

Martin J. Chávez, Mayor

February 8, 1996

Mr. Vincent Malott, Project Manager
U. S. Environmental Protection Agency, Region 6
Hazardous Waste Enforcement Branch (6EN-HX)
1445 Ross Avenue, Suite 1200
Dallas, Texas 75202-2733



Subject: Sparton Ground Water Contamination and Cleanup Alternatives

Dear Mr. Malott:

This letter is the City of Albuquerque's (City's) written statement for the record regarding Sparton Technology, Inc.'s contamination of drinking water resources and the alternatives for cleanup presented in the Environmental Protection Agency's Statement of Basis.¹ This statement supplements my oral comments made at EPA's February 1, 1996, public hearing.

I have prepared this statement in my capacities as the co-chair of the City/County Policy Implementation Committee charged with implementing the Albuquerque/Bernalillo County Ground Water Protection Policy and Action Plan² and as the City of Albuquerque's Water Resources Manager. As co-chair of the Policy Implementation Committee and its designated representative for the Sparton case, I am representing the committee's membership which includes the City of Albuquerque's Environmental Health, Planning, and Public Works Departments and Bernalillo County's Environmental Health Department, Planning and Zoning Department, and Public Works Division. I am a registered professional engineer.

¹ *Statement of Basis RCRA Corrective Action, Sparton Technology, Inc. Coors Road Facility Albuquerque, New Mexico*, attached to author's copy of Desi Crouther's December 18, 1995, letter to Richard Mico.

² Albuquerque/Bernalillo County Ground Water Protection Policy and Action Plan, as adopted by the Board of County Commissioners, November 1993, and the City Council, August 1994.

Good for You, Albuquerque!

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I. EXECUTIVE SUMMARY

In summary, these comments:

- establish that the contaminated resources damage a valuable City interest,
- present the City's position regarding cleanup alternatives and necessary criteria the selected remedy must meet,
- comment regarding the lack of credibility of Sparton's submittals and representations,
- respectfully request the EPA's priority attention to compel Sparton to expeditiously commence an adequate remedy due to the substantial and imminent endangerment to public health and the environment caused by the actively spreading contamination, and
- offer the City of Albuquerque's active assistance and cooperation to expedite implementation of an adequate remedy.

II. SUMMARY OF THE VALUE AND USE OF THE GROUND WATER SPARTON HAS CONTAMINATED

The City has a valuable proprietary interest in the ground water in the area that Sparton has contaminated. The Sparton contamination substantially devalues and damages the City's interest in this critical drinking water resource. The value of the ground water and other resources damaged by Sparton is quantifiable.

Ground water is the sole source of drinking water and all other non-agricultural water uses in Albuquerque, Bernalillo County, and the entire Middle Rio Grande Basin. New wells are needed for water supply, regardless of the future option(s) selected for supplementary conjunctive use of surface water.³ For several reasons, ground water in the vicinity of the Sparton contamination, were it not for the contamination, would be especially attractive for development of new wells and/or enhanced aquifer recharge systems. The surrounding area is rapidly growing.

³ San Juan-Chama Diversion Project Options, summary report and five appendices, CH2M Hill, July 1995. This report was previously submitted to EPA for the Sparton record. This report was substantially misrepresented by Sparton in their November 6, 1995, letter to EPA.

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Albuquerque's existing water master plan⁴ designates the contaminated area for a future well field. Naturally occurring arsenic concentrations at the site are unusually low, making water production from this area especially desirable. The area is adjacent to existing groundwater recharge sources and is hydrogeologically very well suited to enhanced artificial recharge, making high levels of ground water production especially sustainable. And very importantly, the area is in a relatively small portion of the city, generally located along the river where historic drawdown is low, where State Engineer Office staff recommendations⁵ would allow new wells to be drilled. These recommendations would prohibit additional wells within the City's current well fields providing water supply to the west side of the Rio Grande.

In summary, the ground water contaminated by Sparton's disposal and continuous releases is a valuable natural resource committed to beneficial use by the citizens of Albuquerque. The ground water is committed to use by the City of Albuquerque through various City resource planning documents.

III. THE CITY/COUNTY GROUND WATER PROTECTION POLICY CLASSIFIES THE AREA IN QUESTION AS AN IMPORTANT AND VULNERABLE SOURCE OF DRINKING WATER

I have previously submitted for the record a copy of the Albuquerque/Bernalillo County Ground Water Protection Policy and Action Plan. It is a comprehensive source water protection policy and wellhead protection policy formally adopted by the governing bodies of both the City and the County. It classifies areas within the county as crucial for ground water quality protection based on either the current or planned use of the ground water as a drinking water supply or on the geohydrologic vulnerability of the ground water system to contamination. The ground water contaminated by Sparton is both planned for drinking water supply and is vulnerable to contamination.

The document specifies six policy statements formulated to "Ensure the quality of our ground-water resources so that the public health, quality of life, and economic vitality of this and future generations are not diminished." Policy B is focused on contamination such as that caused by Sparton: "The City and County shall identify ground water contamination [in crucial areas] and expedite corrective action." Policy C commits the City and Bernalillo County to "promote the vigorous enforcement of regulations throughout the Upper Rio Grande Drainage Basin" to

⁴ Master Plan of Water Supply for City of Albuquerque N.M. & Environs, Gordon Herkenhoff and Associates, Inc., 1982

⁵ *Rio Grande Task Force Memorandum Report*, State Engineer Office, December 1994.

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improve protection of drinking water supplies. The City of Albuquerque respectfully requests EPA's vigorous enforcement of RCRA and other laws and regulations to expedite corrective action of the Sparton contamination.

Sparton has made numerous unsubstantiated and false assertions regarding (1) the magnitude, extent, and migration of the ground water contamination it has caused and continues to cause, (2) the value and future use of the ground water resource that it has contaminated, and (3) the practicality of corrective measures that it is actively opposing.⁶ The City's response to some of these assertions is contained in my December 5, 1995, letter to EPA's Mr. Desi Crouther, in the four posters prepared by the City of Albuquerque and displayed at the public hearing, and in the attached four page handout distributed by the City of Albuquerque at the public hearing. Additional and more detailed technical rebuttal is also presented in the attached report prepared for the City of Albuquerque.⁷ Exact copies of the four City of Albuquerque posters displayed at the public hearing have been sent to you under separate cover for inclusion in the record.

This letter relies on these separate statements for the record and will not repeat the information contained in them except to emphasize selected points they make.

IV. THE SELECTED REMEDY MUST MEET CERTAIN MINIMUM CRITERIA--RECOMMENDED ALTERNATIVE

The contamination levels presently identified as emanating from the Sparton site exceed established RCRA corrective action levels, and pose an imminent and substantial threat to health and the environment. Therefore, the City believes that EPA does not have discretion to select no further action or natural attenuation as an appropriate remedy. Rather, implementation of the selected remedy must, at a minimum, accomplish the following:

- delineate the three dimensional extent of the contaminated ground water,

⁶ Letter to EPA from James B. Harris of Thompson and Knight, attorneys and counselors, with attached report, November 6, 1995.

⁷ Review of Ground-Water Contamination at Sparton Technology Inc.'s Coors Road Facility, prepared by Amy Halloran and Michael Bitner, CH2M Hill, January 1996.

- implement routine quarterly, or more frequent as necessary to understand the dynamics of the plume, monitoring of contaminant concentrations and water levels in existing and additional monitoring wells,
- arrest the spread of the plume of contaminated ground water,
- stop the continuing source of contamination entering the plume from the vadose zone and from probable liquid phase solvents within the ground water at the Sparton site,
- restore the polluted drinking water resource to meet federal and state safe drinking water standards,
- recharge the aquifer with or make other genuine beneficial use of the contaminated ground water that is pumped and treated, commensurate with the City's adopted Long-Range Water Conservation Strategy⁸, copy attached, and
- design the remedy to accommodate the hydrologic effects, without interference with the remedy, of the City of Albuquerque's potential near-term uses of the Calabacillas Arroyo recharge window for enhanced ground water recharge and the ground water resources in the vicinity of the Sparton contamination for drinking water supply production, during the decades that successful cleanup is anticipated to require.

The City of Albuquerque requests that EPA cause Sparton to implement Alternative #5: Expanded Ground Water Recovery System, Air Sparging, and Soil Vapor Extraction, as presented in the Statement of Basis but with design features to meet the last two criteria in the bullet list above. The containment and pump and treat system is necessary to arrest the continuing spread of the plume. Containment and remediation of the continuing sources of contamination to the ground water system at the site are also required. Both concentrated dissolved solvents and probable liquid phase solvents are a continuing source of contamination within the ground water system that are feeding the off-site plume. Air sparging appears to be the most practicable means available to expedite removal of measured concentrated dissolved solvents. Air sparging will also assist in addressing the likely occurrence of liquid phase trichloroethene (TCE) that the circumstances of the contaminant release and the ground water monitoring data indicate are probably present in the ground water underneath the Sparton site. Soil vapor extraction is the best available technology and an effective means to remove the vadose zone contamination that is another continuing source of contamination feeding the plume.

⁸ City of Albuquerque Council Resolution, Enactment 40-1995, adopting a Long-Range Water Conservation Strategy for the City of Albuquerque, March 1995.

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Pump and treat and reinject systems and soil vapor extraction systems have successful histories of solvent contamination removal at multiple sites in Albuquerque.

Extracted and treated ground water must not be wasted. It must either be beneficially used or must be returned to the aquifer. The Calabacillas Arroyo recharge window may make recharge of the treated water relatively easy and inexpensive. Recharge by surface spreading in the arroyo could also create a hydraulic barrier that would confine the plume to the south of the arroyo and prevent the spread of the contamination underneath the arroyo and into the active recharge window. Alternately, the treated water could be reinjected through wells.

