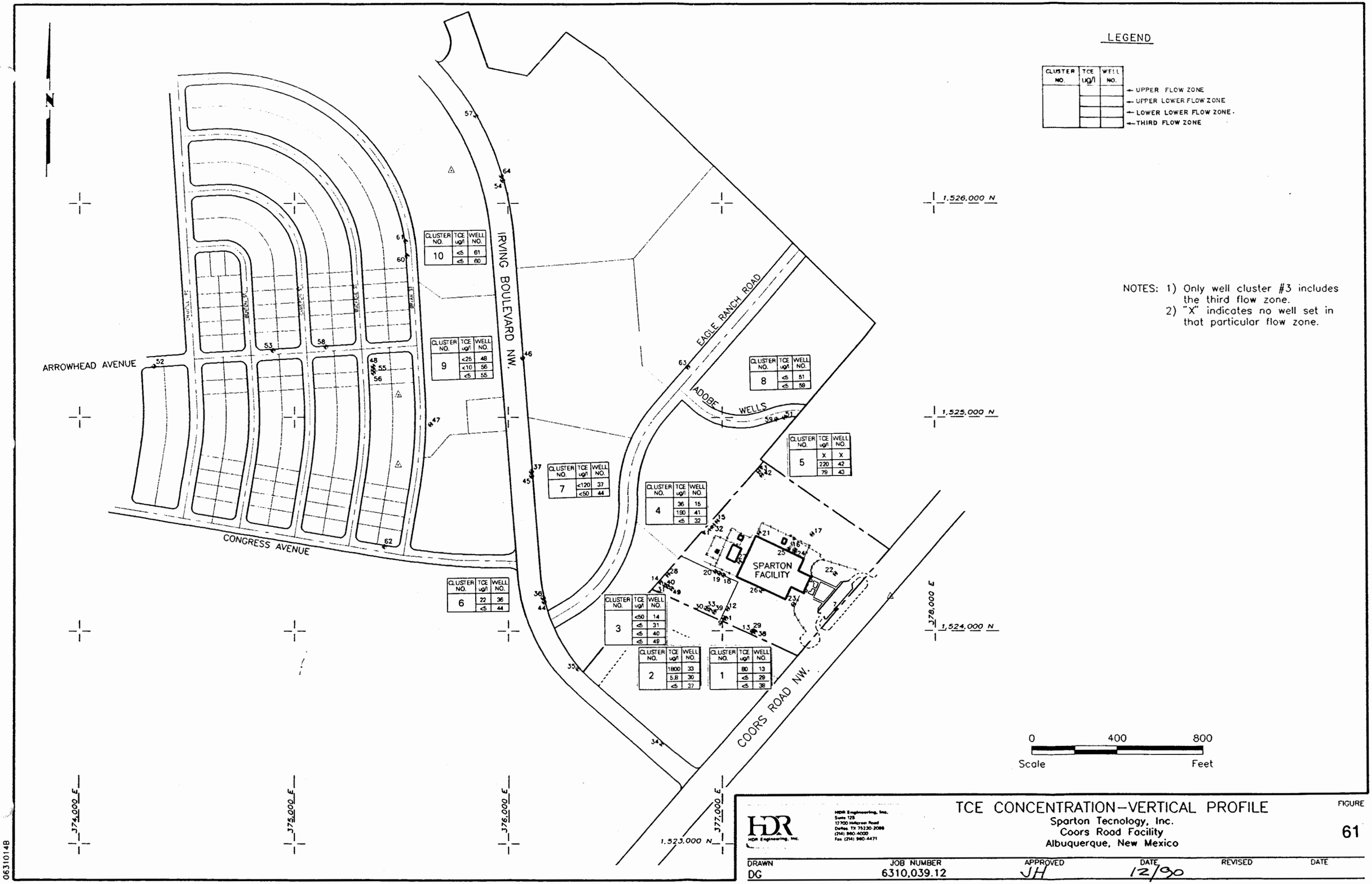
3. Vertical Extent of Contamination

a. Data Presentation

Vertical extent of contamination has been evaluated using groundwater analytical results from ten well clusters and four vertical cross sections covering the plume body. The location of the ten well clusters (five on-site and five off-site) is shown on Figures 61 and 62. Analytical data on these figures is from the June 1991 sampling. Figure 63 is a key for identifying the wells, screen elevations, and flow zones monitored at each well cluster.

FIGURE 60

LOWER LOWER FLOW ZONE TCA CONTOURS



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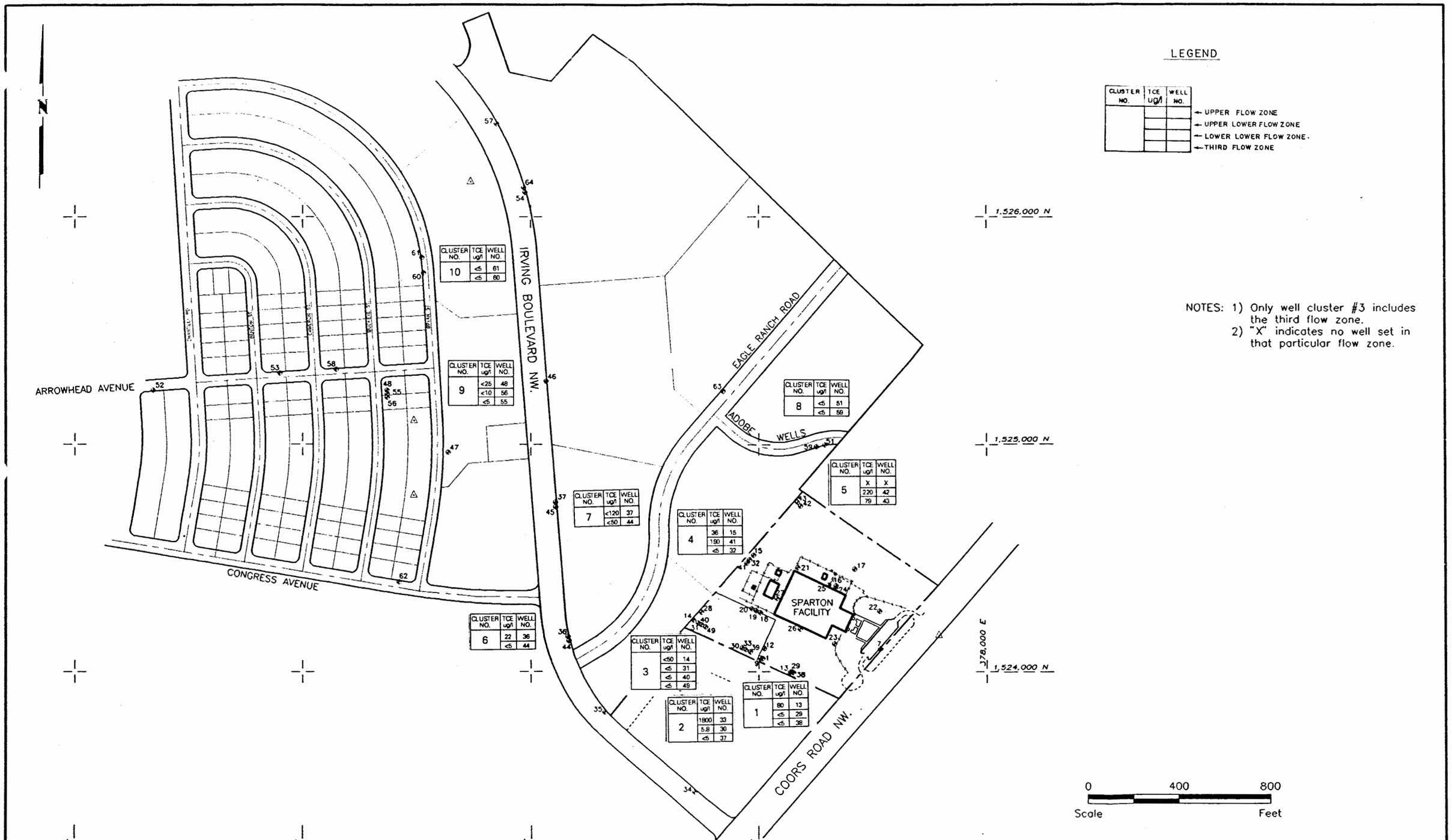
TCE CONCENTRATION–VERTICAL PROFILE

Sparton Tecnology, Inc.
Coors Road Facility
Albuquerque, New Mexico

FIGURE 61

DRAWN	JOB NUMBER	APPROVED	DATE	REVISED	DATE
DG	6310,039.12	JH	12/90		

0631014B



CLUSTER NO.	TCE ug/l	WELL NO.
10	<5	61
	<5	60

CLUSTER NO.	TCE ug/l	WELL NO.
9	<25	48
	<10	56
	<5	55

CLUSTER NO.	TCE ug/l	WELL NO.
8	<5	51
	<5	59

CLUSTER NO.	TCE ug/l	WELL NO.
5	X	X
	220	42
	79	43

CLUSTER NO.	TCE ug/l	WELL NO.
7	<120	37
	<50	44

CLUSTER NO.	TCE ug/l	WELL NO.
4	36	15
	190	41
	<5	32

CLUSTER NO.	TCE ug/l	WELL NO.
6	22	36
	<5	44

CLUSTER NO.	TCE ug/l	WELL NO.
3	<50	14
	<5	31
	<5	40
	<5	49

CLUSTER NO.	TCE ug/l	WELL NO.
2	1800	33
	5.8	30
	<5	37

CLUSTER NO.	TCE ug/l	WELL NO.
1	80	13
	<5	29
	<5	38

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TCA CONCENTRATION–VERTICAL PROFILE

Sparton Tecnology, Inc.
Coors Road Facility
Albuquerque, New Mexico

FIGURE 62

DRAWN	JOB NUMBER	APPROVED	DATE	REVISED	DATE
DG	6310,039.12	JH	12/90		

06310158

FIGURE 63

WELL CLUSTER SUMMARY			
Well Cluster No.	Well No.	Screened Interval Elevation, Ft (MSL)	Flow Zone
1	13	4983.35 - 4978.35	UFZ
	29	4941.57 - 4931.57	ULFZ
	38	4917.85 - 4907.85	LLFZ
2	33	4981.36 - 4971.36	UFZ
	30	4947.70 - 4937.70	ULFZ
	39	4921.07 - 4911.07	LLFZ
3	14	4980.94 - 4970.94	UFZ
	31	4947.57 - 4937.57	ULFZ
	40	4926.46 - 4916.26	LLFZ
	49	4905.88 - 4895.88	TFZ
4	15	4987.51 - 4977.51	UFZ
	41	4954.79 - 4949.79	ULFZ
	32	4940.08 - 4930.08	LLFZ
5	42	4952.28 - 4942.28	ULFZ
	43	4930.69 - 4920.69	LLFZ
6	36	4977.0 - 4967.0	UFZ
	44	4954.68 - 4944.68	ULFZ
7	37	4976.66 - 4966.66	UFZ
	45	4949.35 - 4939.35	ULFZ
8	51	4983.86 - 4973.86	UFZ
	59	4954.68 - 4944.18	ULFZ
9	48	4976.31 - 4961.31	UFZ
	56	4948.61 - 4938.61	ULFZ
	55	4913.61 - 4903.61	LLFZ
10	61	4975.98 - 4960.98	UFZ
	60	4948.62 - 4938.62	ULFZ

NOTE: UFZ = UPPER FLOW ZONE
ULFZ = UPPER LOWER FLOW ZONE
LLFZ = LOWER LOWER FLOW ZONE
TFZ = THIRD FLOW ZONE

Vertical profile sections to depict vertical plume configuration were developed along the longitudinal axis of the plume and at three transverse locations. Profile locations are shown of Figure 31. Profiles are shown on Figures 64 through 69. Concentration isopleths shown on the profiles are based on June 1991 analytical results given in Attachment 9 and based on the flow zone concentration isopleth interpretations given on Figures 55 through 60.

b. TCE Vertical Profile Trends

Of the ten well clusters, eight clusters (1, 2, 3, 4, 5, 6, 7 and 9) have detectable concentrations of TCE. All eight clusters show significant decreases in TCE concentration with depth. In the four cluster wells south and southwest of the facility (Clusters 1, 2, 3 and 6) TCE concentration was below detection limit (5 ug/l) in the bottom well of the cluster.

TCE concentration isopleths shown on the profile cross sections indicate a possible horizontal channeling effect in the upper lower flow zone in the central area of the plume. This channeling is probably related to differential fate and transport processes associated with the gravelly lower flow zone, i.e. minimal sorption, ease of movement. The profile cross sections generally indicate a typical dispersion/diffusion profile in the vertical direction.

FIGURE 64

TCE CONCENTRATION PROFILE

JUNE 1991

SECTION A-A

FIGURE 65

TCE CONCENTRATION PROFILE

JUNE 1991

SECTION B-B

FIGURE 66

TCE CONCENTRATION PROFILE

JUNE 1991

SECTION C-C AND SECTION D-D

FIGURE 67

TCA CONCENTRATION PROFILE

JUNE 1991

SECTION A-A

FIGURE 68

TCA CONCENTRATION PROFILE

JUNE 1991

SECTION B-B

FIGURE 69

TCA CONCENTRATION

JUNE 1991

SECTION C-C AND SECTION D-D

c. TCA Vertical Profile Trends

TCA concentrations in three clusters (6, 8 and 10) are below 5 ug/l detection limits. In three other clusters (3, 7 and 9), TCA is below increased detection limits resultant from sample dilution requirements for other constituents; however, detection limits decreased to 5 ug/l with depth. The remaining four clusters (1, 2, 4 and 5) on the south and west property line show decreasing TCA concentrations with depth.

The TCA concentration isopleths on the profile cross sections indicate a typical dispersion/diffusion profile in the vertical direction.

4. Plume Movement

The current TCE and TCA plume configurations (Figures 55-60) indicate an apparent net advective component of plume movement of 50 to 60 feet per year over the last 25 years. This advective component is within the range of groundwater velocities reported in the HLA report titled "Off-site Investigation" included as Attachment 7. However, groundwater analytical results indicate no discernible movement of the perimeter of the plume since 1989. This reduction or loss of an advective component is believed to be the result of the significant decrease in hydraulic gradient to the west of the facility and retardation effects including sorption, dissolution, hydrolysis, and/or biodegradation.

The TCE and TCA plumes are relatively wide compared to length. The plume width and the movement of constituents upgradient from the source indicate that diffusion has probably played a more significant role in determining the movement and shape of the plume.

5. Presence of Appendix IX Constituents

The predominant Appendix IX constituents found consistently throughout the study area are TCE and TCA. DCE and MeCl were detected on a less frequent or consistent basis, but still with some regularity. *Chromium was detected with some regularity within the boundaries of the TCE plume in the upper and upper lower flow zones.* Occurrences of other Appendix IX constituents were random and inconsistent. A complete listing of all analytical results for wells installed pursuant to the RFI is provided in Attachments 3 *and 9*.

Due to elevated levels of TCE in many of the samples, dilution of the samples prior to analysis was necessary to lower the TCE concentration to within the limits of the analytical instrument. Because of this dilution, the detection limits for other VOC compounds included in the analytical suite were raised to levels which in most cases, exceeded either federal or state standards. All such instances occurred in wells which are inside the plume boundaries and which are therefore considered to be contaminated.

6. Fate and Transport *of Volatile Organic Constituents*

a. Constituent Physical and Chemical Characteristics

Five volatile organic constituents (VOC) have been detected with some frequency in soil, groundwater, and soil gas at this site. These include Acetone, DCE, MeCl, TCE and TCA. TCE and TCA are the most prevalent followed by DCE. 1,1,2,2--tetrachloroethane (TeCA) was detected in two soil borings and tetrachloroethylene (TeCE) was encountered in the soil gas surveys. Physical and chemical data for these constituents

are given in Figure 70. In addition to these VOC, Vinyl Chloride (VC) is also included as a potential biodegradation product of TCE, TCA, TeCE, and DCE.

With respect to solubility, Acetone is the most soluble by several orders of magnitude. MeCl is the next most soluble. TCE, TCA, and DCE are an order of magnitude less soluble. TeCE is the least soluble.

Solution/vapor equilibrium is described by Henry's Law. Henry's Law constants for the various constituents indicate that VC will partition most readily from the dissolved aqueous phase into the vapor phase. DCE and TeCE will partition next most readily. Acetone will be the most difficult to partition into the vapor phase.

