City of Albuquerque
Public Works Department

MEMORANDUM

DATE: December 6, 1995

TO: Distribution

FROM: Norman Gaume

SUBJECT: Sparton Coors Road Facility

12345678910111213141516 DEC 1995 RECEIVED 2829303l

Attached is a copy of my letter to EPA regarding Sparton's November 6, 1995 report. Also attached is a copy of CH2M Hill's memo report to me. I used some of CH2M Hill's information in my response.

I think additional information should be placed on the record during the public comment period on the revised Statement of Basis. For example, we should comment on the necessity that treated water from the pump and treat system not be discharged to the river. Please contact me if you have suggestions regarding important elements of this case that I did not address in the attached letter.

Richard, if Bernalillo County Environmental Health Department is still interested in installing one or more monitoring wells, CH2M Hill's analysis gives me a clear idea where they should be installed. I would recommend a deeper well in the vicinity of MW-55, which is the deepest well in the main part of the plume, screened 100 feet below the water table, and containing 580 μg/L of TCE in the latest sampling. Additional wells might be installed about 700 feet downgradient of MW-61, which Sparton projects as the downgradient limit of TCE exceeding drinking water standards.

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City of Albuquerque
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PUBLIC WORKS DEPARTMENT

December 5, 1995

Mr. Desi A. Crouther
Chief, Hazardous Waste Enforcement Branch
Region VI
U. S. Environmental Protection Agency
1445 Ross Avenue, Suite 1200
Dallas, Texas 75202-2733

Telefaxed to (214) 665-7446 — Attn: Vincent Malott

Dear Mr. Crouther:

This letter responds to Sparton Technology, Inc.'s November 6, 1995, report transmitted by Thompson and Knight, attorneys and counselors, "reacting...to certain issues...raised by EPA" (hereinafter referred to as the Sparton Reaction). I request that this letter be made part of the public record for the revised Statement of Basis public comment period.

It is a fact that 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, five micrograms per liter (μg/L), underlies more than 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 μg/L (400 times the safe drinking water standard) have been measured in two off-site wells (wells 37 and 46). On-site TCE levels have been even higher, exceeding 17,000 μg/L.

The Sparton Reaction does not respond to these facts. Instead, it is a gross, blatant mischaracterization of the relevant contamination, hydrologic, water supply, and water resources management policy situation. Page after page, it consistently turns the truth upside down and as such is not worthy of a detailed, point-by-point response. Instead, this letter will respond to some of the Sparton Reaction's most egregious misrepresentations to show why the Sparton Reaction is not credible and should not be given any weight in EPA's cleanup and enforcement decision making.

I am responding for the City of Albuquerque in two capacities: as the City of Albuquerque Water Resources Manager, charged with developing plans for Albuquerque's long-term sustainable water supply, and as the City Chief Administrative Officer's designee and co-chair of the implementation committee for the Albuquerque/Bernalillo County Groundwater Protection Policy and Action Plan.

This response is organized in sections entitled with headings from the Sparton Reaction.

Sparton Reaction: "Value and Use of Groundwater"

The Sparton Reaction erroneously asserts (pages 1-4): "EPA is mistaken about the value and use of the groundwater impacted by Sparton's operations. In the Albuquerque area the sole-source of drinking water is not a regional aquifer....Public water supply wells are not threatened by the Sparton Plume...[nor are any]...planned for development within two miles of the Sparton Plume....The [City's] Water Management Options Study indicates that no public water supply wells will be developed in the Sparton area through the year 2060. The [New Mexico State Engineer Office] is considering establishing Critical Management Areas...[which]...would almost certainly prevent well development west of the Rio Grande (and particularly in the Sparton facility area)....Alternative existing renewable water resources are already available to the City....The Sparton Plume is **not** a crucial source of drinking water [emphases in original]."