The containment and pump and treat system must be sufficiently robust to arrest the spread of contamination in three dimensions into and through the Calabacillas Arroyo recharge window. This recharge window has been identified by the Bureau of Reclamation in cooperation with the New Mexico Bureau of Mines and Mineral Resources⁹ to be a hydrogeologically rare high conductivity path from the land surface to the Upper Santa Fe Group aquifer system and through the Santa Fe Group to public water supply well fields. The environmental sensitivity of the contaminated site caused by its proximity to the recharge window is being described in separate comments prepared by the Bureau of Reclamation.

The remedy must not preclude the City of Albuquerque's active use of this ground water resource during the estimated 30 year or longer duration of the pump and treat system operation. Nor must the selected remedy preclude the City's possible near-term use of the Calabacillas Arroyo recharge window to increase sustainable ground water system yield through enhanced artificial recharge of the Upper Santa Fe Group aquifer system. Instead, the remedy must be sufficiently robust to accommodate the ground water flow system effects of these water resources management measures and uses without causing interference with or failure of the remedy.

Time is of the essence in selection and implementation of a remedy. Design issues, such as those regarding use or recharge of the treated water and the design features of the remedy needed to allow the City's use of the resource during the long duration of remediation, that have not been considered to date but are raised by this statement and by others, should be made during remedy design and should not further delay EPA's selection of a remedy.

⁹ Bureau of Reclamation, Middle Rio Grande Water Assessment, summary report with 20 technical appendices, in preparation. One major purpose of the Assessment, a four year water resources assessment program jointly funded by the City of Albuquerque, the Bureau of Reclamation, and the New Mexico Bureau of Mines and Mineral Resources, was to identify enhanced ground water recharge opportunities for the City of Albuquerque.

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V. SPARTON'S SUBMITTALS AND REPRESENTATIONS ARE NOT CREDIBLE

Sparton has made numerous unsubstantiated technical claims and assertions which purport to justify "no action" as a solution to the massive and actively spreading contamination continuing to emanate from their Coors Road Facility. These claims and assertions (the plume mass is decreasing due to natural attenuation, the plume is not spreading, concentrations in monitoring wells are decreasing, the contaminated water is not planned or needed for water supply, etc.) are refuted by the City's previous statements for the record. Simply stated, the data on the record belie Sparton's unsubstantiated assertions. The technical report attached and the poster showing Sparton's and the City of Albuquerque's interpretation of the extent of the plume based on the same data are clear evidence that Sparton's interpretation is wrong, and that the depiction of the plume contained in EPA's Statement of Basis, as provided by Sparton, is wrong.

Sparton's submittal for the record dated February 1, 1996, reproduces and attaches old documentation that proclaims these fictions. Why did Sparton not refer to the substantial and formerly secret data base that they have collected over the last four years associated with their quarterly monitoring of 18 monitoring wells at the site? These data are contained in a January 26, 1996, memo to Vincent Malott, EPA, and Ron Kern and Rob Pine of the New Mexico Environment Department (NMED). NMED faxed these data to the City of Albuquerque on the same date. I am attaching a copy of this fax and ask that it be made part of the administrative record.

These new, formerly secret, data even more strongly expose Sparton's incorrect and misleading assertions and lack of credibility. An example is illustrated by two overhead slides I showed at the public hearing. They are attached. TCE concentrations have increased rapidly to very high levels at the farthest down gradient monitoring well #61. Sparton's publicly released data falsely showed two samples above detection limits from this well with a maximum TCE concentration of 720 micrograms per liter ($\mu\text{g/L}$). However, Sparton's knowingly withheld data contains nine additional measurements above detection limits. The knowingly withheld data shows steady increases in TCE concentrations with time to a current concentration of 2,000 $\mu\text{g/L}$. Meanwhile, Sparton proclaims that the plume is attenuating, the contamination is not moving, and contamination concentrations in monitoring wells are decreasing.

Does Sparton's issuance of misleading official statements for EPA's record that are contradicted by directly relevant data which they have knowingly withheld constitute criminal conduct? Obviously, at this point, that is an issue for appropriate enforcement officials to consider. At the very least, it certainly reveals that their intentions and credibility are suspect with regards to the present administrative process. Therefore, Sparton's assertions on the administrative record should be given little or no weight in EPA's decision-making.

VI. THE SPARTON CONTAMINATION POSES AN IMMINENT AND SUBSTANTIAL ENDANGERMENT TO PUBLIC HEALTH AND THE ENVIRONMENT

In the event that Sparton does not willingly and promptly begin implementation of EPA's selected remedy, EPA should act unilaterally to abate the imminent and substantial endangerment to public health and the environment caused by Sparton's pollution. The data gathered to date clearly shows continuous disposal of hazardous wastes, including TCE and hexavalent chromium from the Sparton site, above RCRA corrective action levels. The data, on their face, clearly indicate that contamination levels both on-site and off-site present an imminent and substantial endangerment to public health and the environment.

Very high concentrations of TCE exist in the deepest and farthest down gradient monitoring wells. Contamination concentrations have increased rapidly from zero three years ago to over 400 times drinking water standards at the farthest down-gradient monitoring well #61. Contamination concentrations increase with depth in the nest of monitoring wells #48, #55, and #56 located farthest downgradient from the Sparton site. In addition, the formerly undisclosed data also show high levels of hexavalent chromium in the farthest downgradient monitoring wells. This form of chromium is extremely mobile in the environment, acutely toxic in moderate doses, and a known human carcinogen.

The plume, which has escaped the site and is rapidly expanding, is still being supplied continuously from concentrated contamination at the site. There is insufficient data on the administrative record to adequately characterize the extent of the contamination. However, it is clear that the presence of the massive contamination of a high quality drinking water supply, and its location in a hydrogeologically rare recharge window with an associated ground water flow path from the area of contamination to the public water supply well fields that the recharge window supplies, constitutes an imminent and substantial endangerment to drinking water supplies, public health, and the environment. Neither Sparton nor the EPA have taken action to abate the imminent and substantial endangerment presented by the past, present, and continuous release of hazardous wastes from the site. In fact, as stated above, evidence now on the record suggests that Sparton may have deliberately suppressed information regarding the magnitude of the threat to the citizens of Albuquerque and Bernalillo County and to the environment.

The City believes that imminent endangerment requires swift and decisive action as a matter of law and as a matter of sound public policy. In summary, the City of Albuquerque respectfully requests the EPA's priority attention to compel Sparton to expeditiously commence an adequate remedy without further delay due to the substantial and imminent endangerment to public health and the environment caused by the actively spreading contamination.

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VII. OFFER OF CITY OF ALBUQUERQUE ASSISTANCE AND COOPERATION TO EXPEDITE
IMPLEMENTATION OF AN ADEQUATE REMEDY

It is the City of Albuquerque's adopted policy to expedite clean-up of contamination. Therefore, the City of Albuquerque offers its cooperation to EPA and Sparton in their implementation of an effective remedy. We would appreciate an opportunity to meet with EPA and Sparton to identify specific areas where City of Albuquerque assistance and cooperation can speed the implementation of a remedy meeting the criteria outlined above. Please let us know how we can assist. We simply cannot allow this damage to our vital water resources to go unabated.

Sincerely yours,



A. Norman Gaume, P.E.
Manager, Water Resources Program

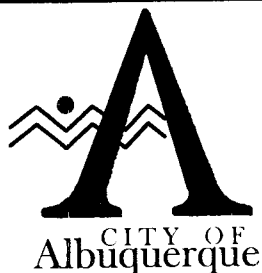
c: Martin J. Chavez, Mayor, City of Albuquerque
Mark E. Weidler, Secretary, New Mexico Environment Department
William M. Turner, State of New Mexico Natural Resources Trustee
Lawrence Rael, Chief Administrative Officer, City of Albuquerque
Robert E. Gurule, Director, Public Works Department
Sarah Kotchian, Director, Environmental Health Department
Ron Short, Director, Planning Department
Robert White, City Attorney
Juan Vigil, County Manager, Bernalillo County
Richard Brusuelas, Director, Bernalillo County Environmental Health Department
Thaddeus Lucero, Director, Bernalillo County Planning and Zoning Department

Attachments

Review of Ground-Water Contamination at Sparton Technology Inc.'s Coors Road Facility

Prepared for
City of Albuquerque Public Works Department
Water Resources Program

JANUARY 1996



CH2M HILL

Review of Ground-Water Contamination at Sparton Technology Inc.'s Coors Road Facility

Prepared for
City of Albuquerque Pubic Works Department
Water Resources Program

One Civic Plaza
Albuquerque, New Mexico

JANUARY 1996

CH2M HILL

6001 Indian School Road, NE.
Albuquerque, New Mexico
Mike Bitner

Review of Ground-Water Contamination at Sparton Technology Inc.'s Coors Road Facility

PREPARED FOR: Norman Gaume, City of Albuquerque

PREPARED BY: Mike Bitner
Amy Halloran
Sharon Minchak

COPIES: Project File
Coy Webb

DATE: January 17, 1996

This memorandum summarizes the results of a review of data and reports related to ground-water contamination at Sparton Technology, Inc.'s Coors Road facility in Albuquerque.

1. Conclusions

1.1 Nature and Extent of Contamination

Widespread and significant amounts of ground-water contamination exist at the Sparton Technology, Inc. Coors Road facility in Albuquerque. The primary hazardous constituents include trichloroethene (TCE), an industrial solvent and suspected human carcinogen, and various metals, including chromium.

The extent of the contamination has not been determined, but existing data show that TCE contamination exceeding safe drinking water standards, 5 micrograms per liter ($\mu\text{g/L}$), occurs beneath over 90 acres of land at the site and next to it.

Very high levels of TCE are found both on and off the site: concentrations approaching or exceeding 2,000 $\mu\text{g/L}$ (400 times the safe drinking water standard) have been measured in two offsite wells (wells 37 and 46). Onsite TCE levels have been even higher, exceeding 17,000 $\mu\text{g/L}$. Figures 1 through 6 show estimated levels of contamination based on the most recent data available—either October 1994 or, for some wells, December 1993. The following paragraphs discuss the apparent extent of contamination.