Based on a comparison of organic carbon partition coefficients (Koc), TeCE would have the highest adsorption potential, highest bioaccumulation potential, and lowest mobility. TCA and TCE would rank next. Acetone and MeCl would have the lowest adsorption potential and the highest mobility.

Specific gravity indicates that all but Acetone and VC are more dense than water with TeCE the heaviest. In the vapor state, all constituents are heavier than air. TeCE is the most dense (almost six times more dense than air). Thus TeCE vapor would settle or migrate downward more readily through the unsaturated zone and also displace less dense vapors. Based on vapor density, the vapor phase of all of the constituents would tend to migrate downward through the unsaturated zone.

b. Active Source Period

Both ponds and sumps were used to contain the waste stream at the facility from 1961 into the early 1980's. Leaks and/or overflows from these units would constitute

FIGURE 70

CONSTITUENT PHYSICAL AND CHEMICAL DATA

NAME	CAS #	MOLECULAR WEIGHT (g/mole)	WATER SOLUBILITY (mg/l)	VAPOR PRESSURE (mm Hg)	HENRY'S LAW CONSTANT (atm-m^3/mole)	Koc (ml/g)	SPECIFIC GRAVITY @ 20^0	VAPOR DENSITY (air=1.0)	BOILING POINT (^{0}C)
Acetone (2-Propanone)	67-64-1	58	1.00E+06	2.70E+02	2.06E-05	2.2	0.7880	2.00	56.5
Dichloromethane (Methylene Chloride)	75-09-2	85	2.00E+04	3.62E+02	2.03E-03	8.8	1.3255	2.90	39.75
1,1-Dichloroethylene (Vinylidene Chloride)	75-35-4	97	2.25E+03	6.00E+02	3.40E-02	65	1.2129	3.40	31.70
1,1,1-Trichloroethane (Methyl Chloroform)	71-55-6	133	1.50E+03	1.23E+02	1.44E-02	152	1.3376	4.60	113-114
Trichloroethylene	79-01-6	131	1.10E+03	5.79E+01	9.10E-03	126	1.4649	4.53	86.7
Tetrachloroethylene (Perchloroethylene)	127-18-4	166	1.50E+02	1.78E+01	2.59E-02	364	1.6230	5.80	121.0
Vinyl Chloride (Chloroethylene)	75-01-4	63	2.67E+03	2.66E+03	8.19E-02	57	0.9106	2.20	-13.4
1,1,2,2-Tetrachloroethane (Tetrachloroethane)	79-34-5	168	2.90E+03	5.00E+00	3.81E-04	118	1.5866	5.80	146.5

an active source to the subsurface. Fate and transport mechanisms responsible for the subsequent movement and distribution of the volatile organic constituents (VOC) are discussed in the following sections.

(1) Unsaturated Zone

In the unsaturated zone, fate and transport processes during the active source period would include gravity mechanisms, advection, sorption, and volatilization. The forces of gravity would carry free phase and/or aqueous phase constituents downward from the ground surface. Due to the heterogeneous nature of the subsurface (lenticular, horizontally bedded sands, silts and clays), the constituents would trace an erratic pathway down to the top of the water table.

In addition to the gravity mechanisms, advective processes associated with precipitation and other infiltration would tend to carry the constituents down to the top of the water table as well. The advection would be subject to similar pathway irregularities as described under gravity mechanisms.

Migration through the unsaturated zone would be influenced by sorption processes due to the presence of silt, clay and organic materials. The effect of the sorption would be to retard the downward migration resulting from the gravity and advection processes.

Volatilization of the constituents into the vapor phase could result in vapor phase movement in three possible directions in the unsaturated zone:

- Molecular diffusion of the vapor phase toward the surface would occur due to concentration gradients. Upon reaching the surface,

the vapor phase constituents would escape to the atmosphere due to wind dispersion effects.

- Because of molecular diffusion the vapor phase would also spread laterally in the subsurface as a function of the concentration gradient and any subsurface vapor currents caused by temperature differentials.
- Vertical movement of the vapor phase downward would also occur due to the relatively high vapor densities of the identified organic constituents in the source area.

Biotransformation may also have taken place in the unsaturated zone; however, the impact of biodegradation is a matter of speculation at this time and at an early stage of source activity it is believed that selective development of microorganism colonies would not have occurred.

(2) Saturated Zone

Fate and transport in the saturated zone would have begun with solution into the groundwater from either contact with the free product and/or the aqueous phase and also contact at the water surface with the vapor phase resulting from volatilization in the unsaturated zone. Solution into the groundwater and subsequent movement would have resulted in development of a contaminant plume.

Horizontal Movement. Based on the hydrogeologic characteristics and the recently observed plume shapes, it is believed that horizontal development of the plume

during the active source period was the result of both advection and mechanical dispersion processes. It is believed that the initial direction of movement was influenced by the perching effect of the zone of relatively lower permeability (ZORLP) and the irregular surface of that zone. Subsequent movement was affected by the groundwater hydraulic gradient and highly permeable gravelly zones. As the plume spread due to advective and mechanical dispersion processes, retardation due to sorption, biodegradation, hydrolysis, and off-gassing or dissolution to the unsaturated zone would have occurred. Sorption would have been related primarily to the silt and clay lenses and off-gassing would, of course, have occurred only at the water surface. In addition, the plume would have been affected by molecular diffusion into the less permeable zones where groundwater velocities would have been essentially zero.

Vertical Movement. Vertical movement of the plume appears to have been primarily a function of molecular diffusion and mechanical dispersion processes expanding the plume downward. Based on the current plume geometry, it is believed that molecular diffusion probably played a larger part in the plume expansion due to the horizontal silt and clay bedding minimizing vertical groundwater velocity components. It should be noted that hydrogeologic studies at this site have observed that vertical hydraulic gradients are related to resistance to vertical flow as opposed to indicating high velocity, vertical flow components. The absence of significant vertical flow components is due to the horizontal bedding and lenticular nature of the subsurface materials. Retardation of the vertical movement *also* occurred due to sorption of the organic chemicals onto clay and silt materials and *may have also occurred* due to biodegradation.

c. Inactive Source Period

In the early 1980's, use of the ponds and sump was discontinued and these waste management units were closed out. In addition, in early 1989, pump and treat remediation of shallow groundwater was initiated within the property boundary. As a result, the fate and transport mechanisms and their influence on the shape and distribution of the plume would have been altered. As in previous sections, discussion of the inactive source period will be subdivided into unsaturated zone and saturated zone processes.

(1) Unsaturated Zone

In the unsaturated zone, the previously discussed processes would have continued. However, the source of volatile organic constituents had been essentially removed. As a result, the supply for the gravity mechanism would have been terminated; however, constituents already present in the subsurface zone would have continued to migrate downward under the influence of gravity. Similarly, materials in the unsaturated zone would also have been subject to advective movements associated with precipitation and other infiltration. However, advective movements would have been slowed by the cap placed on the source area. Sorption would also have been occurring in the lower zones of the unsaturated or vadose zone; however, due to the termination of the source, desorption may have occurred in the upper portion of the unsaturated zone due to equilibrium requirements with respect to the vapor phase and/or as possibly related to the flushing effect of infiltrating water around the edge of the cap.

The cap probably reduced constituent loss to the atmosphere. However, vapor phase mechanics continued to impact soil sorption and groundwater solution due

to equilibrium requirements. Removal of the source and the pumping and treating of shallow groundwater resulted in a decrease in shallow groundwater constituent concentrations with time. As a result of the decreasing shallow groundwater concentrations, shallow groundwater off-gassing may have decreased. Conversely, reduction of the shallow groundwater concentration due to pumping and treating could also have resulted in an increased solution of the vapor phase existing above the water table.

(2) Saturated Zone

During the inactive source time period, a number of artificial penetrations were made into the saturated zone for purposes of sampling and/or monitor well installation. Due to the "perched" hydraulic gradients existing in some areas, these artificial penetrations could have resulted in movement of contaminants in a vertical direction in addition to fate and transport anticipated from natural processes.

In the saturated zone, advection and mechanical dispersion effects became minimal as the plume moved offsite to the west due primarily to the reduced groundwater velocity in this area. As a result, diffusion apparently became the dominant physical process and it is believed to be occurring to the present, often at concentrations below detection limits along the perimeter or surface of the plume.

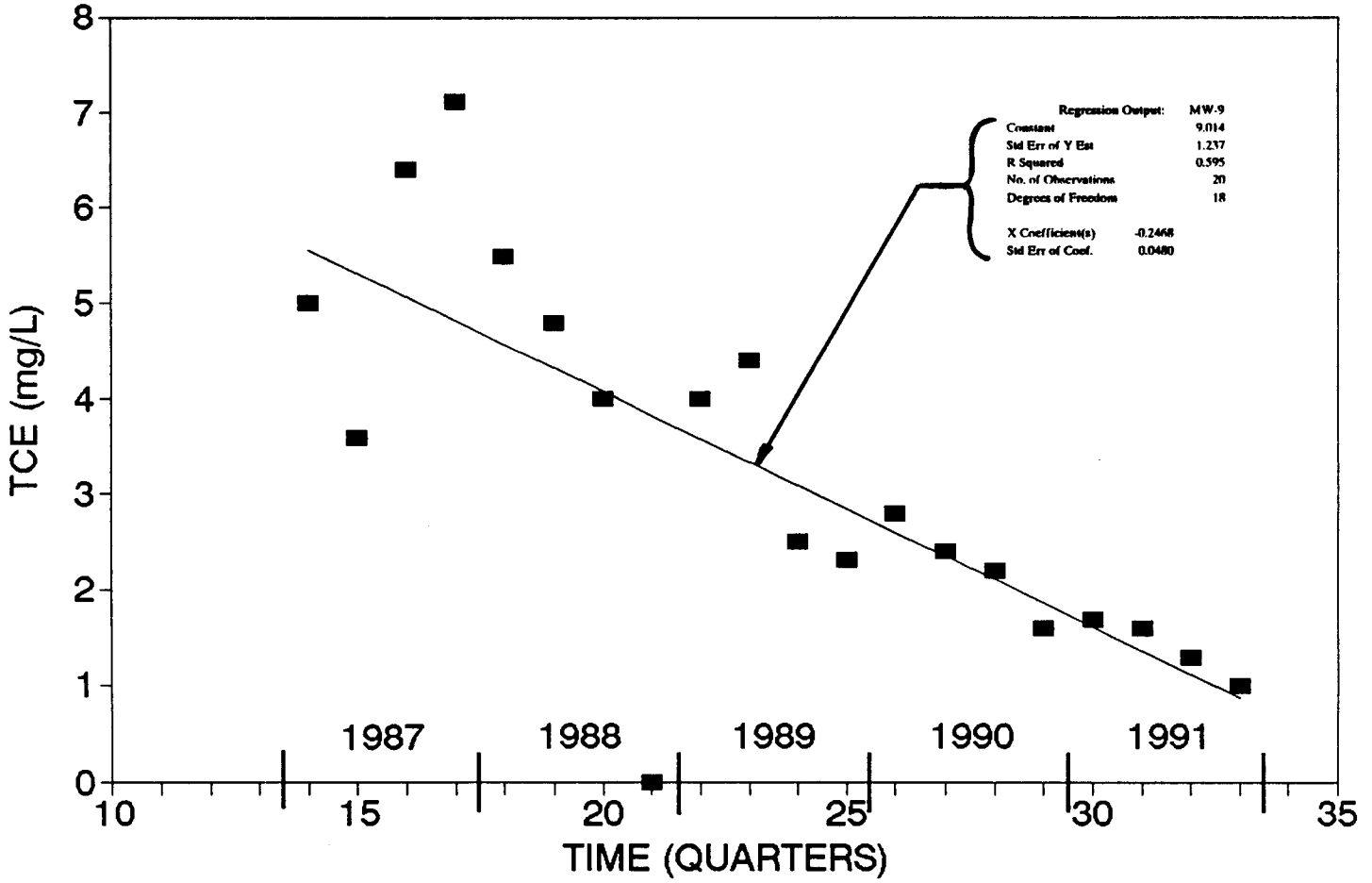
Dissolution or off-gassing occurring from the groundwater surface was probably the most dominant chemical process occurring during this period and the effect of dissolution would retard and apparently has even reduced the areal extent of the plume.

As the plume expanded, sorption became the second most dominant chemical process in stopping or slowing down the advance of the plume. However, it should be noted that, as the concentration drops in the interior of the plume due to removal of the source and due to pump and treat remediation reducing constituent mass, desorption may be occurring in response to the concentration decrease.

Hydrolysis and biodegradation are probably occurring although these processes have not been documented. Biodegradation would be expected to become a more significant process with the passage of time as microbial action would develop in response to the laws of natural selectivity, that is, those organisms that can utilize the constituents present in groundwater as a food source would tend to multiply.

d. Future Movement

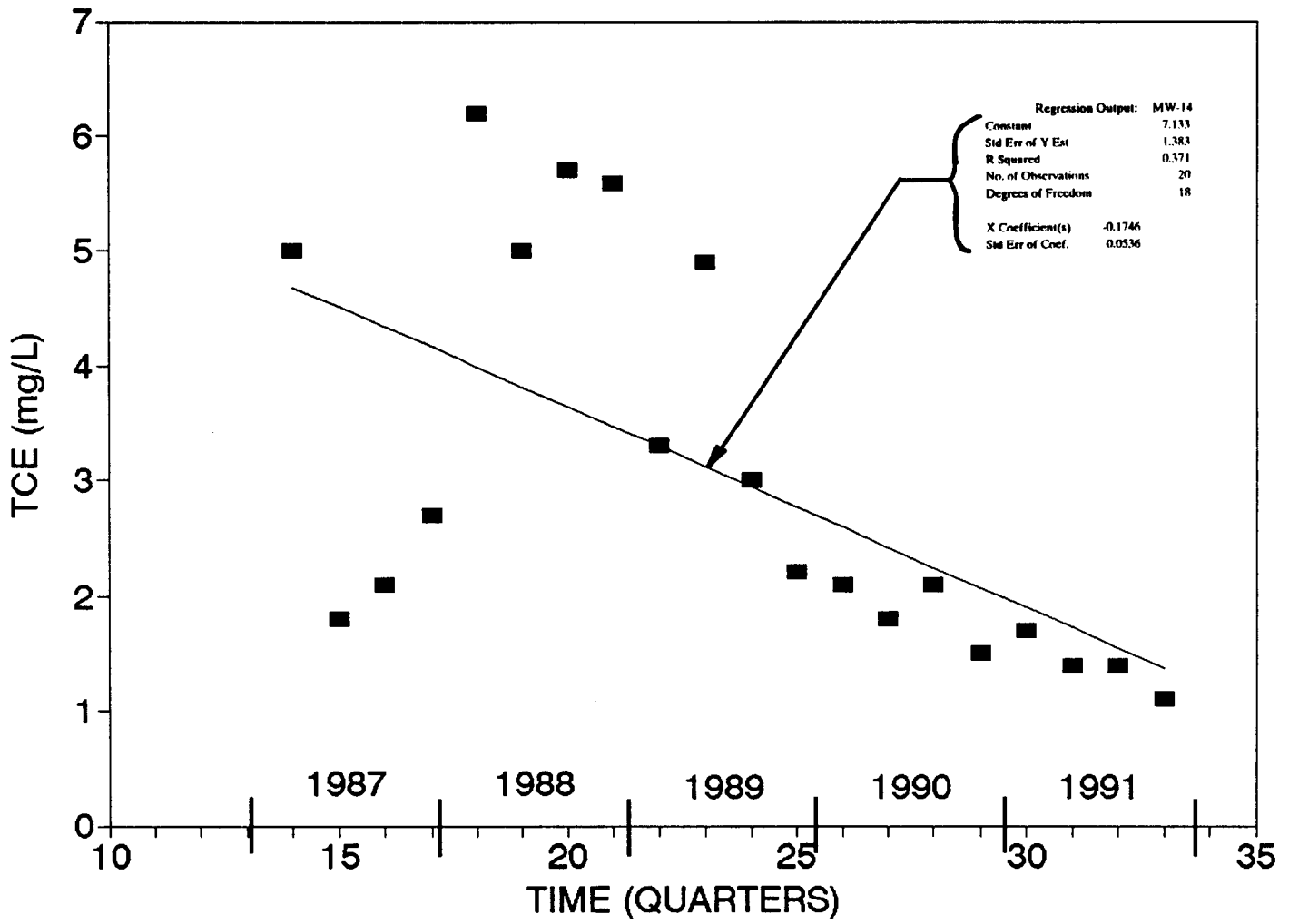
Plume contouring based on groundwater sampling and analysis conducted since early 1989 and soil gas analyses conducted since 1987 indicate that the plume is shrinking in areal and vertical extent and is experiencing a significant reduction in concentration at almost all sampling locations. Time-history plots of TCE concentration obtained from the quarterly monitoring data base also indicate a steady decrease in concentration (see Figures 71-78). Considering that the source has been removed and that the pump and treat remediation is being conducted in the source area, the observed reduction in plume size and constituent concentrations should continue into the future. However, there is insufficient data currently available to predict the rate of plume and/or concentration decrease.