Each of these Sparton Reaction quotations is an example of the truth blatantly turned upside down. In fact, the groundwater contaminated and threatened by Sparton is an extremely valuable natural resource. Here is the truth.

Groundwater produced from local wells is currently the sole source of drinking water supply in the Albuquerque metropolitan area. More than 500,000 people rely solely on groundwater for municipal, industrial, and private domestic water supply. In 1994, the City of Albuquerque pumped 123,000 acre-feet of groundwater to supply its 455,000 customers, who reside both within and without the municipal limits.

The City of Albuquerque in cooperation with Bernalillo County has developed and adopted the Albuquerque/Bernalillo County Groundwater Protection Policy and Action Plan (GPPAP), which is a comprehensive wellhead protection and source water protection plan for the local groundwater resource. The GPPAP, which has been formally adopted by the city and county governing bodies' unanimous votes, designates crucial areas for groundwater protection as those areas that are either especially vulnerable to contamination or are used or are planned to be used for drinking water supply. The Sparton facility and its contamination plume are within the designated crucial area. I am attaching a copy of the GPPAP and ask that it be included as part of the administrative record.

The Sparton Reaction criticizes the crucial area designation because "...there is very little ground in the vicinity of Albuquerque that is not crucial." This presumptuous denigration fails to recognize that: (1) good quality groundwater underlies "most of the ground in the vicinity of Albuquerque," (2) groundwater supply limitations increase its value and the importance of protecting it rather than the reverse as argued by the Sparton Reaction, and (3) the community that relies on this groundwater for its sole source of water supply, as represented by the specific action of its elected officials, says that within crucial areas, "Polluters should mitigate contamination they cause....The City and the County will seek the expeditious remedy of the pollution caused by the responsible parties" (GPPAP, page 49). It simply is not within Sparton's purview to represent that the groundwater they have contaminated is valueless, will not be used for water supply, and is unworthy of cleanup, because local government has expressly stated that its findings are exactly the opposite. Some of the reasons are described below.

Albuquerque is in the process of preparing its long-term water supply plan. I am managing that effort. A report entitled <u>Albuquerque Water Resources Management Strategy: San Juan-Chama Diversion Project Options</u> describes various conceptual options for augmenting local groundwater production with treated surface water, specifically including the City's 48,200 acre feet per year of imported San Juan-Chama project water. That report is also attached with the request that it be included as part of the administrative record.

The Sparton Reaction misrepresents the conclusions of this report. One of the most important conclusions is that groundwater must always remain the City's mainstay source of supply through the year 2060 and that as such <u>the aquifer must be protected.</u> There simply are no other sources available and even if there were, they would cost much more than local groundwater. All water supply planning scenarios rely on continued, sustainable groundwater production. Many options rely on enhanced recharge of the groundwater system to increase sustainable production levels. Sparton's contamination must be remediated such that it does not prevent limited groundwater resources from being used nor foreclose options for enhanced recharge and increased sustainable groundwater supply.

The City's current water supply master plan identifies the Sparton area as the location for a new well field serving the Corrales Trunk, an area that is outside the City's current service area. The Sparton Reaction cites the San Juan-Chama options report not simulating new City wells in this area as their evidence that the City plans no future wells in the area Sparton has contaminated. This statement ignores the study's clear statement that site-specific locations have not been identified for any of the project options and certainly not for the "conceptual future city water wells" which will be required regardless of the method selected for use of the City's San Juan-Chama water. Failure to contain and remediate the plume will certainly reduce the potential new well sites available to the City.

The New Mexico State Engineer Office has issued the report of a staff task force charged with recommending changes in groundwater pumping administration in the Albuquerque area. Their recommendations include establishing Critical Management Areas (CMA) within which no new wells would be allowed. Again, the Sparton Reaction turns the truth on its head. The attached map entitled "Proposed Critical Management Areas in the Albuquerque Area" shows that the Sparton area is outside of the proposed CMA. The Sparton area is located precisely where the task force recommends new wells be allowed; adjacent to the river. In contrast to the Sparton Reaction statement quoted at the beginning of this section, were it not for the Sparton contamination, the Sparton area would be a particularly attractive location for the new City wells that will be required. Wells could be permitted there, but not within most of the City's current groundwater production areas.