1.1.1 Areal Extent

Figure 1 shows the apparent extent of contamination in what Sparton documents refer to as the upper flow zone. Although the Areal extent of the contamination is not known, it is clear that the contamination is spreading rapidly. Sparton's reports estimate that contamination above drinking water standards has moved at least one-half mile offsite and contaminant levels of over 700 µg/L (over 140 times greater than standards) occur at Well 61, almost 2,000 feet from the site's western boundary. Contaminants continue to move through the aquifer at relatively rapid rates. Well 61 is the most distant well directly downgradient (in the "middle" of the apparent plume). Contamination was not detected there in 1989, 1990, or 1991. But in 1993, TCE concentrations jumped to 610 µg/L in 1993 and to an average of 720 µg/L in 1994.

Sparton has estimated that the extent of TCE contamination above standards is only 700 feet downgradient of Well 61. But there are no monitoring data directly downgradient of Well 61, so the extent of these high levels of contamination is not known. Figure 1 reflects this uncertainty by showing question marks where contours of equal concentration cannot be reliably estimated. However, the ground water in this vicinity appear to be moving to the northwest at a rate of between 100 and 300 feet per year. Even if Sparton's apparently optimistic estimate of the lateral extent of the plume is correct (1,400 feet), then the areal extent of the plume is increasing at a rate of between 3 to 10 acres per year.

Wells 53 and 58 appear to be on the lateral fringe of the plume, southwest of Well 61. Contaminant levels are rising here too: no TCE was detected in Well 53 during 1989 to 1991, but 1993 sampling recorded 32 µg/L and 1994 data showed 43 µg/L; TCE in Well 58 increased from less than 30 µg/L in 1989 to 1991 to 74 µg/L in 1993.

The deeper Wells 55 (Figure 3) and 56 (Figure 2) are about 1,600 feet northwest of the site, and appear to be somewhere between the middle of the plume (suggested by well 61) and the lateral fringe (suggested by Wells 53 and 58). They too have seen significant increases in TCE concentrations: Well 56 has gone from 63.5 µg/L in 1989-1990 to 200 µg/L in 1991 to about 400 µg/L (most recent value is the average of 2 measurements) in 1994. The deeper Well 55 has gone from 10.6 µg/L in 1989-1990 to 45 µg/L in 1991 to about 555 µg/L in 1994. These are high levels of contamination indicate that the plume is spreading deeper into the aquifer as well as moving rapidly horizontally.

1.1.2 Vertical Extent

Figures 4 through 6 show TCE concentrations in cross section views. The depth of contamination has also not been determined, but concentrations over 100 times higher than safe drinking water standards have been found in Well 55 (Figures 4 and 6) at depths of over 100 feet beneath the water table and over 250 feet beneath the land surface. Figure 4 is the cross section most closely aligned with the longitudinal axis of the plume. Because Well 55 is the deepest well in the main part of the offsite plume, there are no data to define the vertical extent of the plume.

1.2 Summary of Recent Documents

Sparton claims arsenic in the local ground water would prevent its use for water supply. In fact, naturally occurring arsenic concentrations in the area are not an impediment to water supply development.

Sparton claims that diffusion is the dominant contaminant transport mechanism. In fact, the dimensions of the plume are entirely consistent with advection and dispersion driven transport mechanisms. If diffusion were the sole transport mechanism, the plume would be moving less than 1 foot per year and would not have migrated over 2,500 feet.

There is no basis for Sparton's claim that contaminant mass is decreasing. They base this claim on the large number of onsite wells, but fail to highlight the fact that concentrations are actually increasing in most of the downgradient offsite wells in the plume's path. Moreover, because the "bottom" of the plume has not been adequately delineated, the amount of contamination moving to deeper parts of the aquifer cannot be reliably estimated.

There is no basis for Sparton's assertion that pump and treat containment strategies will not be effective in diffusion-dominated plumes. In fact, pump and treat is easiest to implement when there are no opposing advective forces to counter. As noted, the transport process is largely advective and pump and treat methods are proven reliable ways to effect hydraulic control in this type of aquifer system.

2. Review of Recent Documents

As requested, CH2M HILL reviewed the following documents for the Sparton Technology, Inc.'s Corrective Action at their Coors Road facility in Albuquerque:

- Thompson & Knight's November 6, 1995, letter to US EPA Region VI
- US EPA Region VI's October 3, 1995, letter to Richard Mico/Spartan Technology
- Draft Corrective Measures Study Report, November 5, 1992
- RCRA Facility Investigation, May 1992

The review assessed the validity of the items proposed in the November 6 letter. In particular, our review focused on (1) Sparton's belief that diffusion is the dominant contaminant transport mechanism for the solvent plume from the Sparton facility, (2) Sparton's assertion that the arsenic levels in the ground water impacted by the plume make the ground water unsuitable for a source of drinking water, and (3) Sparton's claim that additional wells are not needed to further delineate the extent of the solvent plume. The following paragraphs address each of these items.

2.1 Contaminant Transport Mechanisms

The physical processes by which solutes are transported in ground water are (1) advection, (2) mechanical dispersion, and (3) molecular diffusion. Advection is the transport of a contaminant by bulk ground-water flow (i.e., as ground water moves, so do the dissolved contaminants). If advection is the dominant transport process, the distances that contaminants may travel are generally the same as the average linear distances traveled by ground water.

The mixing and spreading of contaminants as they move through the aquifer can be described by the process of dispersion. How much spreading occurs is controlled by (1) molecular diffusion of the contaminant, (2) the average velocity of the contaminant in the ground water, and (3) the dispersivity of the aquifer. In alluvial aquifers with relatively high ground-water velocities (such as in the area of the Sparton plume), the mixing caused by molecular diffusion is small relative to the mechanical mixing caused by the dispersivity in the aquifer (Neuman et al., 1987). This mechanical mixing of contaminants occurs when the flowing ground water moves on a tortuous path through heterogeneous material. Some of the water parcels encounter higher permeability materials with coarse sand and gravel and move faster than the average velocity; some flow through material with a higher clay content and move more slowly than the average. This process causes spreading or dispersion.

Thompson & Knight asserts in their cover letter to "Sparton's Reaction to the Responses of EPA..." (Sparton's Reaction) that "any expansion of impacted groundwater is at a very slow rate and caused by diffusion...". They base this assertion in Sparton's Reaction by the following three items:

1. their calculations of offsite plume velocities,
2. their calculations of the relative length and width of the plume, and
3. their estimation of a logarithmic drop-off in TCE concentrations at the leading edge of the plume.

We believe that there are several inconsistencies in these arguments, as pointed out in the following paragraphs.

2.1.1 Offsite Plume Velocities

Thompson & Knight have calculated plume velocities on the Sparton facility, at the west end of the plume, and in the area near MW-61. For these calculations they assume that K , the hydraulic conductivity, and n , the effective porosity, are constant. Yet repeatedly throughout "Sparton's Response" they assert that the aquifer is very heterogeneous. In fact they criticize EPA for what they claim is EPA's assumption that the aquifer is "homogeneous and isotropic". Therefore Thompson & Knight's assumption of a constant K and n , especially on the short distances covered by their analysis, (less than 2,500 feet) reflects the same simplifying assumption for which they criticize EPA.

CH2M HILL has compared ground-water flow characteristics in the vicinity of the Sparton facility using the recent USGS ground-water data and model for the Albuquerque basin. Based on the 1994 USGS data in the vicinity of the Sparton site, hydraulic conductivities

vary from 15 to 40 feet per day. The upper modeled layers, which coincide with the Sparton's Response flow zones, tend to exhibit higher conductivities. Localized hydraulic conductivities shown in Sparton hydrogeologic investigations appear to range from 0.1 to over 100 feet per day depending on which report is referenced. Table 1 illustrates the comparison of general hydrogeologic data between the Sparton reports and the USGS. In their response, Sparton focuses mainly on aerial differences in horizontal water movement and velocities. However, they also point out that horizontally, the aquifer zones display similar properties, but vertical discontinuities are such that they have had to refer to a single regional water bearing zone in terms of the three "flow zones". In fact, the May 1992 RCRA report alludes to a perched water zone potentially underlying the site in the upper flow zone, which causes localized gradient anomalies. This gradient differential could potentially be causing the confusion about whether ground-water velocities are increasing or decreasing as the plume leaves the site, since all other properties used to calculate velocity are assumed constant. Differences in gradient understanding and differing porosities are factors that could drive the resulting average horizontal ground-water velocities to the extreme ranges shown on Table 1.

TABLE 1
Comparison of General Hydrogeologic Data for the Sparton Site Area

| Data Source | Parameter | Upper Flow Zone Values (similar to USGS layer 1) | Lower Flow Zone Values (similar to USGS layers 1-6) |
|---|---------------------------|---|--|
| Sparton Hydrogeologic Investigation Reports | Transmissivity, T | 6 - 615 gpd/ft | 12,000 - 18,000 gpd/ft |
| | Hydraulic Conductivity, K | 0.1 - 8 ft/day | 21 - 32 ft/day |
| | Hydraulic Gradient, i | 0.002 - 0.025 | 0.003 - 0.005 |
| | Porosity, n | 0.25 - 0.4 | 0.25 - 0.4 |
| | Flow Velocity, V_a | 0.2 - 292 ft/yr | 57 - 234 ft/yr |
| USGS, 1994 | Transmissivity, T | 24,000 - 64,000 gpd/ft | 24,000 - 64,000 gpd/ft |
| | Hydraulic Conductivity, K | 15 - 40 ft/day | 15 - 40 ft/day |
| | Hydraulic Gradient, i | 0.002 - 0.003 ft/ft | 0.002 - 0.003 ft/ft |
| | Porosity, n | 0.15 | 0.15 |
| | Flow Velocity, V_a | 73 - 292 ft/yr | 73 - 292 ft/yr |

However, even if Sparton's ground-water velocities are used, the plume movement cannot be primarily due to diffusion. At the west end of the plume they calculate that the ground-water flow velocity is 39 to 94 feet per year (3.77×10^{-5} to 1.0×10^{-4} cm per second). Given the presumably low organic carbon content in the aquifer, "retardation" of contaminants by sorption/desorption phenomena should not be significant and, therefore the contaminants in the plume would be expected to be moving at approximately the same velocity. At the west end of the plume the velocity due to diffusion would be much less than these advective velocities.