TCE CONCENTRATION VS TIME
MW-9 (UPPER FLOW ZONE)
SPARTON TECHNOLOGY, INC.
ALBUQUERQUE, NEW MEXICO

FIGURE 71

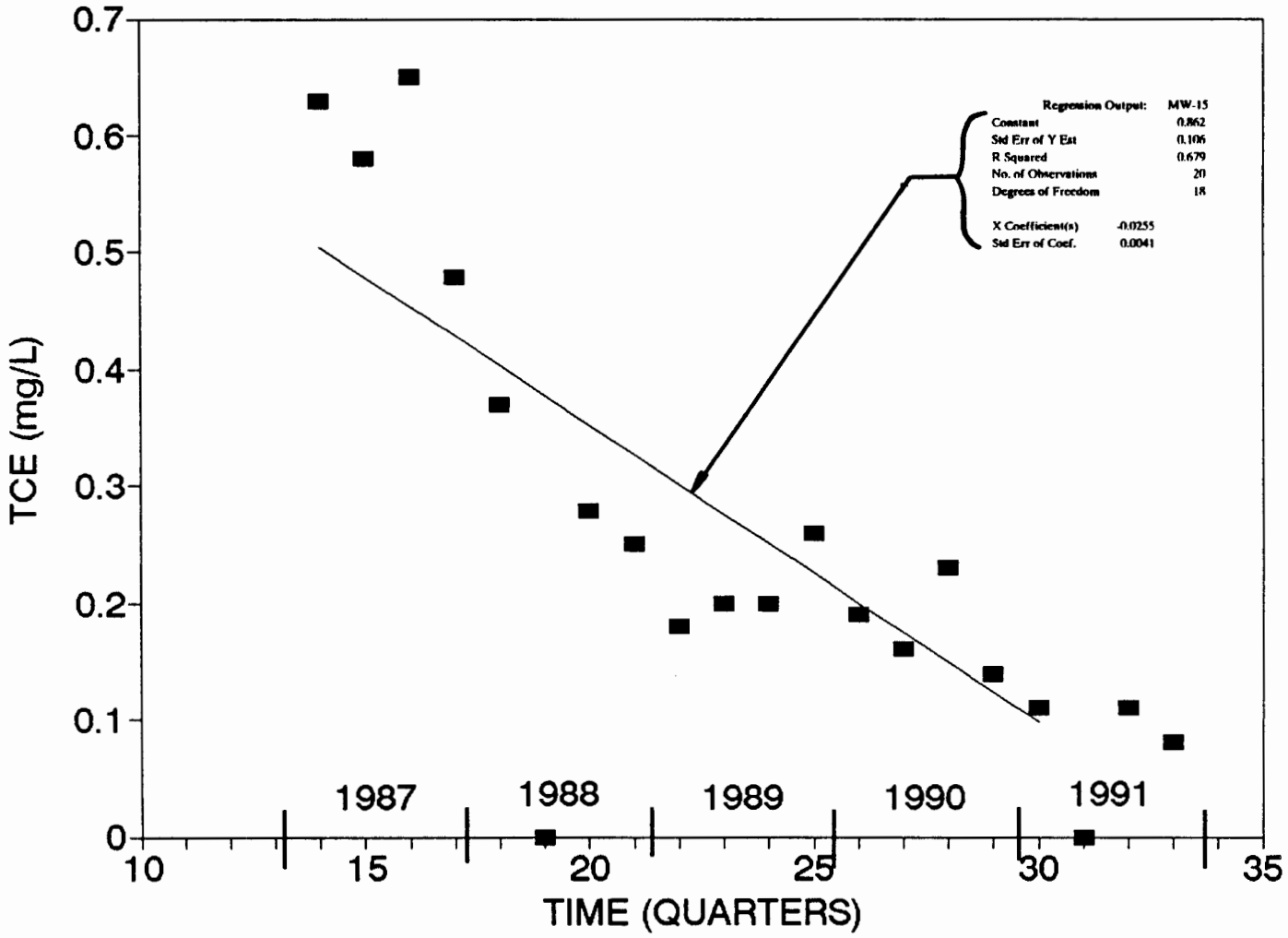
Revised 12/1/91



TCE CONCENTRATION VS TIME
MW-14 (UPPER FLOW ZONE)
SPARTON TECHNOLOGY, INC.
ALBUQUERQUE, NEW MEXICO

FIGURE **72**

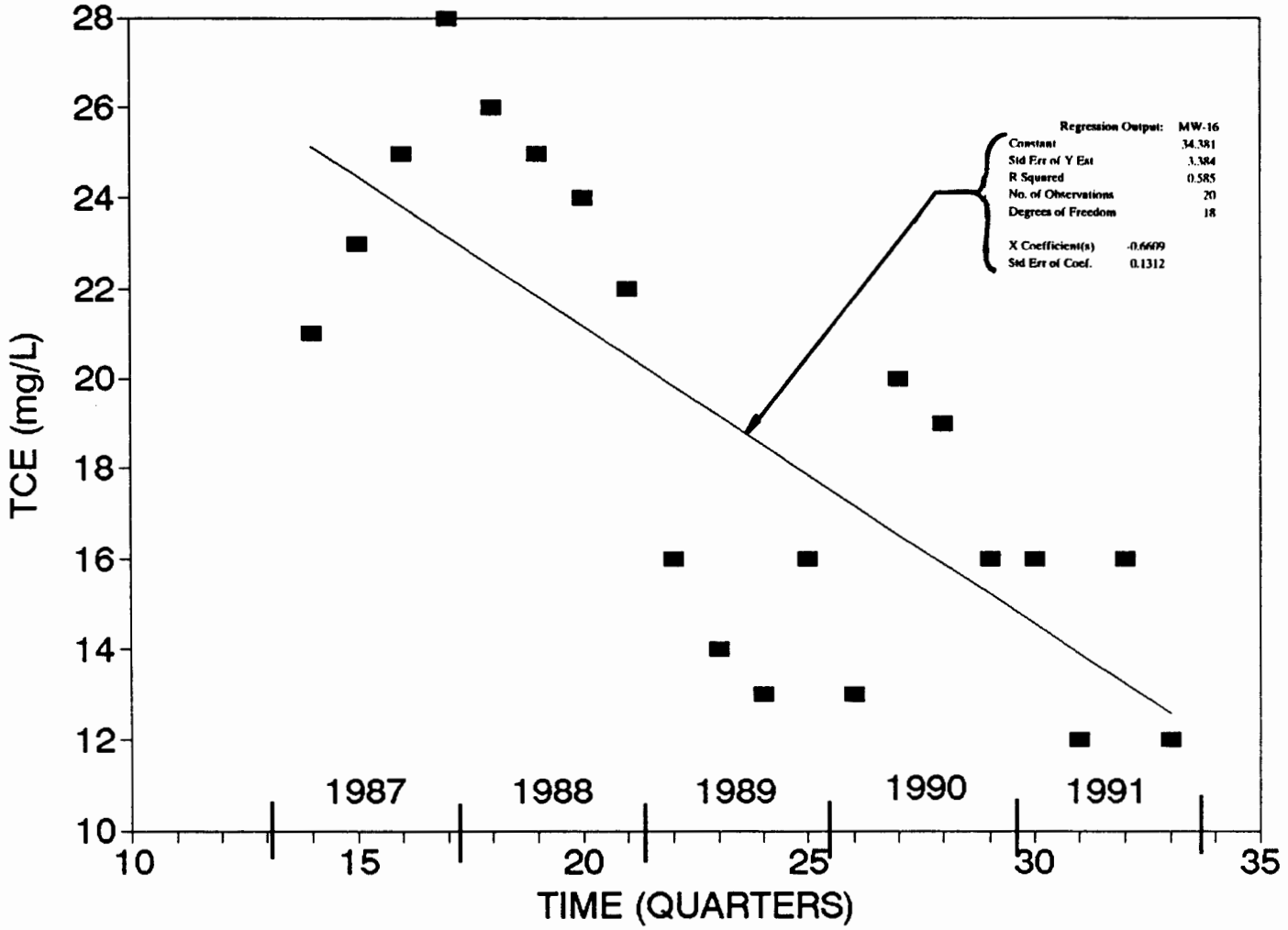
Revised 12/1/91



TCE CONCENTRATION VS TIME
MW-15 (UPPER FLOW ZONE)
SPARTON TECHNOLOGY, INC.
ALBUQUERQUE, NEW MEXICO

FIGURE 73

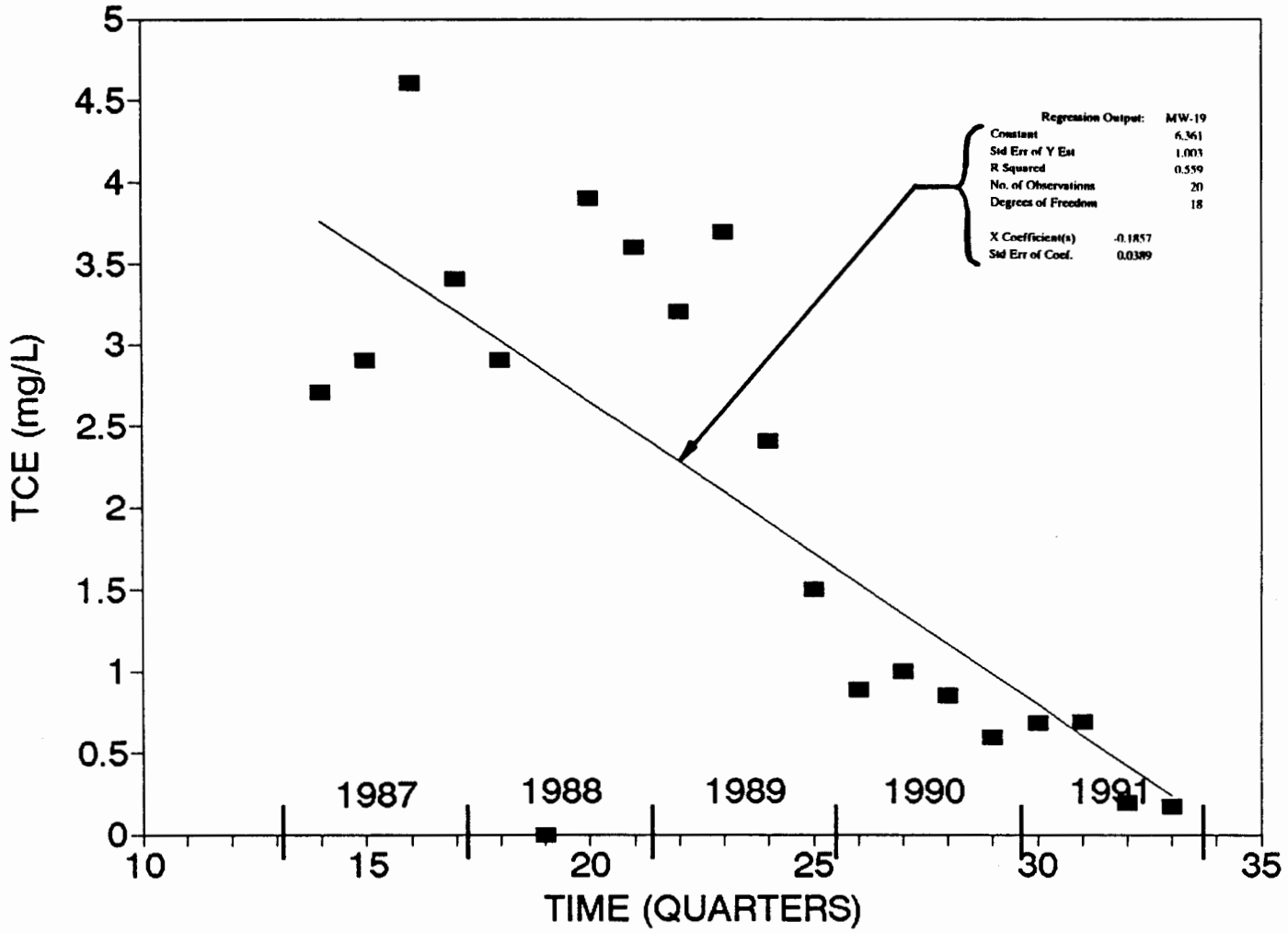
Revised 12/1/91



TCE CONCENTRATION VS TIME
MW-16 (UPPER FLOW ZONE)
SPARTON TECHNOLOGY, INC.
ALBUQUERQUE, NEW MEXICO

FIGURE **74**

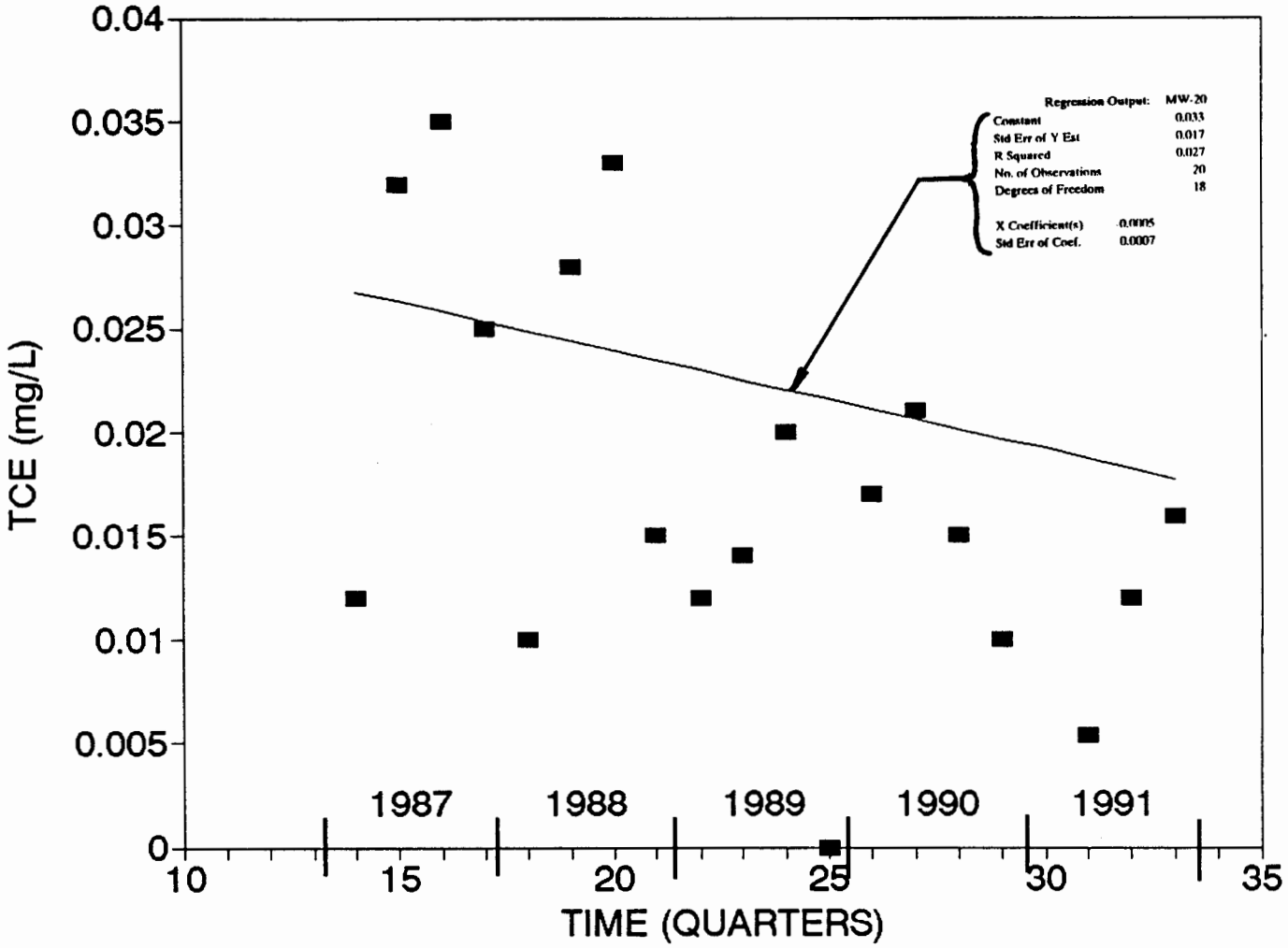
Revised 12/1/91



TCE CONCENTRATION VS TIME
MW-19 (UPPER LOWER FLOW ZONE)
SPARTON TECHNOLOGY, INC.
ALBUQUERQUE, NEW MEXICO

FIGURE 75

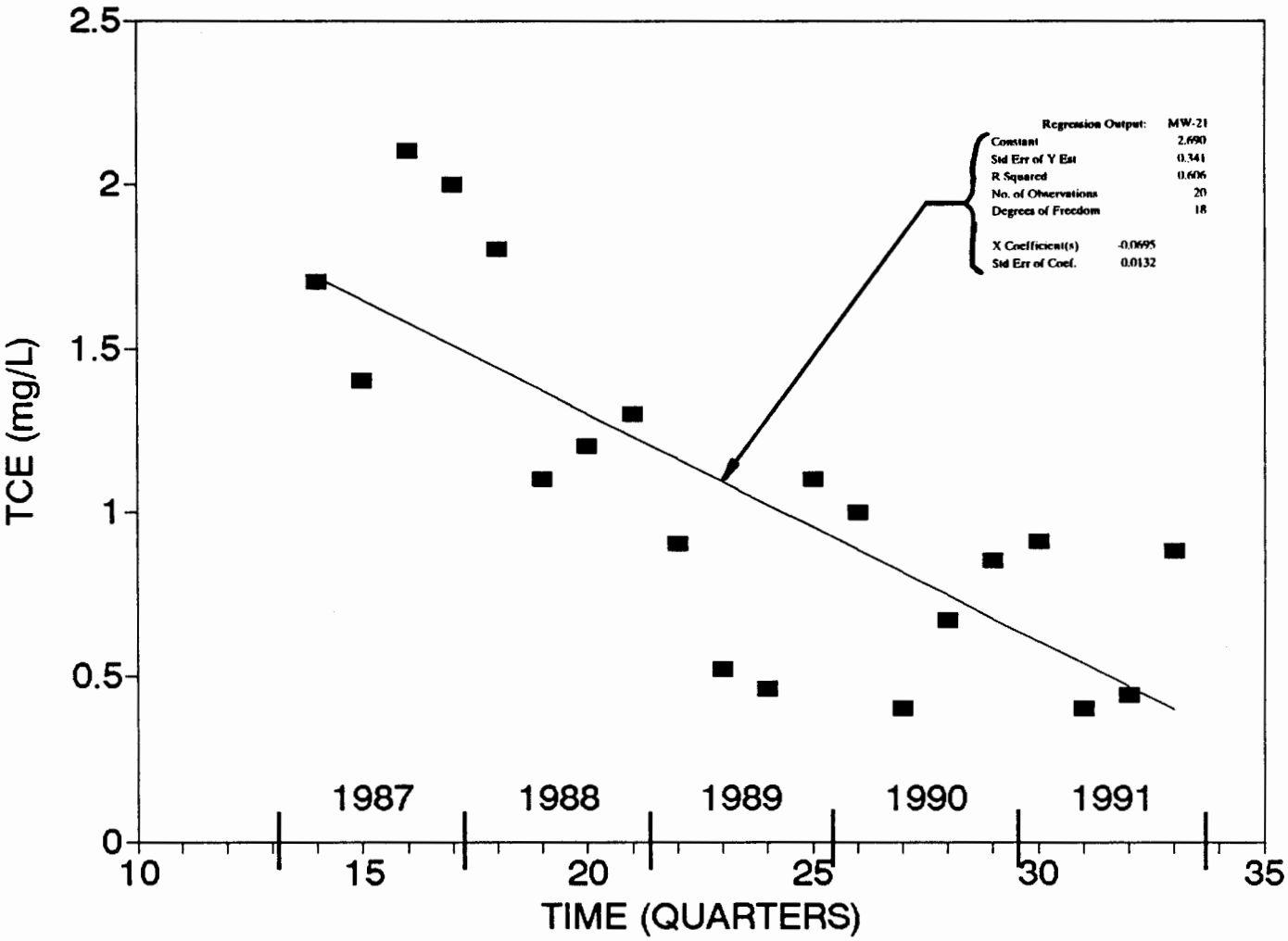
Revised 12/1/91



TCE CONCENTRATION VS TIME
MW-20 (LOWER LOWER FLOW ZONE)
SPARTON TECHNOLOGY, INC.
ALBUQUERQUE, NEW MEXICO

FIGURE **76**

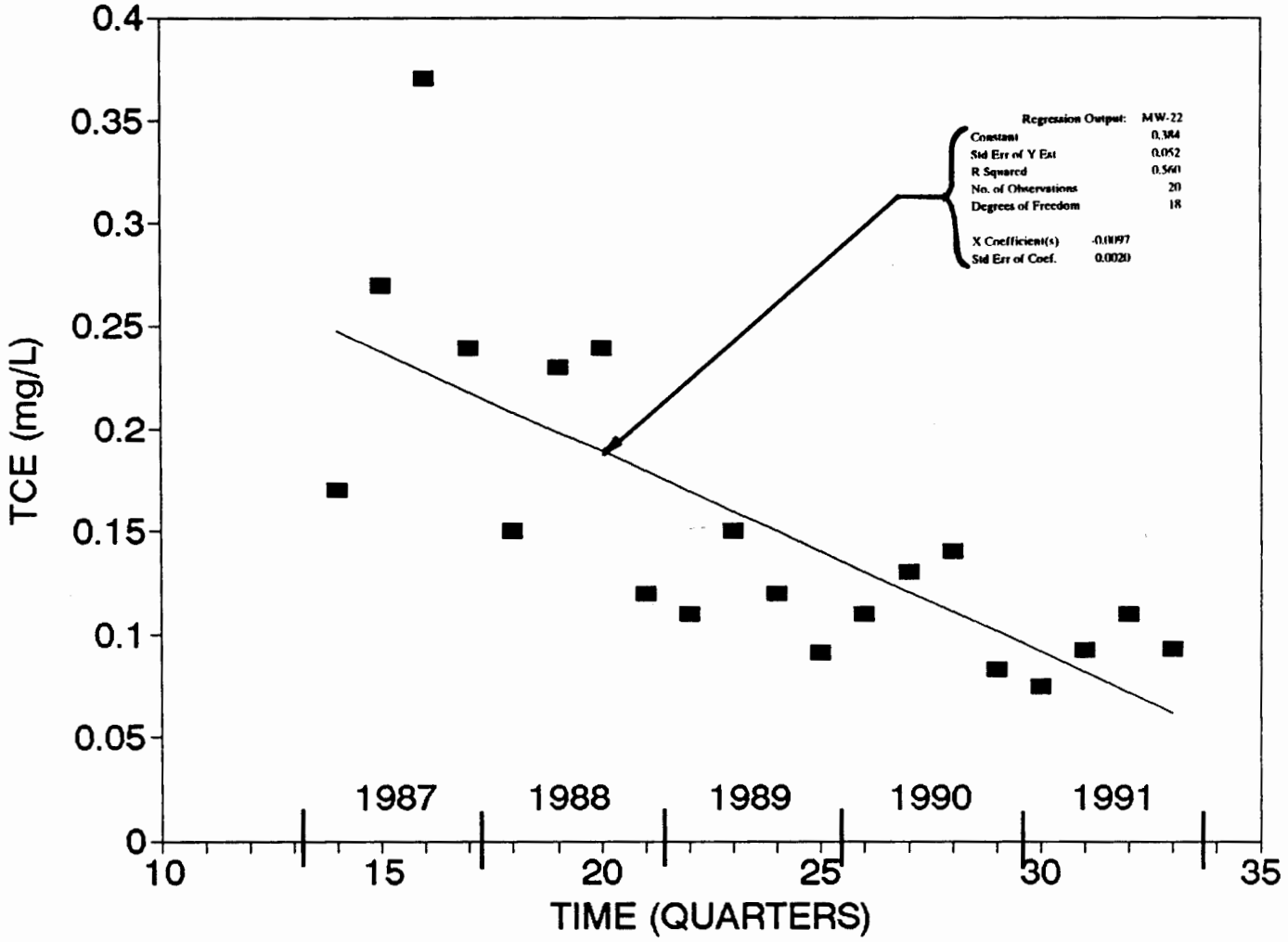
Revised 12/1/91



TCE CONCENTRATION VS TIME
MW-21 (UPPER FLOW ZONE)
SPARTON TECHNOLOGY, INC.
ALBUQUERQUE, NEW MEXICO

FIGURE **77**

Revised 12/1/91



TCE CONCENTRATION VS TIME
MW-22 (UPPER FLOW ZONE)
SPARTON TECHNOLOGY, INC.
ALBUQUERQUE, NEW MEXICO

FIGURE **78**

Revised 12/1/91

7. *Fate and Transport of Metallic Constituents*

Various metals have been detected in soil and groundwater samples at the site. Most detections are very low and within background concentrations. However, elevated concentrations of chromium have been detected in soil samples under the source (pond/sump area) and in groundwater samples within the upper portion of the VOC plume. Fate and transport of chromium and other metals will be controlled by sorption, chelation, and redox reactions. Sorption will predominate in fine-grained soils, however, chemical reactions are poorly understood.

At the Sparton site, chromium was apparently carried downward with percolating water. Chromium was absorbed onto fine-grained soils in the unsaturated zone some 40 to 50 feet below the surface. Chromium was also carried into the groundwater. It is assumed that chromium movement was the result of solvation and being transported with the TCE/TCA. This assumption is based on: the poor solubility of chromium in the metallic state; the high solubility in water/chlorinated solvents in anionic forms such as chromate; and coincidence of elevated chromium concentration with elevated concentration of TCE/TCA.