Attractive groundwater recharge enhancement and management opportunities that would increase sustainable ground production are endangered by the unremediated and spreading Sparton contamination. These opportunities are the focus of a major planning effort being conducted by the U. S. Bureau of Reclamation in cooperation with the City of Albuquerque. The final report of that study is in preparation. Chapter 5 — Applying aquifer recharge enhancement and conjunctive use concepts — of the report draft identifies "recharge window" areas having maximum recharge potential. These are areas where highly conductive materials exist from the land surface to the top of the Santa Fe Group, which includes the regional aquifer. According to the Bureau of Reclamation, "Calabacias Arroyo from Paradise Hills to its mouth is another area offering high [enhanced recharge] potential." This recharge window is located immediately adjacent to the Sparton contamination and the Sparton plume is moving toward it.

Failure to contain and remediate the plume will not only eliminate this opportunity for enhanced recharge, which is potentially one of the least expensive water resources management opportunities available, but also endangers the deep aquifer due to the contamination proximity to and movement toward a recognized recharge window. Areawide deep pumping has already created the vertical gradient to transport contamination downward.

Sparton Reaction: "EPA's perception of the importance of the Sparton Plume as a drinking water resource overlooks significant concentrations of naturally occurring arsenic"

Here too the Sparton Reaction misrepresents the truth. Sparton says "extrapolation of city data... suggest there should be an arsenic problem in the area where the Sparton Plume is located. For instance, the highest concentrations of arsenic in city wells (over

50 µg/L) occur on the west side of the Rio Grande..." Naturally occurring arsenic is indeed a problem in some Albuquerque locations. It is not a problem in the Sparton area as the Sparton Reaction misstates. In fact, Sparton monitoring data shows that naturally occurring arsenic concentrations at the Sparton site are among the lowest in the City. Arsenic would present a much, much lower long-term problem for the City if all its groundwater contained as little arsenic as the groundwater that Sparton has contaminated.

There are 27 wells for which arsenic measurements are presented in Sparton's RFI report. All were sampled at least twice. Twenty-one of these wells had non-detectable levels of arsenic (less than five µg/L) in one or both samples. Six wells had detectable levels of arsenic in both samples, and most of these values were less than eight µg/L. The highest levels of arsenic were measured in wells MW-36 and MW-37, located close to the source area. Arsenic in these wells was more than 30 percent below the arsenic drinking water maximum contaminant level in the first sample. At the second sample, arsenic was less than the detection limit on one well and almost 80% below the maximum contaminant level in the other. Perhaps the elevated arsenic is associated with Sparton contamination and not with natural occurrence.

Another example of the Sparton Reaction's misconstruing facts is their citation of the San Juan-Chama options report Figure C-38 as evidence of high arsenic. What this figure actually shows is that naturally occurring arsenic concentrations in groundwater nearest the Sparton contamination are the lowest in the City's current service area west of the Rio Grande.

Sparton Reaction: "By misunderstanding available data, EPA incorrectly calculated the rate of plume movement and mistakenly concluded the dominant transport mechanism is advection. EPA has incorrectly refused to accept that constituent concentration and constituent mass associated with the plume have substantially decreased since off-site sampling began in 1989"

Sparton claims that diffusion is the dominant contaminant transport mechanism. Although the areal extent of the contamination is unknown, it is clear the contamination is spreading rapidly. The dimensions of the plume are entirely conssistent with advection and dispersion driven transport mechanisms. If diffusion were the sole transport mechanism, the plume would be moving less than one foot per year. In reality, it has migrated over 2,500 feet. Calculations will be furnished upon EPA's request to substantiate these statements.