If a constant source concentration is assumed (which would give the highest diffusion rates), the velocity expected from diffusion can be calculated from the following equation from Freeze and Cherry (1979):

$$C_i(x,t) = C_0 \operatorname{erfc} [x/(2(D^*t)^{1/2})]$$

Where C_i is the concentration at distance x and time t from the source, C_0 is the initial concentration of the contaminant, erfc is the complementary error function, and D^* is the apparent diffusion coefficient.

If it is assumed that $C/C_0 = 0.5$ (i.e. the concentration at point x at time t is half as much as the initial concentration), $D^* = 8.3 \times 10^{-6} \text{ cm}^2/\text{sec}$ (as given by Cohen and Mercer, 1993, for TCE), and that there is a sharp boundary or edge to the plume (which would also maximize diffusive transport), then it would take approximately 1 year for the concentration 15 cm from the plume front to equal one half of what the concentration at the center of the plume was at the beginning of the year. Or, stated another way, if the concentration at the original edge of contamination was 17,000 $\mu\text{g}/\text{L}$, then in 1 year the concentration 15 cm from that edge would reach 8,500 $\mu\text{g}/\text{L}$ if diffusion is the only transport mechanism. It would take thousands of years for diffusion to transport the contaminants observed at Well 61, some 2,000 feet from the site's western boundary. The ground-water flow rates presented in Sparton's Reaction are orders of magnitude greater than this diffusion rate. Therefore, the predominant contaminant transport mechanism cannot be diffusion.

2.1.2 Plume Length and Width

Thompson & Knight further argue that the shape of the plume is evidence that the transport mechanism is diffusion-dominant. They cite the length-to-width ratios of the plume as being "well below the typical advection-dominant threshold of 10:1 L to W". This argument completely ignores the influences of mechanical dispersion. Sparton's Reaction repeatedly refers to the heterogeneous nature of the aquifer, yet they completely ignore this fact in their argument for diffusion-dominant contaminant transport. These heterogeneities likely cause some of the contaminants to migrate faster than the rate predicted by the estimated average linear ground-water flow velocities (as the ground water preferentially flows through lenses of materials with higher permeability); and some contaminants will migrate more slowly than the average. These local-scale variations in velocities and flow directions have the effect of "spreading" the plume, causing the width to become much broader than the original dimensions of the source area.

Moreover, it should be noted that localized high-permeability lenses may be quite narrow and therefore may not have a ground-water monitoring well installed in them. Therefore, the current monitoring network may not be identifying all of the offsite migration of the contaminants. Failure to include this component in a contaminant mass balance could lead to an erroneous conclusion that contaminant mass is decreasing. This may be one explanation for Thompson & Knight's assertion that the contaminant mass is decreasing.

The arguments presented for diffusion-dominant transport also do not take into consideration the seasonal changes in ground-water flow patterns or the changes in flow patterns between the regions of the aquifer. Temporal variations in flow directions are to be expected because of seasonal and annual variations in locations and rates of recharge and pumping. In addition, Sparton's data clearly document the spatial variation in flow directions at the site. As the contaminants initially migrate downward through the ground

water (TCE is heavier than water), they encounter changes in the direction of flow. This is seen in Figures 25 through 30 in the RFI report. These changes would spread out the contaminant plume, giving it a wider path than if the ground-water flow were always in one direction.

The assertion that contaminants detected in "upgradient" wells are evidence of diffusion-dominant transport also ignores (1) the potential for TCE as a dense, non-aqueous phase liquid (DNAPL) to move upgradient by being "deflected" by lower-permeability clays and silts and (2) the roles that mechanical dispersion caused by the heterogeneities of the aquifer and seasonal changes in ground-water flow patterns may play in contaminant transport. Perhaps more importantly, the assertion is inconsistent with calculations that show that transport by diffusion would amount to transport of only a foot or two upgradient, not the more than 100 feet observed.

2.1.3 Shape of Plume Front

Sparton's Reaction states that "another confirmation of the movement by diffusion is the fact that UFZ Wells MW-48, MW-58, and MW-52, which line up in the implied flow direction at the leading edge of the plume, show a logarithmic drop-off in TCE concentration." However, in cases of advective transport with increased dispersivity, the concentrations at the front of a contaminant plume slowly increase from zero to the concentration in the bulk of the plume. Samples collected from a monitoring well as a plume approaches and surrounds the well would gradually increase over time. The TCE concentrations in most of the monitoring wells from the Sparton facility have gradually increased or decreased over the monitoring period of 1989 to 1994. Only monitoring Well 61 appears to have the sharp contaminant spike indicative of advection with low dispersion (although the well was not sampled between the 1991 and 1993 sampling rounds, so a gradual increase may have occurred, but not been observed). Moreover, Wells 48, 58, and 52 do not appear to "line up in the implied flow direction at the leading edge of the plume". Rather, Sparton's water-level and contamination data suggest that the higher levels of contamination observed at Well 61 are moving to the northwest and will not pass these wells at the so-called "leading edge of the plume". Therefore, the most likely contaminant transport force is advection with dispersion.

In summary, for all of the reasons stated above, diffusion cannot be the dominant transport mechanism for the contaminants in the Sparton plume.

2.2 Arsenic Concentrations

Item three of the Sparton Reaction discusses what they refer to as "significant concentrations of naturally occurring arsenic" in ground water in the vicinity of the Sparton plume. Sparton points out that the mean concentration of arsenic in ground water pumped from the City of Albuquerque wells exceeds 15 µg/L. This statement is accurate, however, this mean arsenic concentration value takes into account all of the water produced by all of the City of Albuquerque's wells located throughout the city and does not infer anything about the arsenic concentration of water produced from proposed City wells in the vicinity of the Sparton plume. In fact, Figure C-38 (Albuquerque, 1995, p. C-57) referenced by Sparton shows that estimated arsenic levels in proposed City wells in the vicinity of the Sparton site are on the order of 10 µg/L.

Sparton also points out that three fourths of the City wells produce water with arsenic concentrations exceeding 5 µg/L. However, to date, the MCL for arsenic has not been lowered from 50 µg/L, therefore, wells with arsenic values in excess of 5 µg/L but still below 50 µg/L are not considered to have arsenic exceedances. In addition, the number of wells located throughout the city with or without elevated arsenic levels does not have any bearing on the specific arsenic levels in wells that may be proposed in the vicinity of the Sparton plume.

Sparton references ground-water sampling results for water in the Sparton plume and states that the arsenic values in the plume are "in the range of city results". There are 27 Sparton wells for which arsenic results are presented in the RFI Report. Most of these wells fall into the category referred to by Sparton as upper flow zone wells. All of the 27 wells were sampled at least twice. Of the 27 wells, 13 (48 percent) had arsenic values below the method detection level during both sampling rounds and 8 (30 percent) of the wells had arsenic values below the method detection level during one of the sampling rounds. Therefore, 78 percent of the wells had non-detectable levels of arsenic during at least one of the two sampling events. Of the 6 wells for which detectable levels of arsenic were measured during both sampling rounds, most values ranged from 4-8 µg/L. The highest arsenic levels detected in any of the 27 wells were levels of 31 µg/L and 34 µg/L in wells MW-36 and MW-37, respectively. Both of these levels are more than 30 percent less than the current MCL. Likewise, results from the second sampling round for these wells indicated an arsenic level below the method detection level in MW-36 and a level of 12 µg/L in MW-37. The reason for this dramatic decrease in arsenic levels is not clear. However, overall sampling results available show that arsenic levels in ground water from Sparton plume monitoring wells are below the drinking water standards.

Another comment made by Sparton in this section states that the "highest" concentrations of arsenic in City wells occur in wells to the west of the Rio Grande. Again, this statement is true, however, those high arsenic levels occur in City wells that are located over 5 miles to the southwest of the Sparton site. As discussed previously, estimated arsenic concentrations in proposed City wells in the vicinity of the Sparton site are on the order of 10 µg/L, which is less than the mean concentration for the City's wells.

Sparton comments on the possibility of the EPA lowering the MCL for arsenic, and the need for the City to implement ground-water treatment for arsenic if that occurs. However, as pointed out previously, the MCL for arsenic currently remains at 50 µg/L. Sparton also makes a comment regarding the fact that City management strategies do not include hydraulic containment for arsenic. Hydraulic containment is neither feasible nor possible in this case, as measurable levels of arsenic occur throughout the 3,000 square-mile Albuquerque ground-water basin, so the point of Sparton's comment is not clear.

Sparton comments that, based on the Water Management Options Study, the Sparton plume area will not be used for ground-water production, and that if it is used for drinking water in the future, wellhead treatment for TCE would be no greater impairment than wellhead treatment for arsenic.

While wellhead treatment for TCE is feasible, it would still require a separate remediation system from the arsenic treatment, since the two treatment processes are quite different. Furthermore, it cannot be assumed that arsenic treatment will be required in these areas. In such a case, TCE treatment at a City wellhead may delay use of the well, require additional

property and/or structures, and interfere with well operation and production. Also, contrary to Sparton's statement that TCE treatment does not produce hazardous waste, hazardous wastes (or even radioactive wastes) such as spent activated carbon canisters to control air emissions may be generated by the treatment process.