Source removal probably eliminated the downward movement through the unsaturated zone. The movement in the groundwater is also reasonably static at this time due to the assumed relationship with the VOC plume. Future movement will be related to the dynamics of the VOC plume and partitioning onto fine-grained soils below the water table.

8. Effectiveness of Interim Recovery Well System

Under the provisions of the Consent Order, an interim groundwater recovery well system was installed in the upper flow zone. *A report on the evaluation of the effectiveness of this groundwater recovery well system will be submitted to EPA for approval within 30 days after the final RFI report has been approved by EPA.*

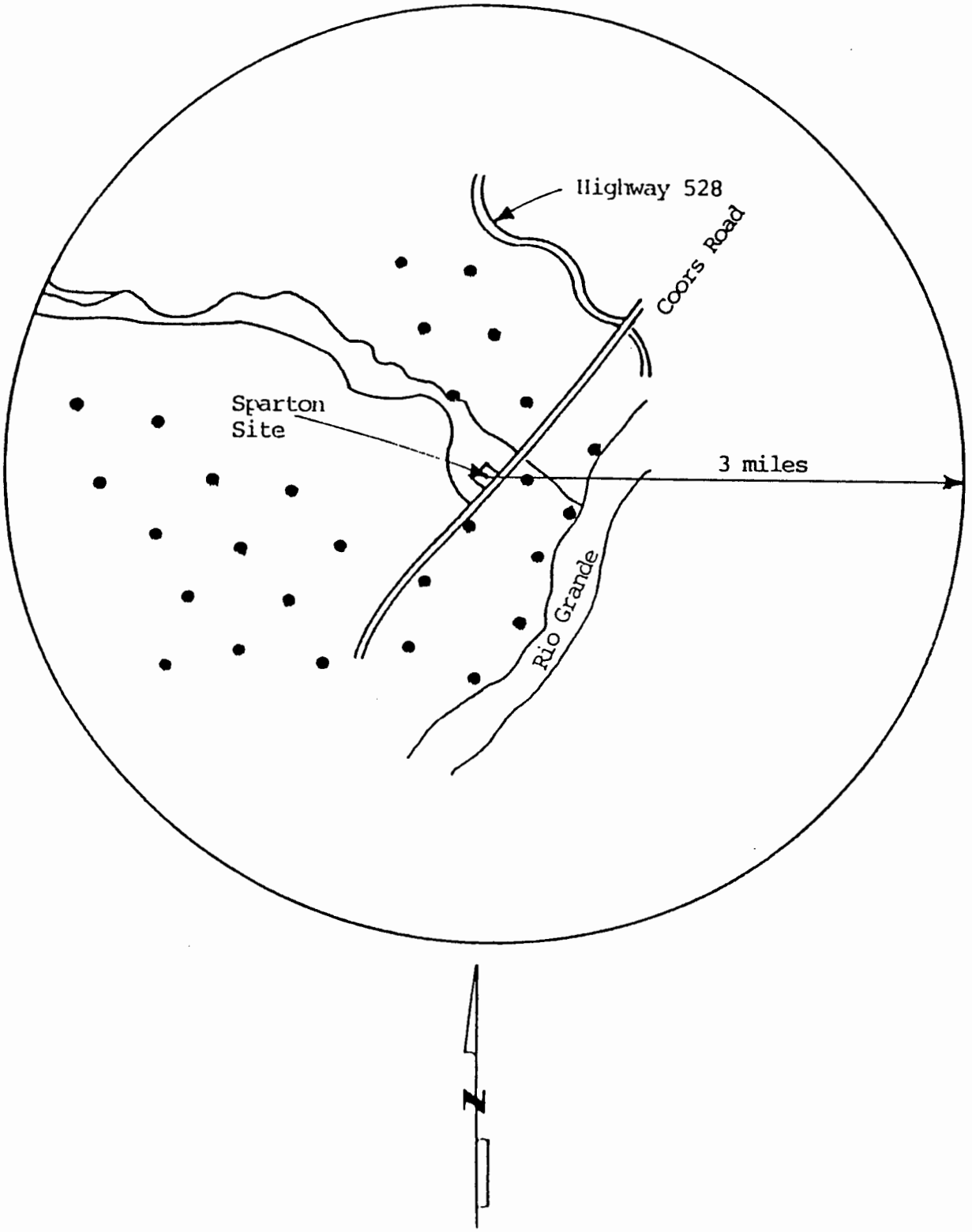
VI POTENTIAL RECEPTORS

A. Groundwater

Figure 8 shows the locations of non-monitor wells in the vicinity of the Sparton site. The wells designated as "wells confirmed by state records" are described in Attachment 8. The information was obtained from New Mexico State Engineer Office records. The wells designated as "wells visually observed" were located by field reconnaissance. Records are not available to determine the type or use for these wells, or if they are even in use.

Figure 79 shows the location of the nearest municipal well to be approximately 2.5 miles westnorthwest of the Sparton facility. There are two other municipal wells located approximately 2.5 miles north. These are the only existing municipal wells known to exist on the west side of the Rio Grande within a three-mile radius of the Sparton site.

Figure 80 shows the locations of planned future wells in the vicinity of the Sparton facility. This information was extracted from the "Water Systems Master Plan for the City of Albuquerque" updated in 1982. None of these wells have been installed at this time. In a personal communication with Mr. Norman Gaume, Operations Manager for the City of Albuquerque Water Utility, Mr. Gaume stated that there are no plans to install municipal wells in this area before the limit of their planning horizon, currently the year 2000.



Scale 1" = 1 mile

● Planned municipal wells

Harding Lawson Associates
Engineers and
Environmental Services

PLANNED MUNICIPAL WELLS
Sparton Technology Inc.
Coors Road Facility
Albuquerque, New Mexico

FIGURE
80

DRAWN	JOB NUMBER	APPROVED	DATE	REVISED	DATE
	6310,039.12	JH	12-90		

B. Surface Waters

No domestic or municipal surface water sources exist within a 1.5-mile radius of the Sparton facility. Irrigation at residential, commercial, and industrial establishments is principally derived from municipal water systems. No future development of surface water for domestic or municipal uses is anticipated for the area.