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 contamination to migrate faster than the rate predicted by the estimated average linear ground-water flow velocities (as the groundwater preferentially flows through lenses of materials with higher permeability); and some contamination 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.

The Sparton Reaction calculates plume velocities on the Sparton facility, at the west end of the plume, and in the area near MW-61. For these calculations Sparton assumes that K, the hydraulic conductivity, and n, the effective porosity, are constant. Yet repeatedly, they assert that the aquifer is very heterogeneous. Also inconsistently, Sparton criticizes EPA for what they claim is EPA's assumption that the aquifer is "homogeneous and isotropic". But, Sparton's assumption of a constant K and n, especially on the short distances covered by their analysis (less than 2500 feet), reflects the same simplifying assumption for which they criticize EPA.

Sparton focuses mainly on areal 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 values as high as 300 feet per year.

Regardless of these arguments, the contamination facts speak for themselves:

Sparton's reports estimate that contamination above drinking water standards has moved at least one-half mile off site and contaminant levels 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 730 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. However, the groundwater in this vicinity appears to be moving to the northwest at a rate of between 100 and 300 feet per year. If Sparton's 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 - 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 - 1991 to 74 µg/L in 1993.

The deeper wells 55 and 56 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 400 µg/L in 1994. The deeper well 55 has gone from 10.6 µg/L in 1989-1990 to 45 µg/L in 1991 to 580 µg/L in 1994. These are high levels of contamination and indicate that the plume is spreading deeper into the aquifer as well as moving rapidly horizontally.

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 at depths of over 100 feet beneath the water table and over 250 feet beneath the land surface. This is the deepest well in the main part of the off-site plume.

There no basis for Sparton's claim that contaminant mass is decreasing. They assert that contaminant concentrations are decreasing in most of the wells, but most of the wells are located close to the site where advection and clean-up have lowered concentrations. Sparton fails 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.

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 off-site 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 the unsubstantiated assertion that the contaminant mass is decreasing.

Sparton Reaction: "Any pump and treat remedy may be 'technologically impractical'"

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 contaminant transport process is largely advective and pump and treat methods are proven reliable ways to effect hydraulic control in this type of aquifer system.

In summary, groundwater 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. New wells are needed for water supply, regardless of the option(s) selected for supplementary conjunctive use of surface water. The existing water master plan designates the contaminated area for a future well field. Arsenic concentrations at the site are unusually low. The area is adjacent to existing and potential new groundwater recharge sources. Additionally, the area is in a relatively small area of the city where State Engineer Office staff recommendations would allow new wells to be drilled.

The existing contamination is spreading rapidly and lies on the path between the existing recharge areas at the river and the production wells to the west. Contamination is adjacent to a newly defined "recharge window." The contamination not only forecloses the opportunity to enhance recharge but also threatens to spread even more rapidly if it reaches the window.

EPA is requested to make enforcement of laws requiring containment and remediation of the Sparton contamination a regulatory priority.