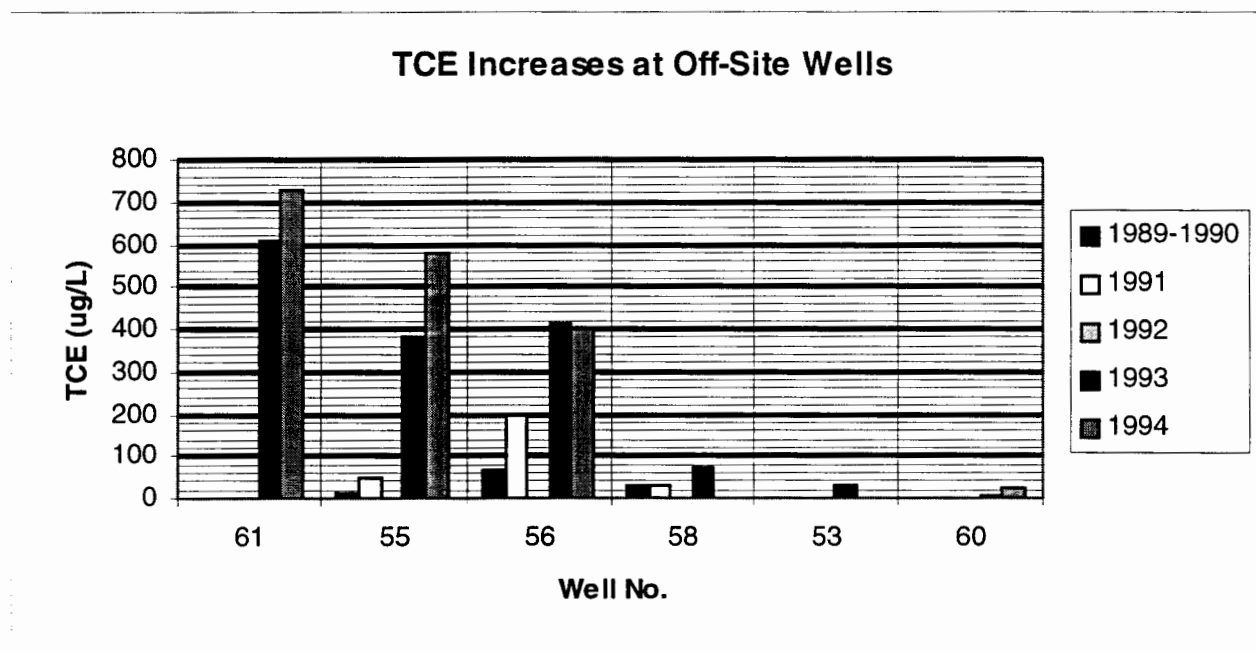
Finally, Sparton's comment regarding the fact that the Sparton plume area will not be used for ground-water production base on the City of Albuquerque's Water Management Options Study. However, that study clearly states that site-specific locations have not been identified for any of the project options and certainly not for the "conceptual future city water wells". Failure to contain the plume will certainly reduce the potential well sites available to the City. Because of the increasing difficulty of permitting new well sites, this would likely adversely impact the City's ability to continue to meet water demands in this area. Moreover, the assertion that the area will not be used for water supply ignores other non-City users. Figure 8 in the Sparton RFI Report shows an abundance of wells within a 3-mile radius of the site that were identified through State records and visual identification. These wells are not City wells and are being used for industrial, domestic, or irrigation purposes. Several of these wells appear to be located downgradient of the Sparton site and the Sparton plume may negatively impact the ground-water quality of these wells.

2.3 Additional Wells

In their documents, EPA and Thompson & Knight have differed as to whether or not TCE concentrations in the wells are increasing or decreasing. Thompson & Knight have chosen to look at all of the monitoring data, by flow zone, to present the percentage of wells where the contaminant concentrations are staying the same or decreasing. CH2M HILL agrees that the concentrations in a majority of the wells are decreasing. This is simply because the majority of the wells are close to the former source of the contamination and significant new sources of contamination may not be present.

The point that is missed in Sparton's Reaction is that the concentrations in the wells on the edge of the plume are increasing, indicating further (advective/dispersive) migration of the plume offsite. For example, as shown in Figure 1, over the sampling period (about 1989 to 1993 or 1994, depending on the well), contaminant concentrations have been increasing in Wells 53, 58, 61, and 62 in the UFZ, 56 and 60 in the ULFZ, and 55 in the LLFZ. All of these wells are on the leading edge of the plume. Therefore, the plume is continuing to migrate offsite.

FIGURE 7
TCE Contamination Increasing at Downgradient Monitoring Wells



One problem with this plume migration, is that since there are less wells on the edges of the plume, there is a greater chance that a "finger" of the plume may slip by the existing monitoring well network. These contaminant fingers are common in heterogeneous aquifers such as are found in the Albuquerque basin. Therefore, the mass reduction cited in Sparton's Reaction has a significant chance of having missed a large pocket or finger of TCE contamination. The decrease in TCE mass that they have attributed to natural attenuation may simply be evidence of a pocket of TCE that has migrated outside of the monitoring network due to channeling or other heterogeneous features or to deeper parts of the aquifer.

Thompson & Knight argue that they have "very good definition of geologic and hydrogeologic conditions" onsite and can therefore extrapolate their data to predict offsite conditions and plume migration. But, in the same document, Thompson & Knight have argued that offsite conditions are significantly different from onsite conditions, thereby causing a significant decrease in ground-water migration rates offsite. Because of these differences, mere extrapolation of the onsite data may not be sufficient to establish a lack of contaminant migration.

Because of these concerns, it seems that, at a minimum, additional monitoring wells should be installed at the edge of and beyond the plume to detect further offsite migration of the plume. In addition, deep wells closer to the center of the plume may be needed to verify that localized flow conditions are not carrying contaminants deeper into the aquifer.

3. References

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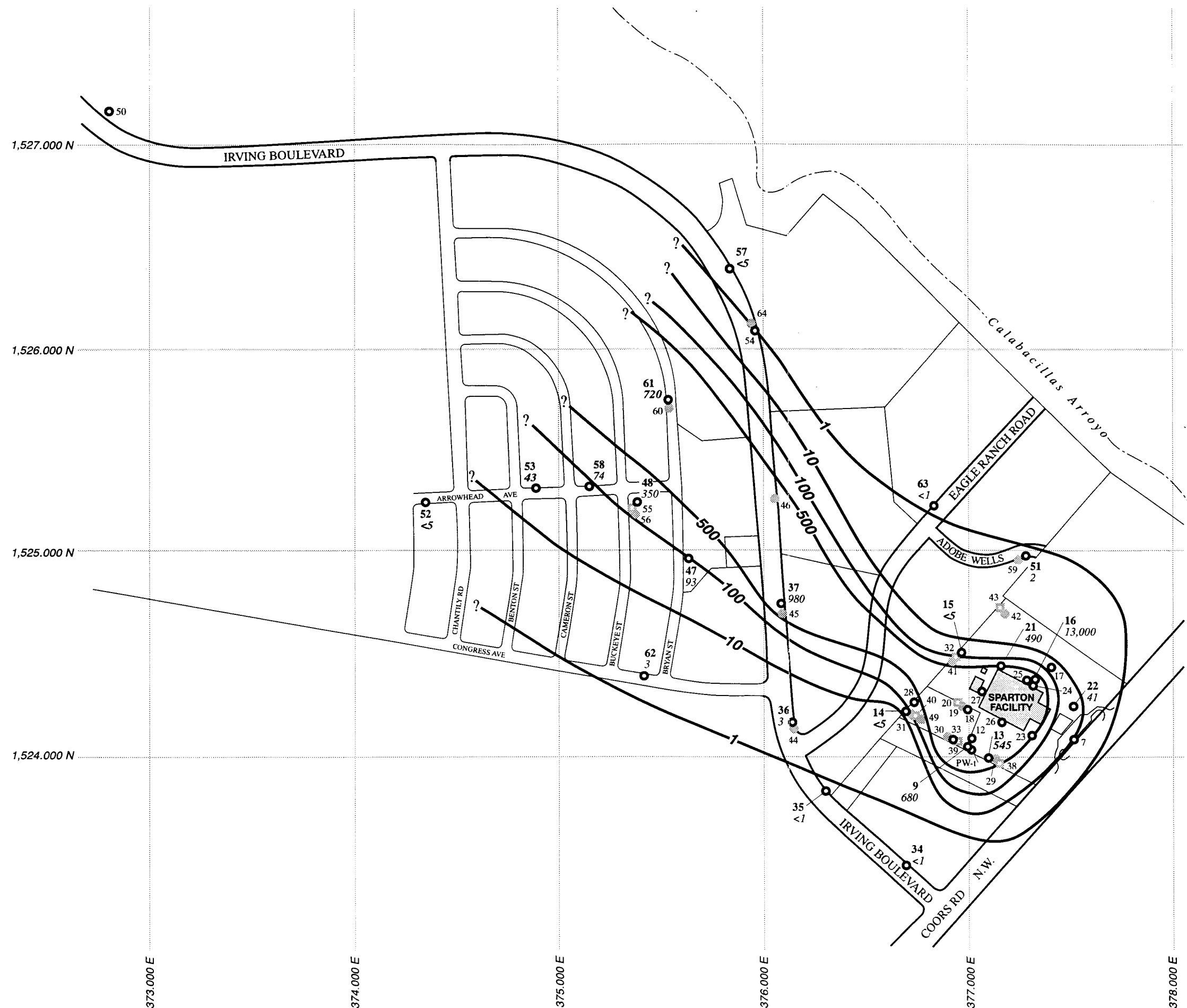
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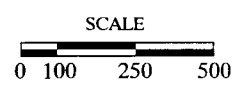
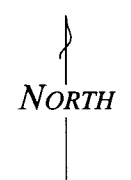


Maps and Cross Sections



LEGEND

- Upper flow zone well
 - Upper lower flow zone well
 - Lower lower flow zone well
 - Third flow zone well
 - 500— Line of estimated equal TCE concentration (µg/L)
- Well No. — 58 — TCE (µg/L) October 1993
- Well No. — 74 — TCE (µg/L) October 1993
- Well No. — 57 — TCE (µg/L) December 1994
- Well No. — <5 — TCE (µg/L) December 1994



Base redrawn from HDR Engineering Inc., and City of Albuquerque Zone Map pages B-12, B-13, C-12 and C13.