Some limited fishing is currently available in the Corrales Riverside Drain and Rio Grande east of the Sparton site. No expansion of fishing opportunities is expected in the future in the area (New Mexico Game and Fish Department, Operations Plan, Aquatic Management of N.M. Wildlife 1987 to 1995, and J. Maracchini, N.M. Area Fisheries Manager, oral communication).

Local surface water sources are the Corrales Main Canal, the Corrales Riverside Drain, and the Rio Grande which provide water for irrigated agriculture to the east of the Sparton site. No expansion of this agricultural use is contemplated.

No current industrial uses of surface waters are known in the local area, and no future surface water use is anticipated.

Surface water in the Corrales Main Canal, the Corrales Riverside Drain, and the Rio Grande supports vegetative habitats and associated wildlife. No expansion of this function is planned.

C. Human Use or Access

There are no existing or planned recreational facilities adjacent to the Sparton facility. Neither are there any existing or planned hunting facilities or opportunities adjacent to the Sparton facility.

There are no existing or planned residential uses of land adjacent to the facility. Current zoning restricts development of residential land uses in proximity to the facility. Commercial land use is currently established on adjacent lands to the north and south of the plant site. Commercial land use is also planned to the west of the facility.

The Sparton facility is located within an area zoned for manufacturing. Adjacent land to the north is also zoned for manufacturing. To the west and south of the facility, zoning is for commercial development. Lands to the east of the facility are zoned for agriculture. These current zone designations for lands adjacent to the facility are supported and recommended to be maintained in the future by the Coors Corridor Plan (April 1984).

Prevailing winds in the area of the Sparton facility are shown in Figure 81. Winds blow most frequently from the north in winter, and from the south along the Rio Grande Valley in summer. Existing and planned residential areas are located to the west of the facility.

FIGURE 81

PREVAILING WINDS AND AVERAGE MONTHLY WIND SPEEDS		
Month	**Average Speed m.p.h.**	**Prevailing Direction**
January	8.0	N
February	8.8	N
March	10.1	SE
April	11.0	S
May	10.5	S
June	10.0	S
July	9.1	SE
August	8.2	SE
September	8.6	SE
October	8.3	SE
November	7.9	N
December	7.7	N

Source: National Oceanic and Atmospheric Administration,
Local Climatological Data, Albuquerque, New Mexico, 1978

D. Surface Water Biota

There are no known surface water bodies on, adjacent to, or affected by the Sparton facility.

E. Ecology

The vegetation in the area of the Sparton facility has been altered through development. The facility site exhibits landscaping comprised of lawn, shrubs, and trees (cottonwood and conifers). The principal plant community in adjacent areas is grassland or shrubland. Dominant grasses include burro grass, gramma grasses, fluffgrass, dropseeds, galleta, alkali socaton, needle and thread, western wheatgrass, three-awn, bottlebrush, and squirreltail. Shrubs and forbs include sagebrush, snakeweed, Morman tea, locust, fourwing saltbrush, indigo bush, yucca, prickly pear, peppergrass, stickleaf, and spectacle pod. Where the grassland or shrubland community is disturbed, there is a decrease in black gramma and bush muckly, and an increase in galleta, sand dropseed, and annual plants.

Wildlife resources in the facility area have been significantly affected by increased urbanization. Much of the original grassland has been replaced by less palatable species as well as shrubs such as snakeweed. Other than acting as a soil stabilizer, many of the shrubs and grasses are of little value to wildlife.

Representative wildlife species inhabiting the vicinity of the Sparton facility include the black-tailed jackrabbit, desert cottontail rabbit, kangaroo rats, pocket mouse, white-footed mouse, ground squirrel, northern grasshopper mouse, horned lark, mourning dove, scaled

quail, mockingbird, several species of sparrows, prairie falcon, collard lizard, roundtailed horned lizard, and roadrunner.

F. Demographic Profile

Demographic data for the vicinity are based on information in the Census of Population and Housing: Census Tracts, Albuquerque, New Mexico, Standard Metropolitan Statistical Area and the 1980 Census of Population and Housing Tape File 1 and 3, U.S. Department of Commerce, Bureau of Census, Washington, D.C., 1980, as summarized in the Northwest Area Plan. The Sparton facility area is contained in Census Tract 47.3. Information for this tract is, in some instances, presented by block which describes a larger area than just the immediate facility vicinity.

The population of the greater area of the facility vicinity is just over 24,000 persons with the largest number of people in the 20-to-64 age group. The school age group, 5-to-19, is approximately half the size of the 20-to-64 age group. The pre-school age group, 0-to-4, outnumbers the over-65 age group. The population is distributed in approximately 8,352 households.

The area population is 47% Spanish ethnicity. There is less than 2% Black, approximately 4% American Indian, and less than 1% Asian. The area population is relatively stable, with 44% maintaining a five-year residency in the same house and 54% having been born in New Mexico.

G. Endangered or Threatened Species

Eight species of plants are currently listed as endangered or threatened in New Mexico by the U.S. Fish and Wildlife Service and the New Mexico Heritage Program, but none of the habitats for these plants occur in the vicinity of the Sparton facility.

Of the seven bird species and one mammal specie listed as endangered in New Mexico by the New Mexico Department of Fish and Game as of 1983, four bird species were recorded as having been sighted in or near the facility area in 1984. The birds were McCown Lingspurs, Bell Vieros, Peregrine Falcons, and Mississippi Kites. Certain federal endangered species, such as the Whooping Crane and Bald Eagle, may fly over the Rio Grande during migration and may land locally to feed.

VII GROUNDWATER PROTECTION STANDARDS

A. Maximum Concentration Limits

Maximum concentration limits for groundwater protection have been established by EPA relative to releases from solid waste management units in 40 CFR 264.94. These MCLs are shown in Figure 82.

B. Maximum Contaminant Levels (MCLs)

Maximum contaminant levels (MCLs) for drinking water are promulgated under the Safe Drinking Water Act and can be found in 40 CFR 141.61 and 141.62. MCL's may be considered as appropriate standards for groundwater protection if the groundwater is, or could be potentially, used for drinking consumption. Current MCLs (January 1991) are given in Figure 83.

C. New Mexico Groundwater Standards

The New Mexico Water Quality Control Commission (WQCC) Human Health Standards for groundwater quality, as defined in Part 3-103 of the WQCC regulations, are shown in Figure 84.

D. Other Standards

For constituents not covered by regulatory protection standards, alternate concentration limits (ACL's) or action levels can be developed using constituent data

FIGURE 82

MAXIMUM CONCENTRATION OF CONSTITUENTS FOR GROUNDWATER PROTECTION	
Constituent	**Maximum Concentration mg/l**
Arsenic	0.05
Barium	1.0
Cadmium	0.01
Chromium	0.05
Lead	0.05
Mercury	0.002
Selenium	0.01
Silver	0.05
Endrin	0.0002
Lindane	0.004
Methoxychlor	0.1
Toxaphene	0.005
2,4-D	0.1
2,4,5- P Silvex	0.01

Source: 40 CFR 264.94

FIGURE 83

SAFE DRINKING WATER ACT MAXIMUM CONTAMINANT LEVELS

Type of Contaminant	Name of Contaminant	Maximum Contaminant Level (MCL) (mg/l)
Inorganic Chemicals	Asbestos	7 MFL (million fibers per liter longer than 10 microns)
	Arsenic	0.05
	Cadmium	0.005
	Chromium	0.1
	Fluoride	4 (secondary MCL of 2 triggers public notice)
	Mercury	0.002
	Nitrate (as N)	10
	Nitrite (as N)	1
	Total Nitrate/Nitrite	10
	Selenium	0.05
	Lead, Copper	Under Revision
Organic Chemicals	**Pesticides/PCBs**	
	Endrin	0.0002
	Lindane	0.0002
	Methoxychlor	0.04
	Toxaphene	0.003
	2,4,5-TP (Silvex)	0.05
	2,4-D	0.07
	Alachlor	0.002
	Atrazine	0.003
	Carbofuran	0.04
	Chlordane	0.002
	Dibromochloropropane	0.0002
	Ethylene dibromide	0.00005
	Heptachlor	0.0004
	Heptachlor epoxide	0.0002
	PCB's	0.0005
	Pentachlorophenol*	0.001
	Volatile Organic Chemicals	
	Benzene	0.005
	Carbon tetrachloride	0.005
	1,2-Dichloroethane	0.005
	p-Dichlorobenzene	0.075
	1,1-Dichloroethylene	0.007
	1,1,1-Trichloroethane	0.20
	Trichloroethylene	0.005
	Vinyl chloride	0.002
	o-Dichlorobenzene	0.6
	cis-1,2-Dichloroethylene	0.07
	trans-1,2-Dichloroethylene	0.1
	1,2-Dichloropropane	0.005
	Ethylbenzene	0.7
	Monochlorobenzene	0.1
	Styrene	0.1
	Tetrachloroethylene	0.005
	Toluene	1
	Xylenes	10

Source: 40 CFR 141

FIGURE 84

NEW MEXICO GROUNDWATER STANDARDS	
Parameter	**Maximum Allowable Concentration**
Arsenic	100 ug/l
Barium	1000 ug/l
Cadmium	10 ug/l
Chromium	50 ug/l
Cyanide	200 ug/l
Fluoride	1600 ug/l
Lead	50 ug/l
Total Mercury	2 ug/l
Nitrate as N	10000 ug/l
Selenium	50 ug/l
Silver	50 ug/l
Uranium	5000 ug/l
Radioactivity: Combined Radium-226 and Radium-228	30.0 pCi/l
Benzene	10 ug/l
Polychlorinated Biphenyls	1 ug/l
Toluene	750 ug/l
Carbon Tetrachloride	10 ug/l
1,2-Dichloroethane	10 ug/l
1,1-Dichloroethylene	5 ug/l
1,1,2,2-Tetrachloroethylene	20 ug/l
1,1,2-Trichloroethylene	100 ug/l
Ethylbenzene	750 ug/l

FIGURE 84 (Continued)

NEW MEXICO GROUNDWATER STANDARDS	
Parameter	**Maximum Allowable Concentration**
Total Xylenes	620 ug/l
Methylene Chloride	100 ug/l
Chloroform	100 ug/l
1,1-Dichloroethane	25 ug/l
Ethylene Dibromide	0.1 ug/l
1,1,1-Trichloroethane	60 ug/l
1,1,2-Trichloroethane	10 ug/l
1,1,2,2-Tetrachloroethane	10 ug/l
Vinyl Chloride	1 ug/l
PAHS: total naphthalene plus monomethylnaphthalenes	30 ug/l
Benzo-a-pyrene	0.7 ug/l
Secondary Standards	
Chloride (Cl)	250 mg/l
Copper (Cu)	1000 ug/l
Iron (Fe)	1000 ug/l
Manganese (Mn)	200 ug/l
Phenols	5 ug/l
Sulfate (SO_4)	600 mg/l
Total Dissolved Solids (TDS)	1000 mg/l
Zinc (Zn)	10 mg/l
pH	between 6 and 9

FIGURE 84 (Continued)

NEW MEXICO GROUNDWATER STANDARDS	
Parameter	**Maximum Allowable Concentration**
Irrigation Standards	
Aluminum (Al)	5000 ug/l
Boron (B)	750 ug/l
Cobalt (Co)	50 ug/l
Molybdenum (Mo)	1000 ug/l
Nickel (Ni)	200 ug/l

Source: New Mexico Water Quality Control Commission Regulations, Part 3-103.

obtained from the Integrated Risk Information System (IRIS) updated on a continuous basis by U.S. EPA's Office of Health and Environmental Assessment. Using the constituent data and standardized human intake assumptions, ACLs can be calculated. Constituent data is given as carcinogen slope factors (CSF's) for carcinogenic effects and as reference doses (RfD's) for systemic toxicants. For those constituents identified at this site, CSF and RfD data is included in Figure 85.

E. Background Concentrations

Monitor well MW-6 was located upgradient of the source area in the northern corner of the facility property. Historical analyses of groundwater samples from this well showed elevated concentrations of the principal parameters found in the Sparton plume (see Attachment 1). *The* well was plugged and abandoned in early 1989 under the provisions of the Consent Order.

Monitor well MW-51 was installed in April 1990. This well is located north of the Sparton facility, west of the car dealership which is adjacent to Sparton's northeastern boundary. Analyses of groundwater samples from this well show slightly elevated concentrations of TCE.

FIGURE 85

CONSTITUENT DATA FOR HEALTH RISK ASSESSMENT

CONSTITUENT NAME	CLASS	ORAL REFERENCE DOSE (mg/kg/day)	ORAL CARCINOGEN SLOPE FACTOR $(mg/kg/day)^{-1}$
Acetone	D	1.0E-01	NA
1,1-Dichloroethylene	C	9.0E-03	6.0E-01
Methylene Chloride	B	6.0E-02	7.5E-03
1,1,2,2-Tetrachloroethane	C	NA	2.0E-01
Tetrachloroethylene	BZ	1.0E-02	5.1E-02
1,1,1-Trichloroethane	D	9.0E-02	NA
Trichloroethylene	BZ	NA	1.1E-02
Chromium (VI)	A	5.0E-03	4.1E+01*

* Inhalation slope factor

Revised 12/01/91

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RCRA FACILITY INVESTIGATION
VOLUME I OF II

SPARTON TECHNOLOGY, INC.
COORS ROAD FACILITY
ALBUQUERQUE, NEW MEXICO

DECEMBER 1991

HDR

ATTACHMENT 1

Alternate Groundwater Monitoring Database

ATTACHMENT 2

Contaminant Properties

ATTACHMENT 3

Plume Delineation Database

RCRA FACILITY INVESTIGATION
VOLUME II OF II

SPARTON TECHNOLOGY, INC.
COORS ROAD FACILITY
ALBUQUERQUE, NEW MEXICO

DECEMBER 1991

HDR

ATTACHMENT 4

Boring Logs and Well Completion Diagrams

ATTACHMENT 5

Groundwater Flow

ATTACHMENT 6

Unsaturated Zone Boring Logs and Analytical Data

ATTACHMENT 7

Off-Site Investigation

ATTACHMENT 8

Description of Vicinity Wells

ATTACHMENT 9

June 1991 Sampling and Analysis

Tracer Research Corporation

PREPARED FOR:

Metric Corporation
8429 Washington Place NE
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SHALLOW SOIL GAS INVESTIGATION

SPARTAN TECHNOLOGY BUILDING
9621 NORTH COORS ROAD
ALBUQUERQUE, NEW MEXICO

JUNE 1991

REVISED 12/91

SUBMITTED BY:

Tracer Research Corporation

191263S.REP
1-91-263-S

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INTRODUCTION

A shallow soil gas investigation was performed by Tracer Research Corporation (*TRACER*) at the Spartan Technology Building site located in Albuquerque, New Mexico. The investigation was conducted on June 17-19, 1991 under contract to Metric Corporation. The purpose of the investigation was to delineate the extent of possible contamination in the subsurface.

During this survey, a total of 63 soil gas samples were collected and analyzed. Samples were analyzed for volatile organic compounds from the following suite:

COMPOUND	DETECTOR
1,1,1-trichloroethane (TCA)	ECD
trichloroethene (TCE)	ECD
tetrachloroethene (PCE)	ECD

The compounds in this suite were chosen as target compounds because of their suspected presence in the subsurface and amenability to soil gas technology. Soil gas samples were screened on a gas chromatograph equipped with an electron capture detector (ECD).