Sincerely yours,

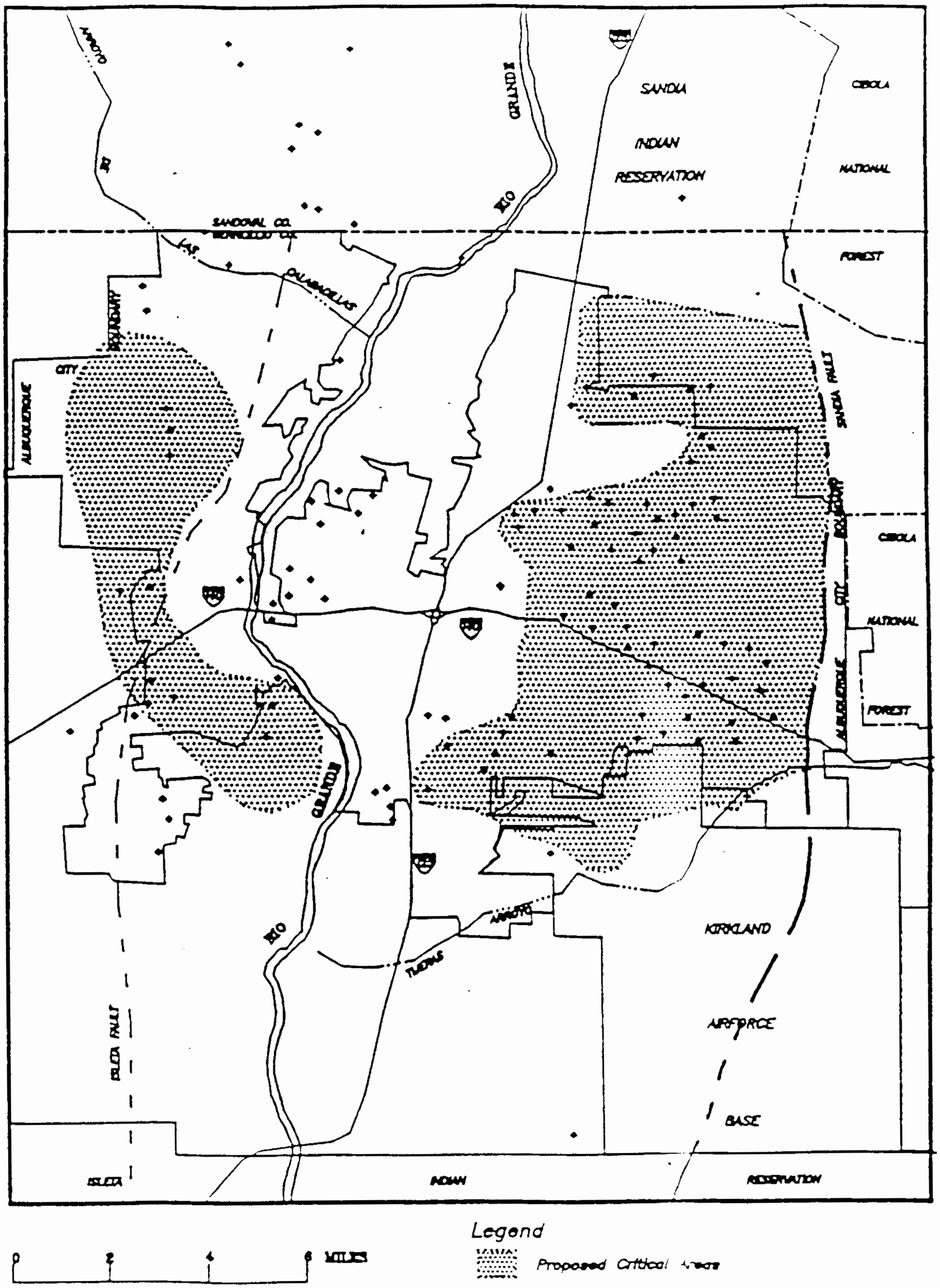
A. N. Gaume

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

c: Martin J. Chavez, Mayor, City of Albuquerque
Lawrence Rael, Chief Administrative Officer, City of Albuquerque
Juan Vigil, County Manager, Bernalillo County
Mark Weidler, Secretary, New Mexico Environment Department
William Turner, State of New Mexico Natural Resources Trustee
Robert E. Gurule, Director, Public Works Department

Attachments

Figure 1



Proposed Critical Management Areas in the Albuquerque Area

OGC-000210

GWB-00246-SPARTON

MEMORANDUM

CH2M HILL

TO: Norman Gaume/City of Albuquerque

FROM: Mike Bitner/CH2M HILL
Amy R. Halloran/CH2M HILL

DATE: December 4, 1995

SUBJECT: Sparton Technology, Inc. Coors Road Facility

PROJECT: 131048.A3.01

SUMMARY

Nature and Extent

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 (µg/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 µg/L (400 times the safe drinking water standard) have been measured in 2 off-site wells (wells 37 and 46). On-site TCE levels have been even higher, exceeding 17,000 µg/L.