SPARTON TECHNOLOGY INC.
ALBUQUERQUE, NM

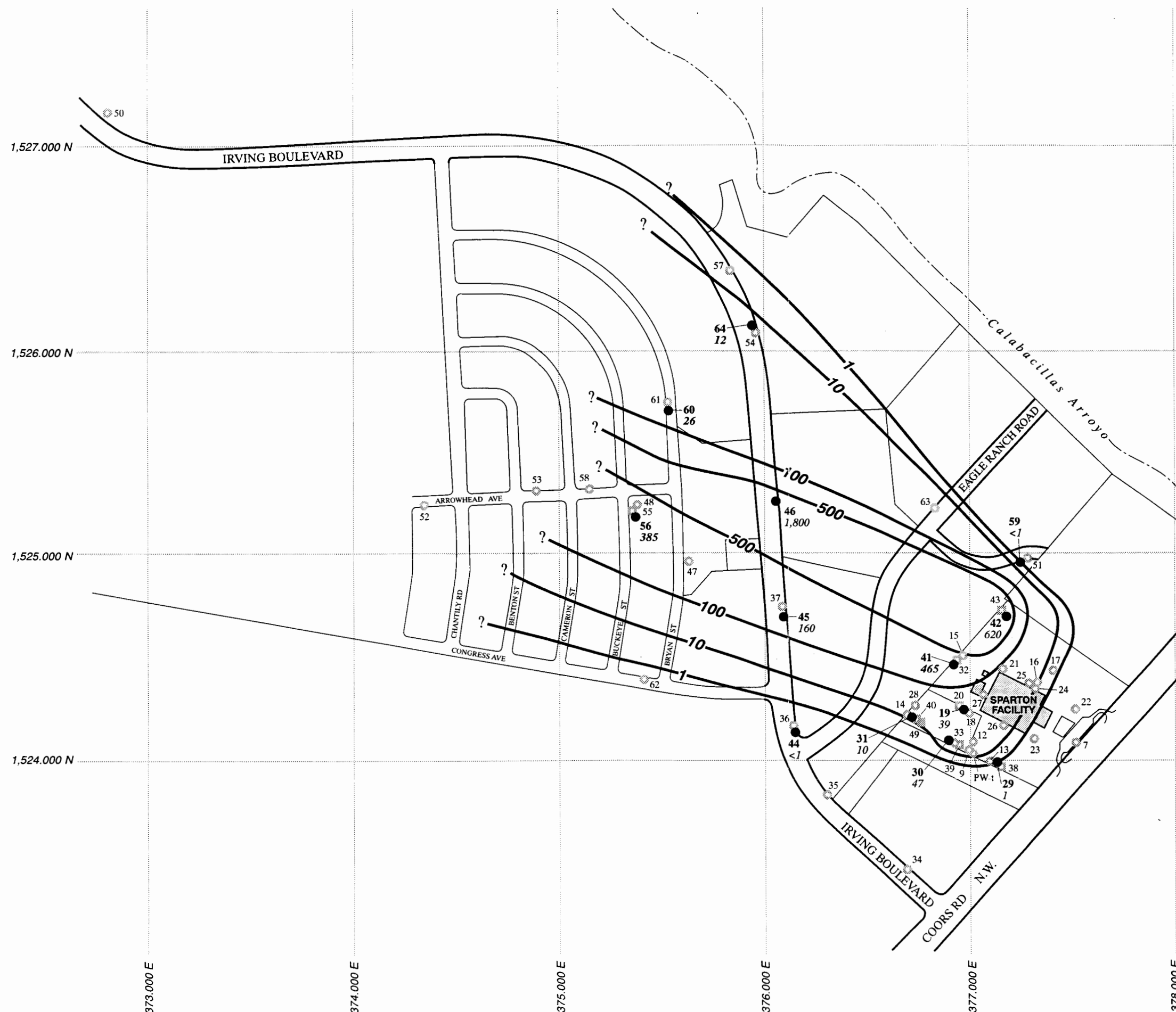
Upper Flow Zone
TCE Concentrations,
December 1993 and October 1994*

*the more recent data are shown

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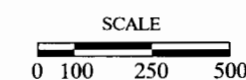
CH2M HILL

Figure 1



LEGEND

- Upper flow zone well
 - Upper lower flow zone well
 - Lower lower flow zone well
 - Third flow zone well
 - 500— Line of estimated equal TCE concentration (µg/L)
- Well No. 45
160 — TCE (µg/L) October 1993
- 56
385 — TCE (µg/L) December 1994



Base redrawn from HDR Engineering Inc., and City of Albuquerque Zone Map pages B-12, B-13, C-12 and C13.

SPARTON TECHNOLOGY INC.
ALBUQUERQUE, NM

Upper Lower Flow Zone
TCE Concentrations,
December 1993 and October 1994*

*the more recent data are shown

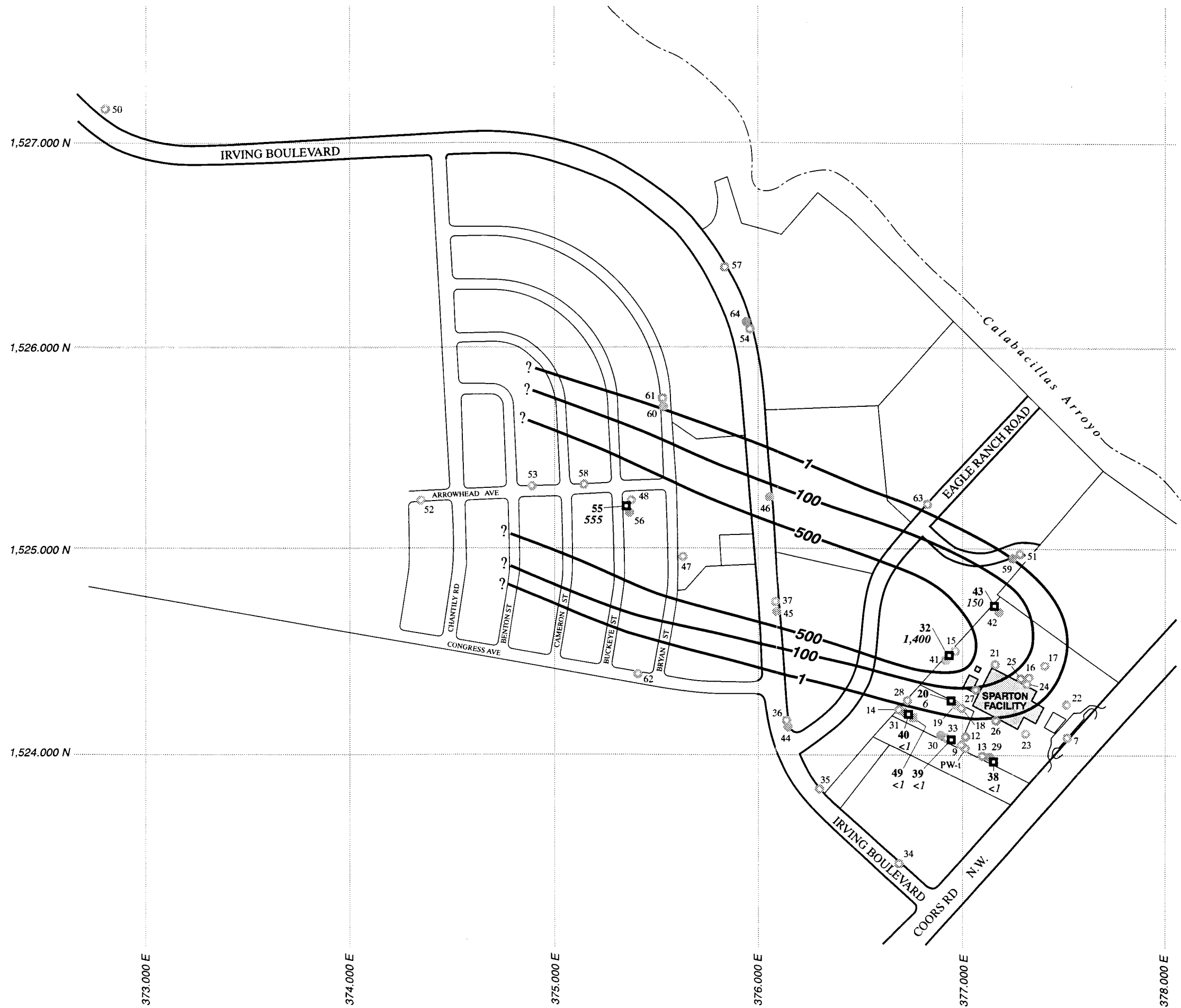
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File: UpLwFlw 1/96

Drawn by: JU
Date: 1/10/96

Approved by:
Date:

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Figure 2



LEGEND

- Upper flow zone well
- Upper lower flow zone well
- Lower lower flow zone well
- Third flow zone well
- 500 Line of estimated equal TCE concentration (µg/L)

Well No. 43 150 TCE (µg/L) October 1993
32 1,400 TCE (µg/L) December 1994



SCALE
0 100 250 500

Base redrawn from HDR Engineering Inc., and City of Albuquerque Zone Map pages B-12, B-13, C-12 and C13.