SHALLOW SOIL GAS INVESTIGATION - METHODOLOGY

Shallow soil gas investigation refers to a method developed by *TRACER* for investigating underground contamination from volatile organic chemicals (VOCs) such as industrial solvents, cleaning fluids and petroleum products by looking for their vapors in the shallow soil gas. The method involves pumping a small amount of soil gas out of the ground through a hollow probe driven into the ground and analyzing the gas for the presence of volatile contaminants. The presence of VOCs in shallow soil gas indicates the observed compounds may either be in the vadose zone near the probe or in groundwater below the probe. The soil gas technology is most effective in mapping low molecular weight halogenated solvent chemicals and petroleum hydrocarbons possessing high vapor pressures and low aqueous solubilities. These compounds readily partition out of the groundwater and into the soil gas as a result of their high gas/liquid partitioning coefficients. Once in the soil gas, VOCs diffuse vertically and horizontally through the soil to the ground surface where they dissipate into the atmosphere. The contamination acts as a source and the above ground atmosphere acts as a sink, and typically a concentration gradient develops between the two. The concentration gradient in soil gas between the source and ground surface may be locally distorted by hydrologic and geologic anomalies (e.g. clays, perched water); however, soil gas mapping generally remains effective because distribution of the contamination is usually broader in areal extent than the local geologic barriers and is defined using a large database. The presence of geologic obstructions on a small scale tends to create anomalies in the soil gas-groundwater correlation, but generally does not obscure the broader areal picture of the contaminant distribution.

Soil gas contaminant mapping helps to reduce the time and cost required to delineate underground contamination by volatile contaminants. The soil gas investigation does this by outlining the general areal extent of contamination. Conventional bore holes or observation wells are used to verify both the presence and extent of the subsurface

contamination as indicated in the soil gas survey. In this manner, soil gas contaminant mapping can assist in determining the placement of monitoring wells. Thus the likelihood of drilling unnecessary monitoring wells is reduced. The soil gas survey is not intended to be substitute for conventional methodology, but rather to enable conventional methods to be used efficiently.

EQUIPMENT

Tracer Research Corporation utilized a one ton Ford analytical van that was equipped with one gas chromatograph and two Spectra Physics computing integrators. In addition, the van had two built-in gasoline powered generators that provide the electrical power (110 volts AC) to operate all of the gas chromatographic instruments and field equipment. A specialized hydraulic mechanism consisting of two cylinders and a set of jaws was used to drive and withdraw the sampling probes. A hydraulic hammer was used to assist in driving probes past cobbles and through unusually hard soil.

SOIL GAS SAMPLING PROCEDURES

Sampling probes consisted of 7 foot lengths of 3/4 inch diameter hollow steel pipe that were fitted with detachable drive tips. Soil gas probes were advanced 4-6 feet below grade. Once inserted into the ground, the above-ground end of the sampling probes were fitted with a steel reducer and a length of polyethylene tubing leading to a vacuum pump. Gas flow was monitored by a vacuum gauge to insure that an adequate flow was obtained.

To adequately purge the volume of air within the probe, 2 to 5 liters of gas was evacuated with a vacuum pump. During the soil gas evacuation, samples were collected in a glass syringe by inserting a syringe needle through a silicone rubber segment in the evacuation line and down into the steel probe. Ten milliliters of gas were collected for immediate analysis in the *TRACER* analytical field van. Soil gas was subsampled (duplicate

injections) in volumes ranging from 1 uL to 2 mL, depending on the VOC concentration at any particular location.

Sample probe vacuums ranged from 1-5 inches Hg. The maximum pump vacuum was measured at 17 inches Hg (If the probe had become plugged or totally obstructed the vacuum would have read the maximum of 17 inches Hg).

ANALYTICAL PROCEDURES

A Varian 3300 gas chromatograph was used for the soil gas analyses. It was equipped with an electron capture detector (ECD). Compounds were separated on a 6' by 1/8" OD packed column with OV-101 as the stationary phase in a temperature controlled oven. Nitrogen was used as the carrier gas.

Halocarbon compounds detected in the samples were identified by chromatographic retention time. Quantification of compounds was achieved by comparison of the detector response of the sample with the response measured for calibration standards (external standardization). Instrument calibration checks were run periodically throughout the day and system blanks were run at the beginning of the day to check for contamination in the soil gas sampling equipment. Air samples were also routinely analyzed to check for background levels in the atmosphere.

Detection limits for the compounds of interest were a function of the injection volume as well as the detector sensitivity for individual compounds. Thus the detection limit varied with the sample size. Generally, the larger the injection size the greater the sensitivity. However, peaks for compounds of interest were kept within the linear range of the analytical equipment. If any compound had a high concentration, it was necessary to use small injections, and in some cases to dilute the sample to keep it within linear range. This may have caused decreased detection limits for other compounds in the analyses.

The detection limits for the halocarbon compounds were approximately 0.0002 ug/L.

Detection limits were dependant upon the conditions of the measurement, in particular, the sample size. If any component being analyzed was not detected, the detection limit for that compound in that analysis is given as a "less than" value (e. g. < 0.1 ug/L). Detection limits obtained from GC analyses were calculated from the current response factor, the sample size, and the estimated minimum peak size (area) that would have been visible under the conditions of the measurement.

QUALITY ASSURANCE/QUALITY CONTROL PROCEDURES

Tracer Research Corporation's normal quality assurance procedures were followed in order to prevent any cross-contamination of soil gas samples. These procedures are described below:

- Steel probes are used only once during the day and then washed with high pressure soap and hot water spray or steam-cleaned to eliminate the possibility of cross-contamination. Enough probes are carried on each van to avoid the need to reuse any during the day.
- Probe adaptors (*TRACER*'s patented design) are used to connect the sample probe to the vacuum pump. The adaptor is designed to eliminate the possibility of exposing the sample stream to any part of the adaptor. Associated tubing connecting the adaptor to the vacuum pump is replaced periodically as needed during the job to insure cleanliness and good fit. At the end of each day the adaptor is cleaned with soap and water and baked in the GC oven.
- Silicone tubing (which acts as a septum for the syringe needle) is replaced as needed to insure proper sealing around the syringe needle. This tubing does not directly contact soil gas samples.

- Glass syringes are usually used for only one sample per day and are washed and baked out at night. If they must be used twice, they are purged with carrier gas (nitrogen) and baked out between probe samplings.
- Injector port septa through which soil gas samples are injected into the chromatograph are replaced on a daily basis to prevent possible gas leaks from the chromatographic column.
- Analytical instruments are calibrated each day by analytical standards from Chem Service, Inc. Calibration checks are also run after approximately every five soil gas sampling locations.
- Subsampling syringes are checked for contamination prior to sampling each day by injecting nitrogen carrier gas into the gas chromatograph.
- Prior to sampling each day, system blanks are run to check the sampling apparatus (probe, adaptor, 10 cc syringe) for contamination by drawing ambient air from above ground through the system and comparing the analysis to concurrently sampled ambient air analysis.
- All sampling and subsampling syringes are decontaminated each day and no such equipment is reused before being decontaminated. Microliter size subsampling syringes are reused only after a nitrogen carrier gas blank is run to insure it is not contaminated by the previous sample.
- Soil gas pumping is monitored by a vacuum gauge to insure that an adequate gas flow from the vadose zone is maintained. A reliable gas sample can be obtained if the sample vacuum gauge reading is at least 2 inches Hg less than the maximum pump vacuum.

TEST RESULTS

A total of 63 soil gas and 8 ambient air samples were collected and analyzed on site. Analytical data are condensed in Appendix A and reported in micrograms per liter. Appendix B contains maps showing the distribution of the target VOCs.

Ambient air samples were collected during the course of the investigation to help evaluate the Level of Significance for the selected compounds. The Level of Significance is simply the level above which is considered to be significant in terms of groundwater or soil contamination. TCA, TCE and PCE were not detected in any of the ambient air samples analyzed in the field. The Level of Significance for each target compound is based on several factors; concentrations in ambient air, background levels, and *TRACER's* past experience. Based on the evaluation of these factors, the Level of Significance for the selected target compounds was determined to be 0.001 ug/L. In other words, soil gas concentrations of TCA, TCE and PCE greater than the determined Level of Significance may indicate possible VOC contamination in the vicinity.

Prior to the start of the soil gas survey, sample locations were placed by the client. The investigation started at sampling point SG-91-1 and continued from that point as data became available. Sample locations SG-91-1 through SG-91-10 were collected along North Coors Road, investigation proceeded to the north-northwest of the Spartan Building and proceeded to cover the area surrounding the building.

TCA concentrations over the entire site ranged from non-detect (<0.0004 ug/L) to 12 ug/L. The highest concentration was detected at sampling location SG-61. The elevated levels of TCA are concentrated around the Spartan Building and decrease as you move further away from the building decreasing to non-detect (<0.0004 ug/L) levels to the northwest.

The TCE detected followed much the same path as the TCA mentioned earlier although not a broad spread. TCE ranged in concentration from non-detect (<0.001 ug/L)

to 24 ug/L detected at sampling location SG-91-61. Concentrations of TCE above 1 ug/L were detected at those sampling locations immediately surrounding the Spartan Building with concentrations decreasing away from the building. The TCE seemed to be concentrated in a more southwesterly direction than the TCA as shown if figure 3.

PCE was also detected during the investigation. The PCE was detected in a much smaller area that either the TCA or the TCE and at lower concentrations. The PCE ranged in concentration from non-detect (<0.0006 ug/L) to 0.2 ug/L being detected at sampling locations SG-91-42, SG-91-49, SG-91-50, and SG-91-61, these samples being located immediately to the north-northwest of the Spartan Building. One isolated area around sampling location SG-91-38 also showed contourable levels of PCE.

CONCLUSIONS

The highest concentrations of TCA, TCE and PCE were detected at those sampling locations in the immediate vicinity of the Spartan Building. Concentrations decreased to levels of non-detect to the northwest. No conclusions can be drawn regarding the area to the southeast of this site because no samples were collected to the southeast of the Spartan Building, further investigation would need to be conducted to assess the area in this direction and soil gas technology would be ideal for this function.

APPENDIX A: ANALYTICAL DATA

METRIC CORPORATION/SPARTAN FACILITY/ALBUQUERQUE, NEW MEXICO JOB #1-91-263-S
6/17/91
CONDENSED DATA

SAMPLE	TCA ug/l	TCE ug/l	PCE ug/l
AIR	<0.0002	<0.0007	<0.0003
SG-91-1-6'	0.01	0.003	0.009
SG-91-2-6'	0.1	0.02	<0.0006
SG-91-3-6'	0.08	0.03	0.001
SG-91-4-6'	0.4	0.3	0.004
SG-91-5-6'	0.2	0.2	0.003
SG-91-6-6'	0.2	0.4	0.004
SG-91-7-6'	<0.0004	0.004	<0.0006
SG-91-8-6'	0.07	<0.001	<0.0006
SG-91-9-6'	<0.0004	<0.001	<0.0006
SG-91-10-6'	<0.0004	<0.001	<0.0006
SG-91-11-6'	<0.0004	<0.001	<0.0006
SG-91-12-6'	<0.0004	<0.001	<0.0006
SG-91-13-6'	<0.0004	<0.001	<0.0006
SG-91-14-6'	0.005	<0.001	<0.0006
SG-91-15-6'	0.1	0.02	<0.0006
SG-91-16-6'	<0.0004	<0.001	<0.0006
AIR	<0.0002	<0.0007	<0.0003
SG-91-17-6'	<0.0004	<0.001	<0.0006
SG-91-18-6'	<0.0004	<0.001	<0.0006
SG-91-19-6'	<0.0004	<0.001	<0.0006
SG-91-20-6'	<0.0004	<0.001	<0.0006
SG-91-21-6'	<0.0004	<0.001	<0.0006
SG-91-22-4'	<0.0004	<0.001	<0.0006

Analyzed by: D. Ho
Proofed by: KW

METRIC CORPORATION/SPARTAN FACILITY/ALBUQUERQUE, NEW MEXICO JOB #1-91-263-S
6/17/91
CONDENSED DATA

SAMPLE	TCA ug/l	TCE ug/l	PCE ug/l
SG-91-23-5'	<0.0004	<0.001	<0.0006
SG-91-24-6'	<0.0004	<0.001	<0.0006
SG-91-25-6'	<0.0004	<0.001	<0.0006
SG-91-26-4'	<0.0004	<0.001	<0.0006
SG-91-27-6'	0.003	<0.001	<0.0006
SG-91-28-6'	0.02	<0.001	<0.0006
SG-91-29-6'	0.09	0.02	<0.0006
SG-91-30-5'	0.04	<0.001	<0.0006
SG-91-31-6'	<0.0004	<0.001	<0.0006
SG-91-32-6'	<0.0004	<0.001	<0.0006
AIR	<0.0002	<0.0007	<0.0003

Analyzed by: D. Ho
Proofed by: KW

METRIC CORPORATION/SPARTAN FACILITY/ALBUQUERQUE, NEW MEXICO JOB #1-91-263-S
6/18/91
CONDENSED DATA

SAMPLE	TCA ug/l	TCE ug/l	PCE ug/l
AIR	<0.0002	<0.0007	<0.0003
SG-91-33-6'	0.02	0.01	<0.0006
SG-91-34-6'	0.1	0.8	0.01
SG-91-35-6'	0.06	0.1	0.003
SG-91-36-6'	0.3	0.4	0.03
SG-91-37-6'	0.07	0.06	<0.0006
SG-91-38-6'	0.5	0.2	0.001
SG-91-39-6'	0.04	<0.001	<0.0006
SG-91-40-5'	0.06	<0.003	0.007
SG-91-41-6'	0.03	0.03	0.001
SG-91-42-6'	0.6	8	0.2
SG-91-43-6'	0.07	0.3	0.02
SG-91-44-4'	<0.0004	<0.001	<0.0006
SG-91-45-5'	<0.0004	<0.001	<0.0006
SG-91-46-6'	<0.0004	<0.001	<0.0006
AIR	<0.0002	<0.0007	<0.0003
SG-91-47-6'	0.3	0.1	<0.006
SG-91-48-6'	2	1	0.03
SG-91-49-5'	7	8	0.2
SG-91-50-6'	8	8	0.2
SG-91-51-5'	0.001	<0.001	<0.0006
SG-91-52-5'	0.002	<0.001	<0.0006
SG-91-53-5'	0.006	<0.001	<0.0006
SG-91-54-5'	0.003	<0.001	0.002

Analyzed by: D. Ho
Proofed by: kr

METRIC CORPORATION/SPARTAN FACILITY/ALBUQUERQUE, NEW MEXICO JOB #1-91-263-S
6/18/91
CONDENSED DATA

SAMPLE	TCA ug/l	TCE ug/l	PCE ug/l
SG-91-55-6'	1	2	0.09
SG-91-56-6'	2	3	0.1
SG-91-57-6'	1	3	0.1
SG-91-58-6'	0.8	4	0.1
SG-91-59-5'	0.8	0.8	0.02
SG-91-60-6'	2	5	0.06
AIR	<0.0002	<0.0007	<0.0003