Areal Extent. 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 off site and contaminant levels 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 730 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. 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. If Sparton's 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 - 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 - 1991 to 74 µg/L in 1993.

The deeper wells 55 and 56 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 400 µg/L in 1994. The deeper well 55 has gone from 10.6 µg/L in 1989-1990 to 45 µg/L in 1991 to 580 µg/L in 1994. These are high levels of contamination and indicate that the plume is spreading deeper into the aquifer as well as moving rapidly horizontally.

Vertical Extent. 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 at depths of over 100 feet beneath the water table and over 250 feet beneath the land surface. This is the deepest well in the main part of the off-site plume.

Review of Recent Documents

Sparton claims arsenic in the local groundwater 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 constant with advection and dispersion driven transport mechanisms. If diffusion were the sole transport mechanism, the plume would be moving less than one foot year and would not have migrated over 2,500 feet.

There no basis for Sparton's claim that contaminant mass is decreasing. They base this claim on the large number of on-site 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.

Introduction

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.

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 my molecular diffusion is small relative to the mechanical mixing caused by the dispersivity in the aquifer (Neuman at el., 1987). This mechanical mixing of contaminants occurs when the flowing groundwater 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 off-site 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.

Off-site 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 2500 feet) reflects the same simplifying assumption for which they criticize EPA.

CH2M HILL has compared groundwater 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, Va	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, Va	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 groundwater flow velocity is 39 to 94 feet per year (3.77 x 10-5 to 1.0 x 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 (C= 5 mg/l) the velocity due to diffusion would be much less that 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:

Ci (x,t) = C0 erfc [x/{2(D*t)1/2}]

Where Ci = the concentration at distance x and time t from the source,

Co = the initial concentration of the contaminant,

erfc = the complementary error function, and

D* = the apparent diffusion coefficient

If it is assumed that Ci/C0 = 0.5 (i.e. the concentration at point x at time t is half as much as the concentration at the edge of the plume), D* = 8.3 x 10-6 cm2/sec (as given by Cohen and Mercer, 1993, for TCE) then it would take approximately 1 year for the concentration 15 cm from the edge of the plume to equal one half of what the concentration at the edge of the plume was at the beginning of the year. Or, stated another way, if the concentration at the edge of the plume is 5 mg/l, then in one year the concentration 15 cm from the original edge of the plume will be only 2.5 mg/l if diffusion is the only transport mechanism. The ground-water flowrates presented in Sparton's Reaction are orders of magnitude greater than this diffusion rate. Therefore the predominant contaminant transport mechanism can not be diffusion.

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 contaminant 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 off-site 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 & Knights 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.

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. 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.

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 groundwater pumped from the City of Albuquerque wells exceeds 15 mg/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 mg/l.

Sparton also points out that three fourths of the City wells produce water with arsenic concentrations exceeding 5 mg/l. However, to date, the MCL for arsenic has not been lowered from 50 mg/l, therefore wells with arsenic values in excess of 5 mg/l but still below 50 mg/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%) had arsenic values below the method detection level during both sampling rounds and 8 (30%) 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 mg/l. The highest arsenic levels detected in any of the 27 wells were levels of 31 mg/l and 34 mg/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 mg/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 mg/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 mg/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.

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 off-site. For example, over the sampling period (approximately 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 off-site.

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" on-site and can therefore extrapolate their data to predict off-site conditions and plume migration. But, in the same document, Thompson & Knight have argued that off-site conditions are significantly different from on-site conditions, thereby causing a significant decrease in groundwater migration rates off-site. Because of these differences, mere extrapolation of the on-site 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 off-site 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.

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