SPARTON TECHNOLOGY INC.
ALBUQUERQUE, NM

Lower Lower Flow Zone
TCE Concentrations,
December 1993 and October 1994*

*the more recent data are shown

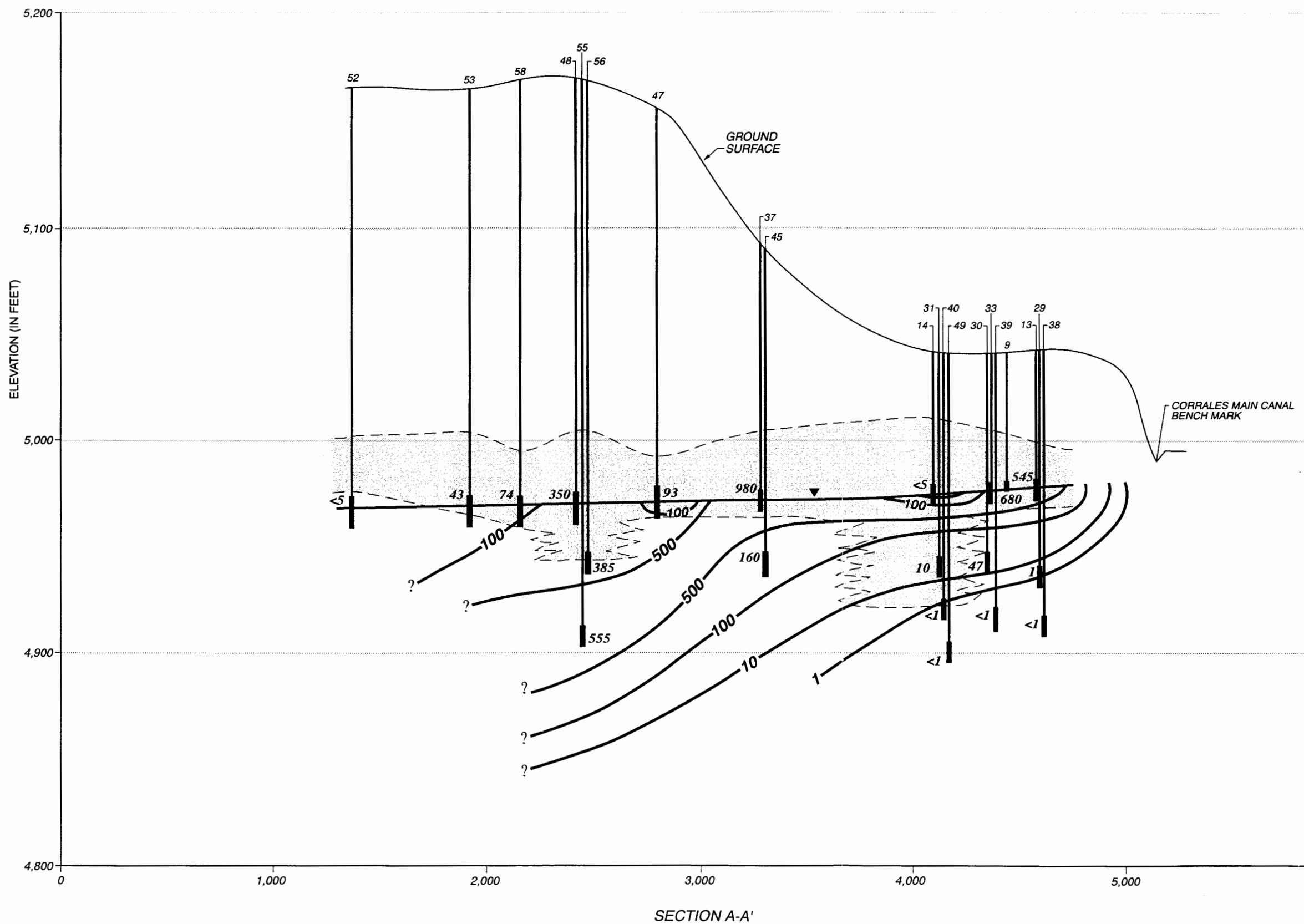
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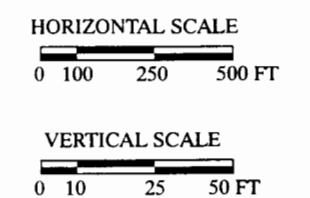
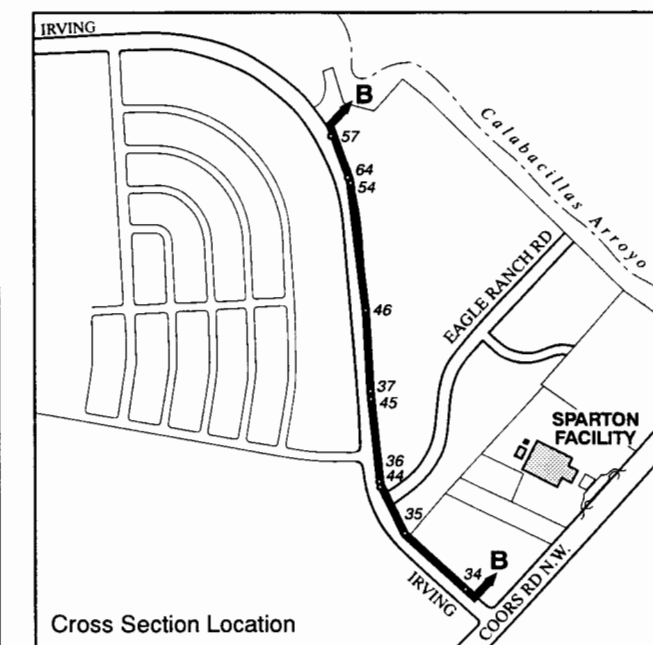
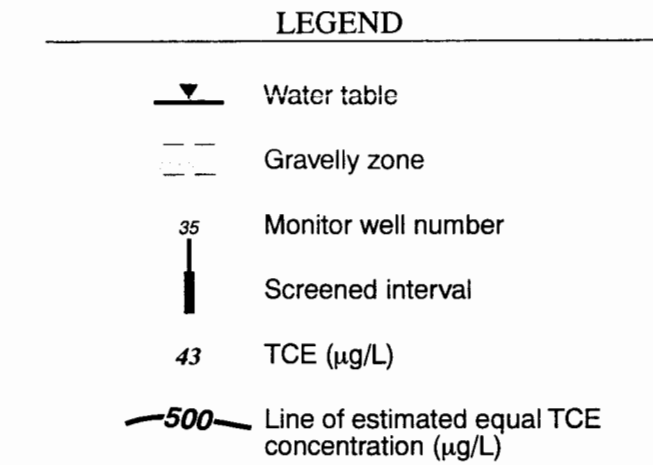
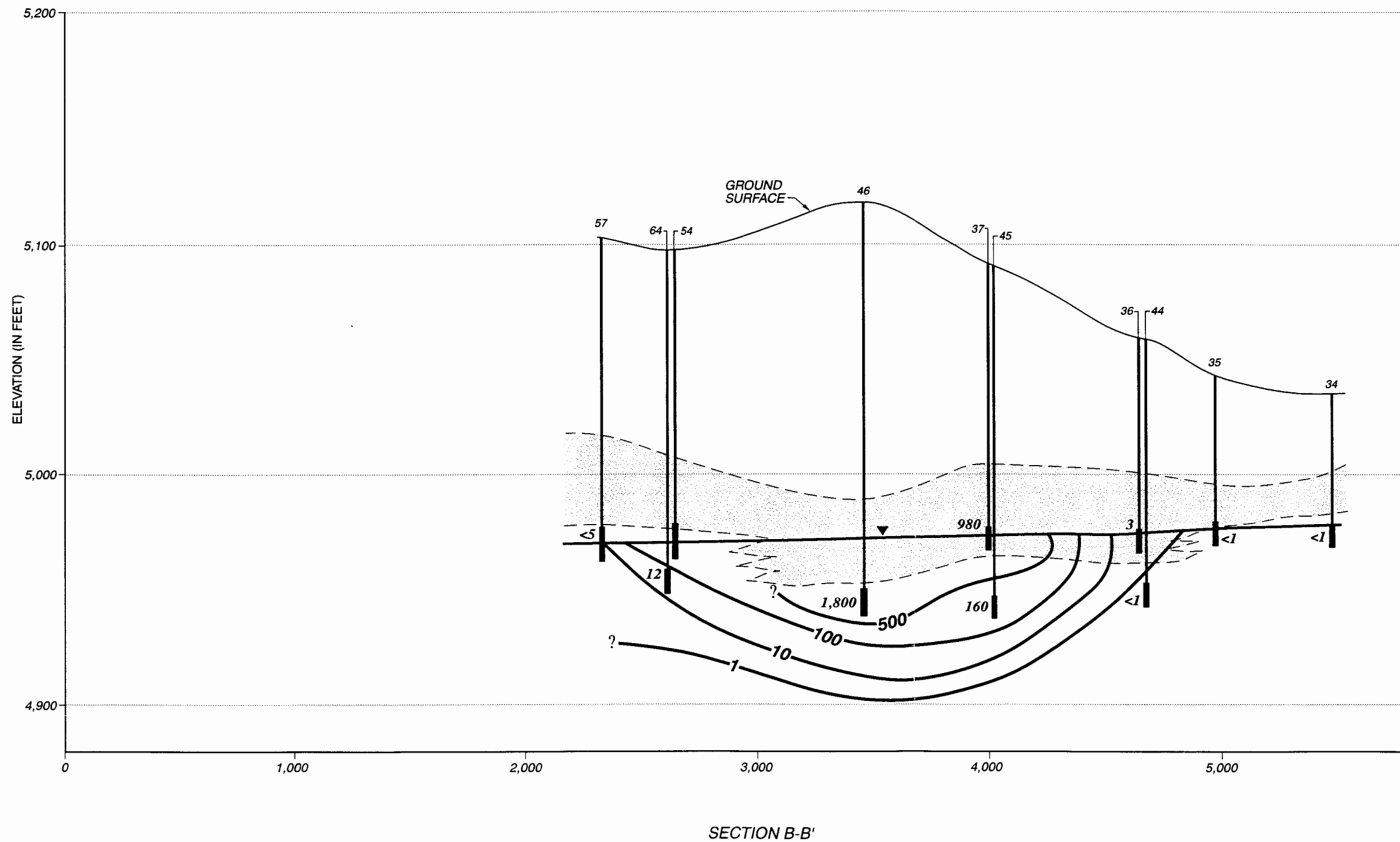
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Date:

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Figure 3





Cross-section and base map redrawn from HDR Engineering Inc.