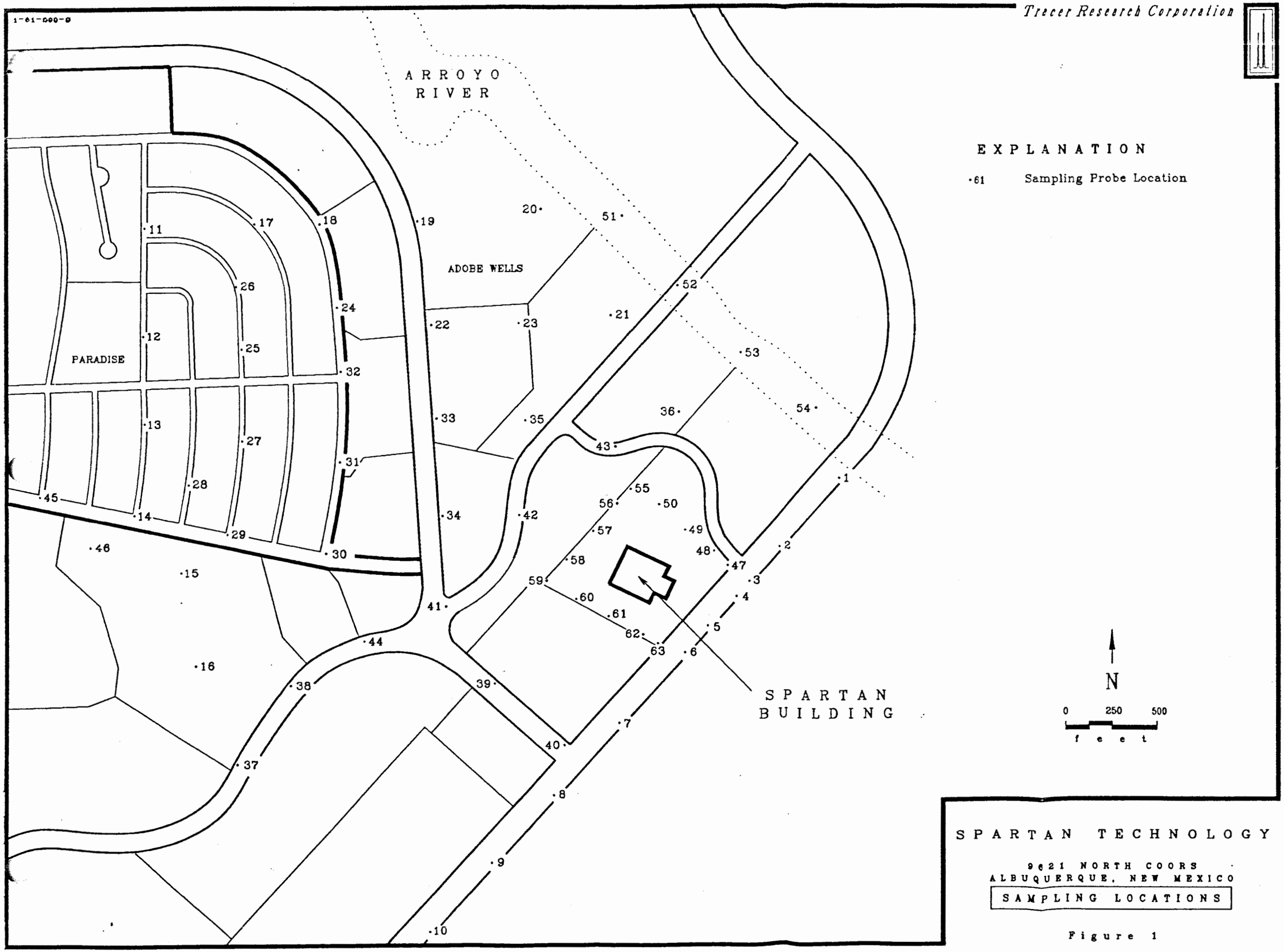
Analyzed by: D. Ho
Proofed by: KW

METRIC CORPORATION/SPARTAN FACILITY/ALBUQUERQUE, NEW MEXICO JOB #1-91-263-S
6/19/91
CONDENSED DATA

SAMPLE	TCA ug/l	TCE ug/l	PCE ug/l
AIR	<0.0003	<0.001	0.0009
SG-91-61-6'	12	24	0.2
SG-91-62-6'	6	7	<0.1
SG-91-63-6'	1	2	<0.05
AIR	<0.0003	<0.001	<0.0005

Analyzed by: D. Ho
Proofed by: KW

APPENDIX B: FIGURES



SPARTAN TECHNOLOGY

9621 NORTH COORS
ALBUQUERQUE, NEW MEXICO

SAMPLING LOCATIONS

Figure 1

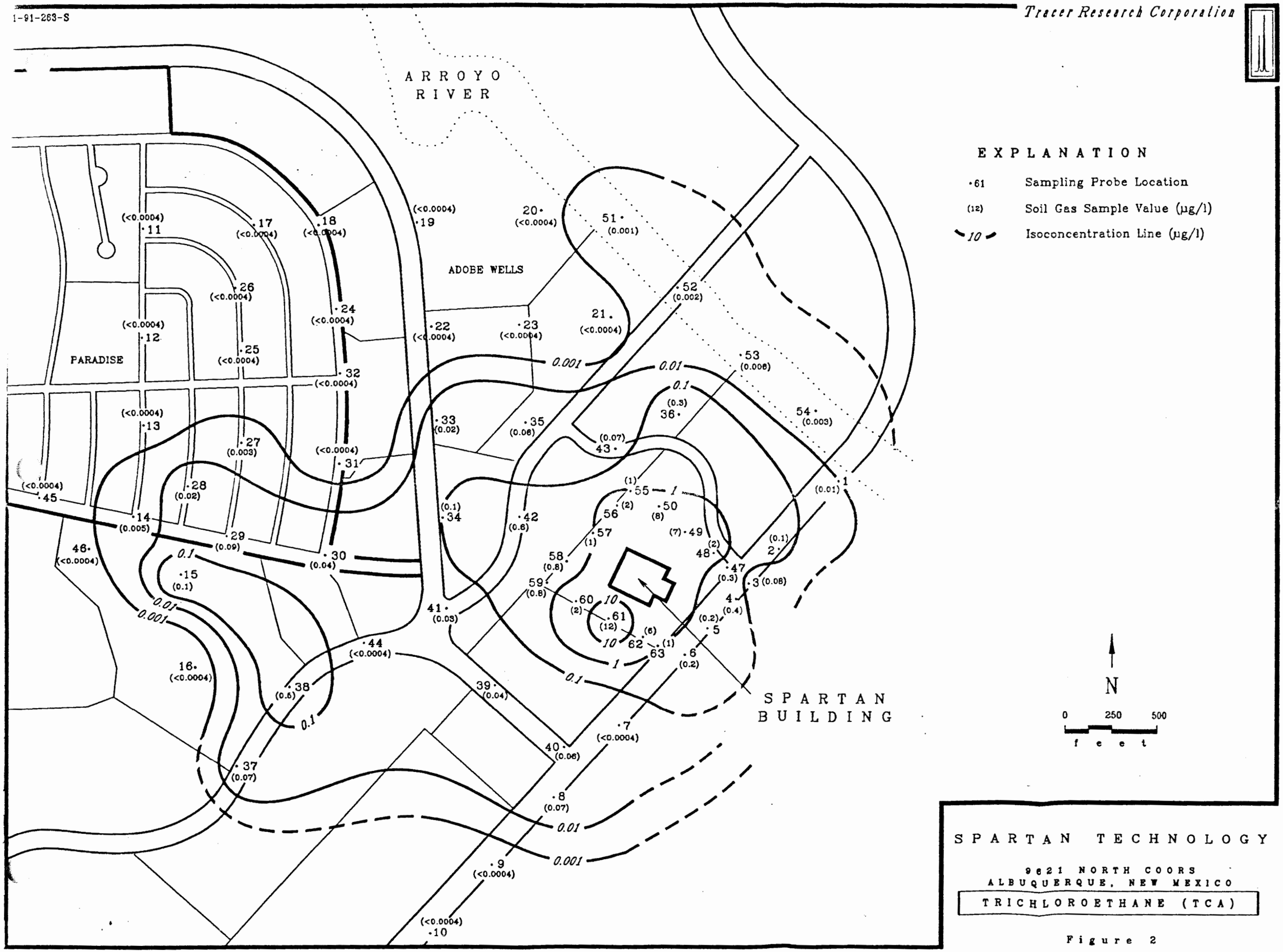
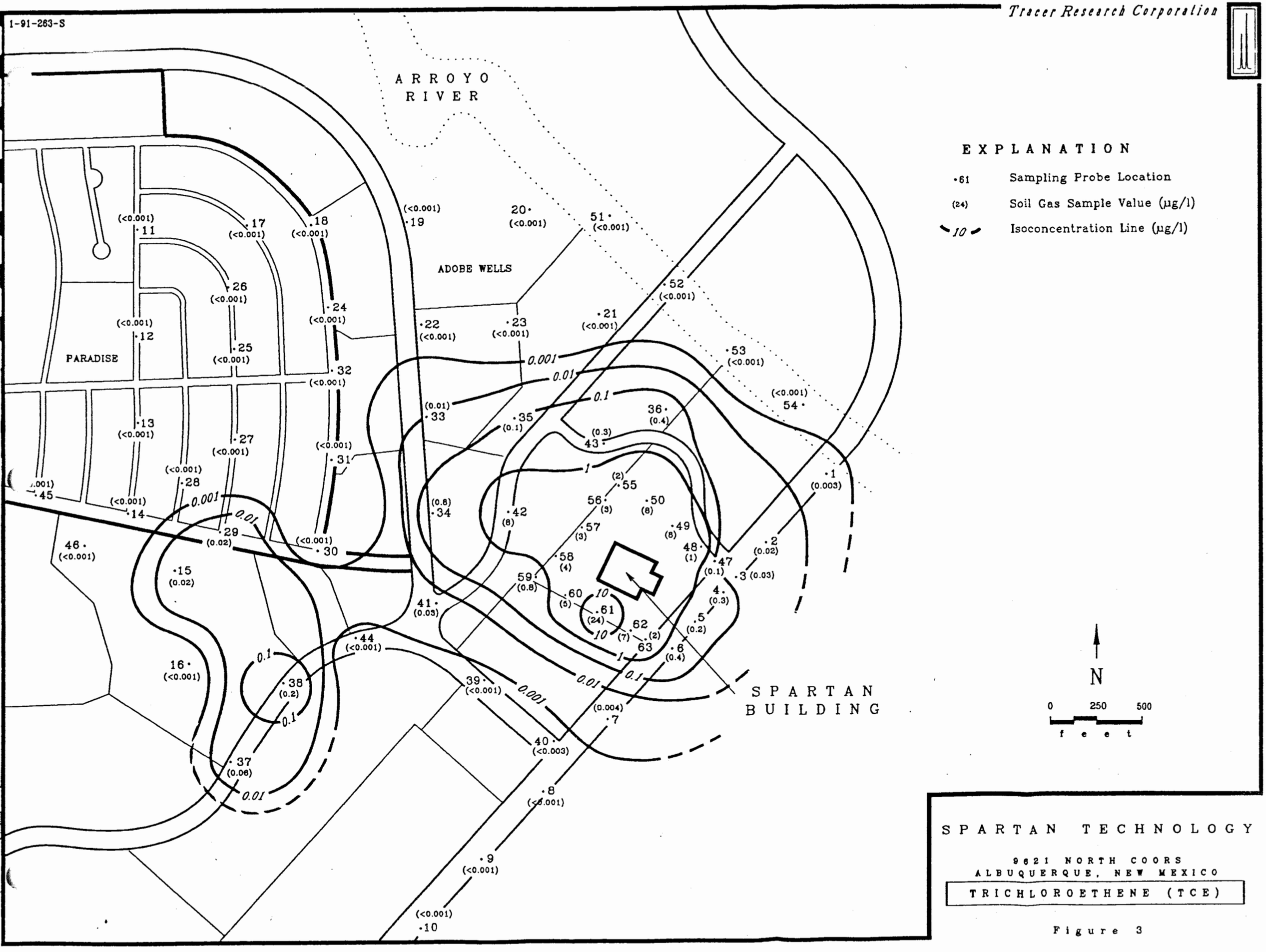

ARROYO RIVER
ADOBE WELLS
PARADISE
SPARTAN BUILDING
EXPLANATION
·61 Sampling Probe Location
(12) Soil Gas Sample Value (µg/l)
10 Isoconcentration Line (µg/l)
N
0 250 500
feet
SPARTAN TECHNOLOGY
9621 NORTH COORS
ALBUQUERQUE, NEW MEXICO
TRICHLOROETHANE (TCA)

Figure 2



SPARTAN TECHNOLOGY

9621 NORTH COORS
ALBUQUERQUE, NEW MEXICO

TRICHLOROETHENE (TCE)

Figure 3

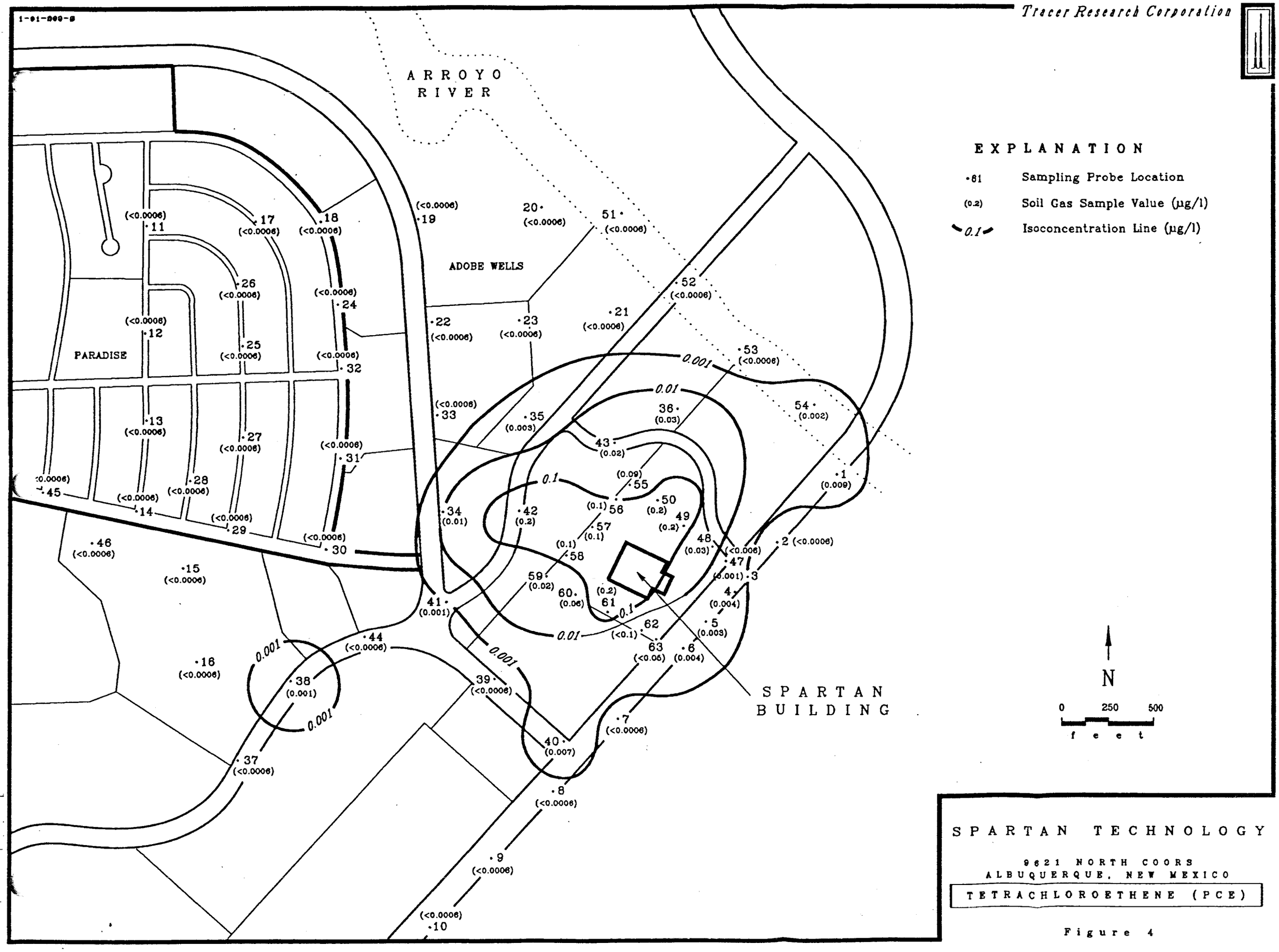

ARROYO RIVER
ADOBE WELLS
PARADISE
SPARTAN BUILDING
EXPLANATION
•61 Sampling Probe Location
(0.2) Soil Gas Sample Value (µg/l)
0.1 Isoconcentration Line (µg/l)
N
0 250 500
feet
SPARTAN TECHNOLOGY
9621 NORTH COORS
ALBUQUERQUE, NEW MEXICO
TETRACHLOROETHENE (PCE)

Figure 4

A Report Prepared for:

Sparton Technology, Inc.
4901 Rockaway Boulevard, SE
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DRAFT BENCH-SCALE REPORT
AVAILABLE CORRECTIVE MEASURE TECHNOLOGIES
Sparton Technology, Inc.
Coors Road Facility
Albuquerque, New Mexico

Prepared by HDR Engineering, Inc.
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December 1, 1991

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I INTRODUCTION

This report is being submitted pursuant to an Administrative Order of Consent dated October 1, 1988. This document satisfies the requirements of TASK V: Laboratory and Bench-Scale Studies of the RCRA Facility Investigation Scope of Work. This report is being furnished concurrently with the final RFI report.

The purpose of this study is to determine the applicability of a corrective measure technology or technologies to facility conditions. Emphasis was placed on technologies that have been successfully used on sites having similar geology, contaminants, contaminant levels, and groundwater levels as found on this project site.

II BACKGROUND

The Sparton facility is sited on an approximate 12-acre parcel of land located on the northwest side of Albuquerque, on State Highway 448, known locally as Coors Road, approximately 0.75 miles north of the intersection of Coors Road and Paseo del Norte.

The Sparton facility began operation in 1961, and since that time has been engaged in the manufacturing of electronic components, including printed circuit boards, The manufacturing process generates two waste streams which are managed as hazardous wastes: an aqueous metal plating waste, and a solvent waste stream. The plating wastes were stored in two in-ground ponds until August 1983. Waste solvents were stored in a sump until October 1980. Both waste streams are currently stored in drums prior to shipment to a permitted off-site disposal facility.

The pond and sump area, located on the north side of the main building, is believed to be the source of soil and groundwater contamination at the site. Final pond and sump area closure was conducted in December 1986 under a State-approved closure plan.

The wastes which were stored in the pond and sump area were typical of electronic manufacturing facilities. The waste stream stored in the ponds was an aqueous stream from the metal plating process which contained a variety of metal ions. The sump was used to store a mixture of waste solvents from process and degreasing operations. Historical analyses of the contents of either the ponds or sump are not available, however the predominant constituents can be inferred from the groundwater analyses. Groundwater analyses were first conducted in 1983, and in 1985, routine quarterly

analyses were instituted under a State-approved program for a number of on-site monitoring wells.

Based on these historical groundwater analyses, the primary hazardous constituents appear to include trichloroethylene (TCE) and 1,1,1-trichloroethane (TCA), with lesser amounts of methylene chloride (MeCl) and 1,1-dichloroethylene (DCE). Based on analytical results from groundwater samples taken from on-site monitoring wells, it is apparent that the contaminant release originated primarily from the solvent storage sump.

III AVAILABLE CORRECTIVE MEASURE TECHNOLOGIES

A. Review of Treatment Technologies

This report documents the performance or demonstrates the applicability of available technologies for the remediation of primarily trichloroethylene (TCE) and 1,1,1-trichloroethane (TCA) contamination at the Sparton facility. This information was compiled from a review of available literature and previous experience. Separate bench-scale studies were not performed for this report because of the wealth of data that already exists on these technologies. Since TCE and TCA are found at many sites, numerous field applications and pilot-scale studies have been completed on a wide range of treatment technologies. Two treatment methods, air stripping and granular activated carbon, are considered best available techniques (BAT) for treatment of TCE and TCA, especially at the relatively low concentrations found at the project site.

The report focuses on the technologies for remediation of three phases of the contaminants, which include the (1) dissolved groundwater phase (saturated zone), (2) soil sorbed phase (unsaturated zone), and (3) soil gas vapor phase (unsaturated zone). TCE and TCA in the free product or non-aqueous phase in the saturated zone (if any) or the soil pore water dissolved phase (unsaturated zone) can be remediated as part of the three phases described above. It is recognized that a combination of several methods, or treatment train, may be necessary to accomplish successful remediation of the

specified contaminants. The general treatment technologies available for remediation of these three phases include:

- Pump and Treat
- In-Situ Air Stripping
- Bioremediation
- Soil Flushing
- Vapor Extraction

The treatment alternatives for each phase are discussed in detail in the following paragraphs. Appropriate references for each technique are contained in the text and detailed in the bibliography.

B. Remediation of the Dissolved Groundwater Phase (Saturated Zone)

Groundwater remediation alternatives for this project would include pump and treat, in-situ air stripping, and in-situ bioremediation. Treatment of the water effluent pumped from the ground could utilize air stripping, granular activated carbon (GAC), advanced oxidation, aerobic bioreactors, or a combination of all above. Vapor obtained from in-situ air stripping could be treated with granular activated carbon (GAC) or incinerated. Bioremediation provides total treatment in place.

1. Pump and Treat Technology

One method to remediate contaminated groundwater at the Sparton site is extracting groundwater with pumps and treating it at the surface. This technology is

discussed in the U.S. EPA publication "Basics of Pump-and-Treat Ground-Water Remediation Technology" (U.S. EPA, 1990).

For maximum efficiency in contaminant removal from the groundwater, intermittent or pulse pumping will be required. Continuous pumping removes a constant volume of water which can result in a initial rapid decrease in contaminate concentration. Continuous pumping, however, often cannot decrease the contamination level below a certain minimum concentration level because the rapid pore velocities do not provide sufficient time for contaminant levels to build back up to equilibrium levels. Pulse or intermittent pumping provides greater efficiency in contaminant removal by allowing sufficient time for dissolved contaminants to diffuse out of less permeable zones and sorbed contaminants to reach equilibrium concentrations in local groundwater prior to removal for surface treatment. This method may require three to ten years of operation before an acceptable cleanup level is reached. However, recent literature has suggested that Pump-and-Treat technology alone will not remove all of the contaminants.

Treatment options for groundwater pumped to the surface at the Sparton site include the following technologies which may be used individually or in combination with one another.

a. Air Stripping

Air stripping is a mass transfer process in which volatile contaminants in water or soil are transferred to gas. Air stripping is considered one of several best available technologies (BAT) for removal of volatile contaminants such as those present at the Sparton site. Air stripping is frequently accomplished in a packed tower aerator (PTA) equipped with an air blower.

Air stripping is particularly suitable for this site. This technology has been used at the site for approximately three years as an Interim Measure (IM). The effectiveness of this method has been demonstrated by pumping and treating approximately 1.9 million gallons of water to date with a contaminant removal efficiency of 99 percent. Other sites having similar contaminants and soil conditions have responded well to air stripping techniques as shown in Appendix B of the U.S. EPA publication "Basics of Pump-and-Treat Groundwater Remediation" (U.S. EPA, 1990). Depending on the contaminant emission rate, treatment of the air stripper off gas may be necessary to conform to air quality standards. Two methods available for treating off gas are granular activated carbon (GAC) and incineration. The technical and economic feasibility of treating air stripper off gas with GAC at various rates of production is discussed in the article "Using GAC to Remove VOC's From Air Stripper Off-Gas", in the May 1988 issue of the American Water Works Association Journal (Crittenden, 1988). For TCE, air stripping followed by off gas GAC treatment was shown to be very effective and economical compared with aqueous-phase GAC treatment, which is discussed in the next section. Thermal destruction of the contaminants in off gas is also feasible using mobile incineration units. A catalytic operation may be considered using lower temperatures. Based on personal communication with Metric Corporation, incineration has been successfully used in the Albuquerque area at petroleum hydrocarbon remediation sites.

b. Granular Activated Carbon Treatment (GAC)

This process consists of passing the water through packed beds of granular activated carbon. Contaminants are absorbed in the internal pores of the carbon granules. The activated carbon is an effective method for removing volatile organics and

it is not sensitive to flow rate changes, concentration changes, or toxic materials. It is sensitive to suspended solids and oil and grease concentrations. This method is also considered a best available technology for treatment of Volatile Organic Compounds (VOC's).

A general description of the treatment method is contained in Section 10.1.1 of the U.S. EPA Handbook "Remedial Action at Waste Disposal Sites" (U.S. EPA, 1985). Table 10-2 of that reference provides influent and effluent concentration values for groundwater treated with granular activated carbon. This table shows that TCE levels of 5 ug/liter to 16 mg/liter and TCA levels of 60 ug/liter to 25 mg/liter can be treated to levels of less than 1 ug/liter for both compounds. Additional discussion is contained in the article "Evaluating the Costs of Packed-Tower Aeration and GAC for Controlling Selected Organics" in the January 1991 issue of the American Water Works Association Journal (Adams, 1991).

c. Advanced Oxidation

This technology consists of treating contaminated groundwater with ozone and hydrogen peroxide. The process oxidizes volatile organic compounds (i.e., TCE) into non-toxic constituents. This process can be used to eliminate the organic chemical, not merely transfer the problem to another medium (air or GAC) as is the case with air stripping or granular activated carbon.

A bench-scale laboratory study and pilot-scale field study for advanced oxidation treatment of groundwater contaminated with TCE and PCE is contained in the May 1988 issue of the American Water Works Association Journal. Two articles in this reference, "Advanced Oxidation Processes for Treating Groundwater Contaminated with

TCE and PCE: Laboratory Studies" (Glaze, 1988), and "Advanced Oxidation Processes for Treating Groundwater Contaminated with TCE and PCE: Pilot-Scale Evaluations" (Aieta, 1988), conclude that this process can be a cost effective treatment for TCE in the groundwater. The pilot study, which used groundwater from City of Los Angeles wells having a TCE concentration of 77 to 143 ug/liter and a PCE concentration of 8 to 16 ug/liter, demonstrated TCE removal efficiencies of up to 99 percent. PCE removal efficiencies ranged from 41 to 88 percent. Depending on the dosage ratio of hydrogen peroxide to ozone, contact time as little as three minutes was observed for a TCE removal efficiency in excess of 95 percent.

d. Aerobic Bioreactors

This technology also destroys volatile organics instead of transfer to other mediums. This process uses aerobic biodegradation to convert the volatile organics into non-toxic constituents.

A pilot-scale study of this technology is described in the report "Treatment of Trichloroethylene-contaminated Groundwater Using Aerobic Bioreactors," of the Innovative Hazardous Waste Treatment Technology Series Volume 3 (Wickramanayake, 1990). The pilot scale study was conducted at a site where groundwater was contaminated with TCE concentrations of 0.5 to 1.4 mg/liter. The study utilized two trickle-type aerobic bioreactor units with a water flow rate of 2 L/min.

2. Vapor Extraction Technology

Vapor extraction removes existing soil gas by placing a vacuum on the subsurface soils. Removal of the existing soil gas causes contaminants dissolved in the

groundwater to volatize in order to maintain phase concentration equilibrium. The newly created vapor is subsequently removed by the vapor extraction system. A review of vapor extraction technology is provided in EPA document "Soil Vapor Extraction VOC Control Technology Assessment" (Pacific Environmental Services, Inc., 1989). This reference describes soil vapor extraction installation, VOC treatment and eleven selected studies of sites using soil vapor extraction and VOC treatment. Several of these sites had similar soil conditions and contamination levels as the Sparton site. If necessary, treatment of vapor effluent could be provided with GAC or incineration.

The use of vapor extraction as a groundwater remediation technique has been demonstrated under similar geologic and contamination conditions at a RCRA Corrective Action site in Spokane, Washington. At the Spokane RCRA site, vapor extraction was used to remove soil gas contamination existing above a relatively stagnant shallow groundwater zone. Continued use of the vapor extraction resulted in a significant decrease in concentrations of various chlorinated solvents in shallow groundwater. The results of this demonstration are documented in an Interim Measures Report submitted to Region 10 of U.S. EPA in late 1990.

3. <u>In-Situ Air Stripping Technology</u>

An innovative technology for treatment of volatile organic compounds in groundwater is in-situ air stripping. This concept utilizes an air injection well in the saturated zone and a vapor recovery well in the unsaturated zone. The VOC's are stripped from the groundwater by the mechanics of the rising air stream and are removed from the subsurface by a vapor extraction system. An example of this technology is

discussed in a paper entitled "Innovative Ground Water and Soil Remediation: In Situ Air Stripping Using Horizontal Wells" (Kabach, 1991). The Savannah River site discussed in the paper has geologic and hydrogeologic conditions similar to the Sparton site. Both have significant surficial layers of sands, clayey sands, and sandy clays with a relatively deep water table (70-140 feet). Groundwater from the two wells at this site did show a decrease in TCE concentration from approximately 1600 to 1300 mg/liter to 10 to 30 mg/liter. TCE concentration remained stable in several wells and actually increased in three wells, however, this was attributed to deeper contaminated water being forced upward toward the well screens because of the air injection. In situ air-stripping has also been successfully used in the Albuquerque area for petroleum hydrocarbon remediation. If required, effluent from the vapor extraction system can be treated with GAC or incineration.

4. In-Situ Bioremediation Technology

This technology uses existing or transplanted microbes to biologically transform volatile organic compounds under aerobic and anaerobic conditions. A bench-scale study of TCE degradation under aerobic conditions is discussed in the unpublished draft paper "Pilot Study of Trichloroethylene Biodegradation By A Commercial Culture" (Grubbs, 1991). The study concluded that the most probable degradation mechanism was bacterial enzyme systems that can degrade substituted aromatics. Two separate experiments were conducted in the laboratory bench-scale study. The first study utilized a TCE concentration of 25,000 to 475,000 ppb, a flow rate of 15 to 30 gallons per day, and a mean residence time of 40 to 80 hours in the single pass fixed film reactor. The

second study used a lower TCE concentration level of 10,000 ppb, a flow rate of 200 mL per minute and a mean residence time of 12 hours in a smaller two chamber aerated activated sludge biotank. Both studies degraded the TCE, under aerobic conditions, down to non-detectable limits. The TCE was completely mineralized without any hazardous intermediate products.

Reductive dehalogenation appears to be principal mechanism involved in the anaerobic process. A laboratory bench-scale study of this process is described in the article "Biological Transformations of 1,1,1-Trichloroethane in Subsurface Soils and Groundwater" (Klecka, 1990). In this study, TCA, in concentrations of 0.1 to 0.5 mg/liter, was readily degraded by both methanogenic and sulfate reducing microcosms using soil and groundwater samples from an unconfined aquifier along the South Canadian River in Oklahoma. In addition, the products resulting from the dehalogenation process are less likely to bioaccummulate and are more susceptible to further microbial attack, especially by aerobic micro-organisms utilizing oxidative biodegradative processes (Sims, 1991). Documentation of anaerobic degradation of TCE is given in various EPA literature.

C. Remediation of the Soil Sorbed Phase (Unsaturated Zone)

Potential technologies for removing this phase of contamination include soil flushing, in-situ bioremediation, and vapor extraction systems.

1. Soil Flushing Technology

This process utilizes water, steam or air injected into the ground near a recovery well. The resultant cross flow flushes contaminants towards the recovery well for removal to the surface where the effluent is collected and treated. The flushing agent may utilize additives such as reducing agents or surfactants to assist in removing the contaminants from the soil particles. A discussion of the process and a table of surfactant characteristics is provided in Section 9.2.3 of U.S. EPA publication Handbook-Remedial Action at Waste Disposal Sites, (U.S. EPA, 1985). Although the text references a site in Germany that reduced TCE levels significantly using only water flushing, a demonstration specifically applicable to the Sparton site could not be identified. If necessary, the water and/or gas effluent may be treated with granular activated carbon (GAC) or incineration.

2. In-Situ Bioremediation Technology

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3. Vapor Extraction Technology

Vapor extraction removes contaminants from the soil particles by placing a vacuum on the subsurface soils. As the existing soil gas is removed, the VOC's sorbed to the soil particles volatilize to maintain phase concentration equilibrium and are subsequently removed by the vapor extraction system. A review of vapor extraction technology is provided in EPA document "Soil Vapor Extraction VOC Control Technology Assessment" (Pacific Environmental Services, Inc., 1989). This reference describes soil

vapor extraction installation, VOC treatment and eleven selected studies of sites using soil vapor extraction and VOC treatment. Several of these sites had similar geologic conditions and contamination levels as the Sparton site. If necessary, treatment of gas effluent could be provided with GAC or incineration.

D. Remediation of Soil Gas Phase

Treatment of the soil gas phase would utilize only one technology - removal of the existing soil gas with a vapor extraction system. Vapor extraction removes contaminants from the soil particles by placing a vacuum on the subsurface soils. As the existing soil gas is removed, the VOC's sorbed to the soil particles volatilize to maintain phase concentration equilibrium and are subsequently removed by the vapor extraction system. A review of vapor extraction technology is provided in EPA document "Soil Vapor Extraction VOC Control Technology Assessment" (Pacific Environmental Services, Inc., 1989). This reference describes soil vapor extraction installation, VOC treatment and eleven selected studies of sites using soil vapor extraction and VOC treatment. Several of these sites had similar geologic conditions and contamination levels as the Sparton site. If necessary, treatment of gas effluent could be provided with GAC or incineration.

The use of vapor extraction as a soil gas remediation technique has been demonstrated under similar geologic and contamination conditions at a RCRA Corrective Action site in Spokane, Washington. At the Spokane RCRA site, vapor extraction was used to remove soil gas contamination. Continued use of the vapor extraction system resulted in a significant decrease in soil gas concentrations of various chlorinated

solvents. The results of this demonstration are documented in an Interim Measures Report which was submitted to Region 10 of U.S. EPA in late 1990.

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