SPARTON TECHNOLOGY INC.
ALBUQUERQUE, NM

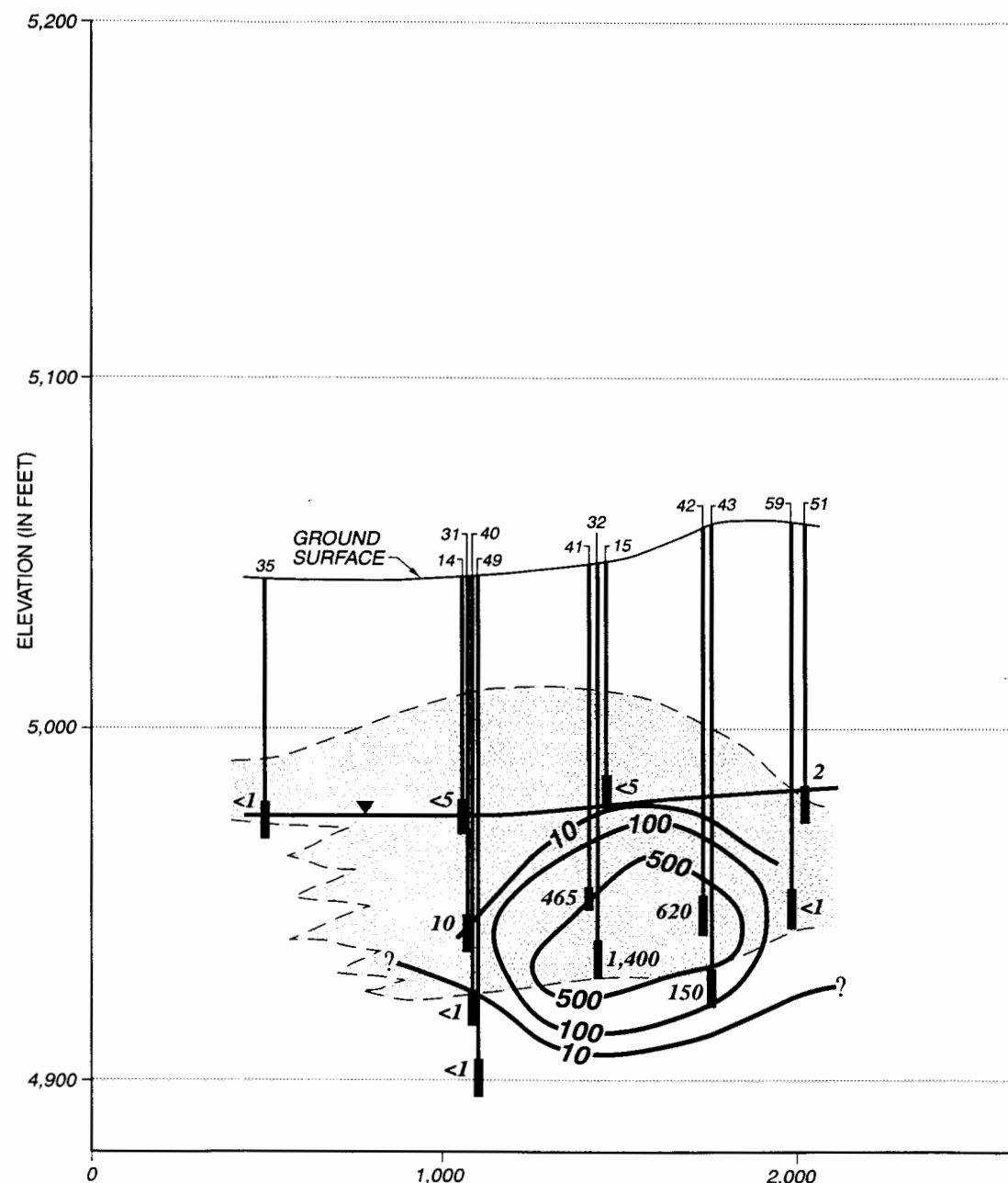
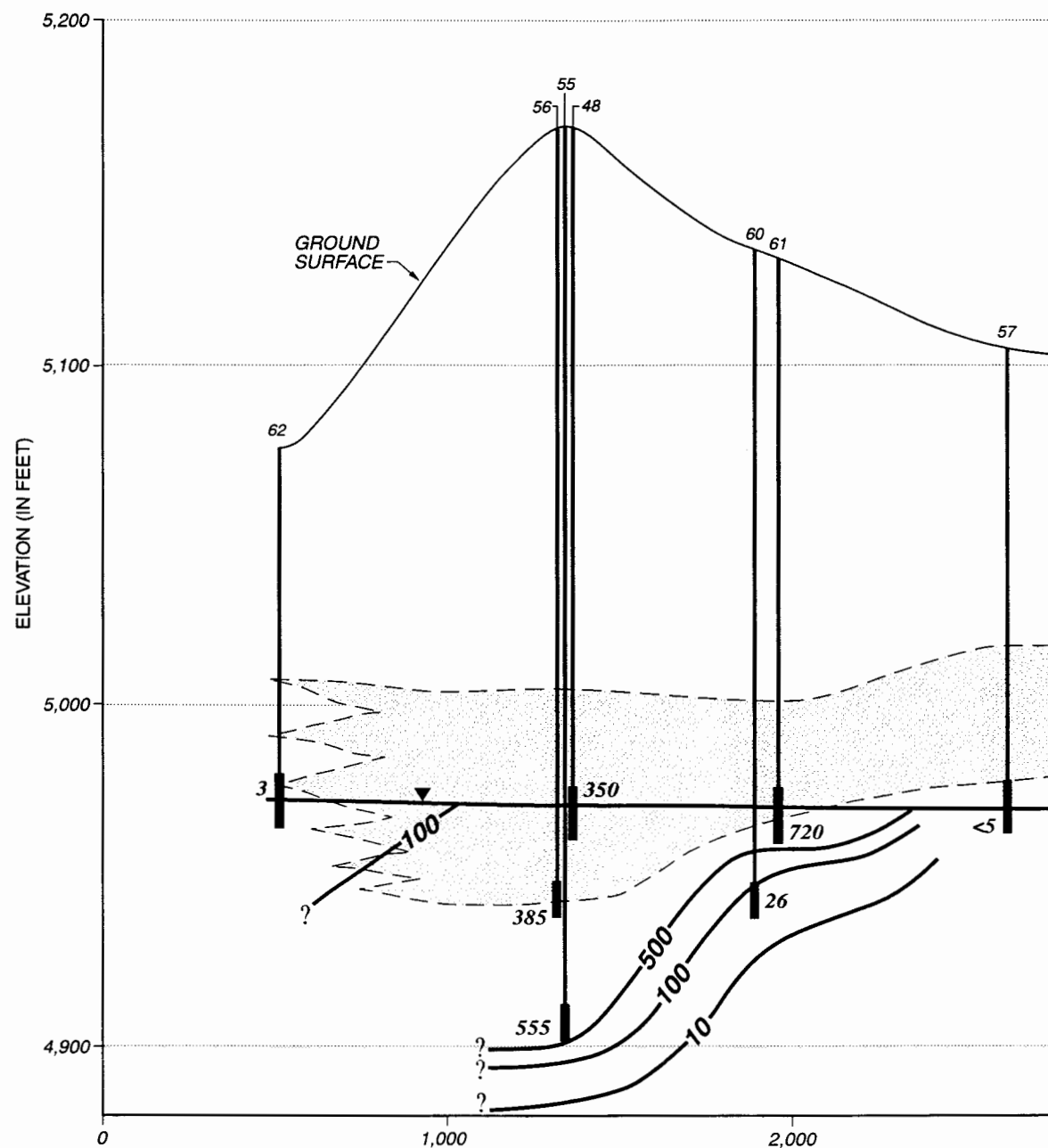
TCE CONCENTRATION PROFILE SECTIONS B-B'

MONITORING DATES: DECEMBER 1993 AND OCTOBER 1994*
***the more recent data are shown**

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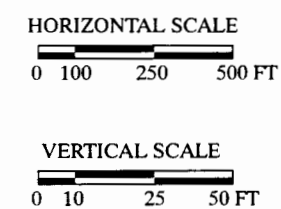
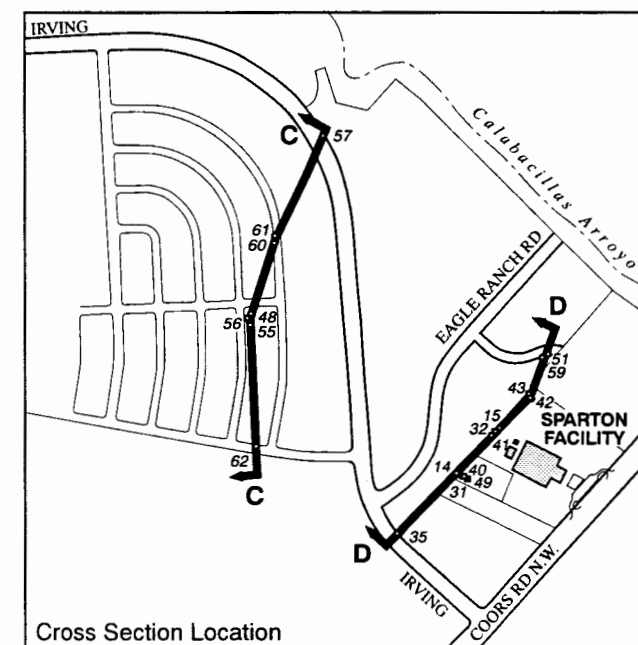
CH2M HILL

Figure 5



LEGEND

- Water table
- Gravelly zone
- 35 Monitor well number
- Screened interval
- 43 TCE ($\mu\text{g/L}$)
- 500 Line of estimated equal TCE concentration ($\mu\text{g/L}$)



Cross-section and base map redrawn from HDR Engineering Inc.

SPARTON TECHNOLOGY INC.
ALBUQUERQUE, NM

TCE CONCENTRATION PROFILE SECTIONS C-C' AND D-D'

MONITORING DATES: DECEMBER 1993 AND OCTOBER 1994*

*the more recent data are shown

Folder: Sparton Tech
File: X-S C-C' D-D'

Drawn by: JU
Date: 1/10/96

Approved by:
Date:

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Figure 6